THE RELATION BETWEEN BUILDING ASSESSMENT SYSTEMS AND BUILDING PERFORMANCE SIMULATION

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ABSTRACT: The aim of the paper is to reveal the relationship between building performance simulation and building assessment systems as a performance indicator.
The paper is part of an ongoing research project on developing a guideline for effective use of building performance simulation in design towards high performance buildings. The description of high performance buildings will be interpreted as sustainable (green) buildings and the assessment criteria of the level of performance will be evaluated by building assessment (rating) systems.
The expectations due to different rating systems are nearly the same based on global benefits, but may vary depending on the stage where they are going to be questioned during design process. Thus, the paper will describe both the design process stages and the stakeholders as decision takers who affect the future performance of the building.
By analysing current rating systems as a performance indicator, the available information necessary for assessment during design process will reveal the possibilities *(potential?)* of using building performance simulation as a support tool for getting high performance buildings.

Keywords – assessment systems, building performance simulation, high performance building, performance indicators.

1. INTRODUCTION:

Any building forms a system with a number of sub-systems, characterised by a large quantity of parameters that need to be considered during the design process. Traditionally, the design process involves multiple design and engineering disciplines, which design, analyse and optimise individual subsystems and their components separately. Nevertheless, all building component parameters are inter-related and affect each other. In order to optimise the dynamic interaction between different building systems and components, it is necessary to use an integrated design approach (Hensen, 2003). The recent trend called “whole building design approach” asks the members of the design and construction team to look at materials, systems and assemblies from many different professional perspectives. The design is evaluated for cost, quality-of-life, future flexibility, efficiency, overall environmental impact, productivity and creativity and how the occupants will be enlivened. The basic aim of “whole building design” is to create a successful high-performance building. To achieve that goal, it is necessary for the people involved in the building design to interact closely throughout the design process.

To assess design decisions and subsequently the building performance during the design process, building performance modelling/simulation tools become gradually more important. However performance simulation tools are usually used as a “performance confirmation” at the almost final stage of design. On the other hand, it became clear that basic design decisions during early design stages have higher benefits; considering the extend of the design process participants dedication and comparability of more than one design option towards high performance.

In order to query the performance issues during various phases of design process, this paper aims to reveal the relationship between building performance simulation (BPS) and the building assessment systems as a performance indicator. The answers to the questions below have been investigated:

- What are the current design rating systems for sustainable buildings?
- Could rating systems be helpful to structure a basis of high performance building design?
- When and how is BPS effective for performance assessments and design decisions?

The expectations due to different rating systems are nearly the same based on global benefits, but may vary depending on the stage where they are going to be questioned during design process. An extensive literature review has been carried out to describe both the design process stages and the rating systems approach to the future performance of the building. By analysing the current rating systems as a performance indicator, the available information necessary for assessment during design process has revealed the potential of using building performance simulation as a support tool for getting high performance buildings.

2. DEFINITIONS

In the literature, there are several terminologies used to define the performance characteristics of buildings. Different descriptions are made in their context to achieve high performance. The most frequently encountered terms are green building, sustainable building and high performance building.

National Renewable Energy Laboratory (NREL, 2005) made a description for high performance building as "…a high-performance building is a building that uses *whole-building design approach* to achieve energy, economic, and environmental performance that is substantially better than standard practice. Whole-building design creates energy-efficient buildings that save money for their owners, besides produces buildings that are healthy places to live and work. It helps to preserve our natural resources and can significantly reduce a building's impact on the environment." It is obvious that the explanation of NREL also includes the scores of green building.

Kibert, et al (2001) defined that a green building is the creation and maintenance of a healthy built environment based on resource efficient and ecological principles and they emphasised that the green building covers the definitions of high performance buildings, sustainable construction, ecological design and ecologically sustainable design.

Therefore whatever phrase is used, achieving high performance of buildings has a few basic benefits as to reduce the impacts of natural resource consumption, to improve the bottom line of costs, to enhance occupant comfort and health and to minimise strain on local infrastructures and improve quality of life.

In the paper, the context "high performance buildings" has been considered based on the conceptual frame explained above. Nevertheless, MacDonald (2000) emphasised that if one attempts to develop a definition of what a high performance building is, without also developing the metrics and approaches for assigning a performance rating, it will probably lead to quite extended development efforts. The process of developing the actual metrics and approach for obtaining a rating usually leads to insights into how performance should be defined. If the definition and metrics approach are not handled in tandem, serious problems with eventual use are likely to develop.

3. PERFORMANCE RATINGS AND BUILDING ASSESSMENT SYSTEMS

The *ASHRAE GreenGuide* (Grumman, 2003) defines green design as "…one that is aware of and respects nature and the natural order of things; it is a design that minimizes the negative human impacts on the natural surroundings, materials, resources, and processes that prevail in nature." Gowri (2004) interpreted this definition that it emphasised the need for a holistic approach to designing buildings as an integrated system. Green building rating systems transform this design goal into specific performance objectives and provide a framework to assess the overall design. Gowri (2004) highlighted that three major green building rating systems provide the basis for the various green building rating systems and certification programs used throughout the world.

3.1. Building Research Establishment Environmental Assessment Method (BREEAM)

BREEAM (Building Research Establishment Environmental Assessment Method) is by far the oldest building assessment system. Developed in 1988 by the Building Research Establishment (BRE), the national building research organization of the UK, it was initially created to help transform the construction of office buildings to high performance standards. BREEAM has been adopted in Canada, and several European and Asian countries (Kibert, 2003).

BREEAM assesses the performance of buildings in the following areas:

- *management*: overall management policy, commissioning site management and procedural issues
- *energy use*: operational energy and carbon dioxide (CO_2) issues
- *health and well-being*: indoor and external issues affecting health and well-being
- *pollution*: air and water pollution issues
- *transport:* transport-related CO_2 and location-related factors
- *land use*: greenfield and brownfield sites
- *ecology*: ecological value, conservation and enhancement of the site
- *materials*: environmental implication of building materials, including life-cycle impacts
- *water*: consumption and water efficiency

BREEAM has two categories; for "design & procurement assessment" at the beginning of the design process and "management & operation" assessment after it is in use.

3.2. Leadership in Energy and Environmental Design (LEED)

In North America, the U.S. Green Building Council (USGBC) developed the LEED rating system with a market driven strategy to accelerate the adoption of green building practices. The LEED rating system has gained a lot of momentum since Version 2.0 was released in March 2000. As of August 2004, about 1,450 projects have been registered for LEED certification (Gowri, 2004).

LEED is structured with seven prerequisites and a maximum of 69 points divided into six major categories which are listed below.

1. Sustainable Sites
2. Water Efficiency
3. Energy and Atmosphere
4. Materials and Resources

5. Indoor Environmental Quality
6. Innovation and Design Process.

LEED is still only used at the end of the construction process or design process for rehabilitation projects (LEED, 2005).

3.3. Green Building Challenge Assessment Framework (GB tool)

The Green Building Challenge is a collaborative of more than 20 countries committed to developing a global standard for environmental assessment. The first draft of the assessment framework was completed in 1998 and a spreadsheet tool (GBTool) was developed for participating countries to adapt the framework by incorporating the regional energy and environmental priorities (Gowri, 2004).

GB Tool provides a standard basis of comparison for the wide range of buildings being compared in Green Building Challenge. It requires a comprehensive set of information not only on the building being assessed, but also for a benchmark building for use in comparing how well the green building performs compared to the norm. GB Tool requires the group using it to establish benchmark values and weights for the various impacts (Kibert, 2003).

The basic difference of GBtool among others is to provide different assessments for every sub-phase of the design process.

3.4. Discussion

The wide variety in assessment criteria of the rating systems and different implementation phases during building process are the basic determinative of the selection of the effective system (Table.1).

Table.1. rating systems based on building process phases.

	BUILDING PROCESS →				
	Pre-design	Design	Construction	Operation	Renovation Demolishment
BREEAM	Design & Procurement Assessment			Management & Operation	
LEED			At the end of design process, construction process or design of rehabilitation		
GB-tool	Pre-design assessment	Design assessment	Construction assessment	Operation assessment	

Since buildings are so diverse, serving many different types of occupancies or functions, any attempt to develop a single system to define and rate performance of these buildings will not be perfect and will even be unsatisfactory for many potential users (MacDonald, 2000). Hence, it might be one strategy to at least define a flexible system that can have many possible configurations for dealing with the issues created by the diversity.

Mac Donald (2000) emphasised that; major issues related to who will be the users of such a rating system; how any rating results will impact actions of building owners, operators, and other building industry actors; how such abilities will be deployed and maintained; and how quality will be assured also exist. These and other wide-ranging issues must be considered during development of performance definition and rating methods, although abilities to adequately address them all will likely be limited.

On the other hand, inquirying the performance expectations during design process requires a decision support which could assist the designer while selecting the appropriate option among design alternatives. This is very essential particularly in the early design phases when options are diverse and the decisions are fuzzy. Hence, researches are held on redevelopment of implementation fields of the design decision supports as to meet with expectations during early phases of design. From this point of view, efforts are focused on searching the ways of enchancing the effective area of building performance simulations as a decision support tools towards high performance buildings.

4. EFFECTIVE AREA OF BUILDING PERFORMANCE SIMULATION IN THE CONTEXT OF RATING SYSTEMS

Since the early 1970's, building performance simulation programs have been developed to undertake non-trivial building (design) analysis and appraisals (Kusuda 2001). Dramatic improvements in computing power, algorithms, and physical data make it now possible to simulate physical processes at levels of detail and time scales that were not feasible only a few years ago. This enables contemporary software to deliver an impressive array of performance assessments (see e.g. Augenbroe and Hensen 2004, Hensen and Nakahara 2001, Hong et al. 2000). However at the same time, the ever increasing complexity of the real world built environment and the issues to be addressed (environmental for example) create barriers to routine application of building performance simulation in practice, mainly, in the areas of quality assurance, task sharing in program development and program interoperability (see e.g. Augenbroe and Eastman 1998, Bazjanac and Crawley 1999, Blis 2002, Bloor and Owen 1995, Crawley and Lawrie 1997, Eastman 1999), and because the use is mainly restricted to the final stages of the overall building design process. (Hensen, 2004).

Although there are many efforts held to overcome these barriers, it is an increasing awareness in design practice as well as in the building simulation research community that there is no need for more of the same. However there is definitely a need for more effective and efficient design decision support applications (Hensen, 2004).

Through implementing building performance simulations as decision support tools, it is obvious to consider the answers of the questions like: what is going to be decided?, when is the correct time for effective decisions?, what are the limitations?. If one would like to make people aware of the knowledge and skills to perform the simulations, it is essential to put the limits and needs of every design phase as a base for simulation abstraction and refer to the appropriate assessment tools. Hence, performance indicators assist for evaluation of the expected results with available knowledge capability.

Hitchcock (2003) defined that performance indicators (metrics) are intended to explicitly represent the performance objectives of a building project, using quantitative criteria in a dynamic, structured format. Performance Indicators (PI) can be used to more clearly and quantitatively define the performance objectives for a building. Documenting and communicating performance data can provide value across the complete life cycle of a building project, from planning, through design and construction, into occupancy and operation. Performance criteria are limited based on several assessment indicators for sustainability directly related with building performance simulation.

In Table.2, the indicators that can directly be obtained from simulation results are listed. There is no need to put a weight on the indicators to highlight their significance, as the weight for each building design might vary for the same performance indicators.

Table.2. Performance Indicators that are obtained from simulation results.

Performance Criteria	**Performance Indicators (PI)**		**Simulation Approach**
1. Energy	a. Heating energy demand		BES
	b. Cooling energy demand		BES
	c. Electricity consumption		BES
	d. Gas consumption		BES
	e. Primary energy		BES
2. Comfort	*A. Thermal*	f. Predicted Percentage Dissatisfied (PPD)	BES
		g. Max temperature in the zone	BES
		h. Min temperature in the zone	BES
		i. Over heating period	BES
		j. Local discomfort	AFN-CFD
	B. Indoor Air Quality (IAQ)	k. Contaminant distribution	AFN-CFD
		l. Ventilation efficiency	AFN
	C. Visual	m. Lighting level	DLA
	D. Acoustic	n. Reverberation time	AA
3. Cost	o. Investment costs		CA
	p. Energy costs		CA
	r. Life cycle costs		CA
4. Environmental Impact	s. Embodied energy		LCA
	t. CO2 emissions		LCA

Table.3. The match of rating systems criteria and BPS criteria.

Performance Criteria of BPS	LEED	BREEAM	GB Tool
1. Energy	**Energy and atmosphere**	**Energy use**	**Energy and resource consumption**
	* Energy performance	* Operational energy	* Electrical demand
2.Comfort	**Indoor environmental quality**	**Health and well being**	**Indoor environmental quality**
	* Daylight and views * Ventilation effectiveness * Thermal comfort	* Indoor and external issues	* Indoor air quality * Ventilation * Air temperature and relative humidity * Daylighting and illumination * Noise and acoustics
3. Cost	---	---	**Social and economic aspects**
			* Cost and economics
4. Environmental Impact	**Energy and atmosphere**	**Energy use**	**Environmental Loadings**
	* CO_2 emissions	* CO issues	* Greenhouse gas emissions
		Pollution	
		* Air and water pollution	

Performance criteria listed at Table.2 can be assessed by different kinds of simulation tools based on their abilities. "*1. Energy*" performance assessment can be held by "building energy simulations (BES)", "*2A. Thermal comfort*" by "building energy simulations (BES) and air flow network (AFN)", "*2B. Indoor air quality*" performance by "air flow network (AFN)", "*2C. Visual comfort*" by "daylighting analysis (DLA)", "*2D. Acoustic comfort*" by "acoustic analysis (AA)", "*3. Cost*" performance by "cost analysis (CA)" and "*4. Environmental impact*" performance by "life cycle assessment analysis (LCA)".

The comparison between the expectations of rating systems and the performance criteria which can be obtained from the results of building performance simulation shows that among many other criteria like urban design and site development, waste management, materials and transport; the issues directly related with *health*, *comfort* and *energy* can be questioned by building performance simulations (Table.2, Table.3).

Matching the rating systems criteria with the performance assessments by BPS listed above will show the integration possibilities of BPS to the rating system assessments. Table.3 shows the match of rating systems criteria and BPS. The further steps will be the exploration of the simulation integration based upon the simulation tool capabilities. An enhanced information of the rating systems intents and the possible simulation integration opportunities are listed in Table.4.a-b-c at Appendix.A. The tables include issues only related with energy and comfort as an exemplar.

5. CONCLUSION

The ability to define and measure building performance is a stepping stone to many other important goals, including performance improvement and recognition of good performance. The process of developing building performance definition and metrics approaches should be guided by the need to put reasonable limits on what metrics are expected to accomplish, in order to keep this important ability distinct and able to serve its purpose and also to not retard its development (MacDonald, 2000).

The research has been continued on the development of a guideline for effective use of building performance simulations in design towards high performance buildings. The rating systems analysis will be a basis for definition and expectations of high performance building. Revealing the limits of building performance simulation together with the effective implementation area will assist the designer who would like to use building performance simulations in decision support applications. Since, integrating BPS into the design needs to focus on the complexity level of BPS depends on design process requirements in each phase, the exploration of necessary information for design process phases and expected challenges and expected results of BPS should be the next step of the research.

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Appendix .A

Table.4.A. LEED categories intents and BPS integration possibilities.

BPS abilities / Rating system/category	**1. Energy simulation**	
LEED* Energy and Atmosphere	Minimum energy performance (Prerequisite 2)	
	Intent	*Simulation integration*
	Establish the minimum level of energy efficiency for baseline building	- model the energy performance relative to baseline building - identify the most cost effective energy measures
	Optimize energy performance (Credit 1)	
	Intent	*Simulation integration*
	Increase energy performance to reduce environmental impacts	- model energy performance to demonstrate that design energy cost is < energy cost budget
	Measurement and verification (Credit 5)	
	Intent	*Simulation integration*
	Provide for the ongoing accountability and optimization of energy and water performance	- model the energy and water systems to predict saving that will be compared with actual consumption

BPS abilities / Rating system/category	**2. Daylighting Analysis**		**3. Multizone Air Flow**	
LEED* Indoor Environmental Quality	Daylight and views (Credit 8.1)		Ventilation effectiveness (Credit 2)	
	Intent	*Simulation integration*	*Intent*	*Simulation integration*
	Provide a connection between indoor spaces and the outdoors via the use of daylight and views	- model the daylighting strategies to assess footcandle levels and daylight factors achieved	Provide for the effective delivery and mixing of fresh air to support the safety, comfort and well-being of building occupants	- include a table summarizing the air flow simulation results for each zone
			Thermal Comfort (Credit 7.1)	
			Intent	*Simulation integration*
			Provide a thermally comfortable environment that supports the productivity and well-being of building occupants	- establish temperature and humidity comfort ranges and design the building envelope and HVAC system to maintain these comfort ranges

* information from IBPSA educational presentation for engineers

Table.4.B. BREEAM categories intents and BPS integration possibilities.

Rating system/category \ BPS abilities	**1. Energy simulation**	
BREEAM Energy Use	Operational energy (E01-E03)	
	Intent	*Simulation integration*
	To reduce the dependency of the building on mechanical systems to provide thermal comfort conditions and so reduce energy and CO2 emissions and also the pollution aspects of systems use.	-model the energy performance strategies to predict the looses and gains in kWh/m2 according to the form and fabric of the building

Rating system/category \ BPS abilities	**4. Acoustic Analysis**	
BREEAM Health and Well-Being	Acoustic performance (HW10)	
	Intent	*Simulation Integration*
	To encourage adoption of good acoustic performance standards	-model the acoustic strategies testing to confirm that standards have been met on site

Rating system/category \ BPS abilities	**2. Daylighting analysis**	
BREEAM Health and Well-Being	Daylighting, lighting design and control (HW01-HW06)	
	Intent	*Simulation integration*
	-To improve the level of daylighting for building users -To ensure lighting has been designed in line with best practice for suitability and visual comfort	- model the daylighting strategies to assess that the building is adequately daylit. -model the lighting strategies to maintain the illuminance levels in each space

Rating system/category \ BPS abilities	**3. Multizone Air Flow**	
BREEAM Health and Well-Being	Thermal zoning and thermal comfort (HW07-HW08)	
	Intent	*Simulation integration*
	To ensure that thermal comfort is achieved and to encourage it to be optimized without resorting to mechanical systems.	Encouraging to use design tools to confirm that a thermal comfort assessment has been undertaken
	Ventilation and indoor air pollution (HW13-HW15)	
	Intent	*Simulation integration*
	-To provide sufficient, controlled and controllable ventilation for indoor air quality and health and hygiene	-Model the zone to confirm fresh air rates and naturally ventiated building criteria listed are met.

Table.4.C. GB Tool categories intents and BPS integration possibilities.

BPS abilities / **Rating system/category**	**1. Energy simulation**	
GB TOOL Energy and Resource Consumption	Electrical peak demand (B2)	
	Intent	*Simulation integration*
	To minimize the peak monthly electrical demand for building operations, especially where the grid is near peak capacity.	Model the electrical systems that average of peak monthly electrical demand for one year,, as predicted by means of an acceptable method or tool.
	Primary energy used (B1.2)	
	Intent	*Simulation integration*
	To minimize the amount of non-renewable energy used annually for building operations.	Model the building that MJ of delivered non-renewable energy per m2 of net area as predicted by means of an acceptable method or tool.

BPS abilities / **Rating system/category**	**2. Daylighting Analysis**		**3. Multizone Air Flow**	
GB TOOL Indoor Env. Quality	Daylighting and illumination (D4)		Ventilation (D2)	
	Intent	*Simulation integration*	*Intent*	*Simulation integration*
	-To ensure an adequate level of daylighting in all primary occupied spaces. -To ensure that lighting systems provide adequate illumination and quality levels in public and work areas.	-The predicted Daylight Factor in a typical occupancy area located on the ground floor of the building, as indicated by simulations. -Model lighting strategies that appropriateness of illumination levels and lighting quality to planned tasks	-To ensure that the number, placement and type of the openings in a naturally-ventilated building are capable of providing a high level of air quality and ventilation. -To ensure that mechanical ventilation and cooling systems are designed in a manner that will ensure a satisfactory level of air quality and ventilation.	-Model to conformance of the design to the requirements of a recognized relevant standard, such as ASHRAE or CIBSE. -Ensure, through the use of appropriate simulation programs, that the ventilation system in mechanically-ventilated non-residential occupancies will bring ventilation air to where it is needed,
			Indoor air quality (D1)	
			Intent	*Simulation integration*
	4. Acoustic Analysis		-Ensure that zones generating chemical pollutants, are separately ventilated and isolated from other occupied spaces. -To ensure that CO2 concentrations stay below acceptable levels in typical primary occupancy areas.	-Model that confirm measures taken to isolate areas or rooms where pollutants may be generated. -Model for HVAC systems that conform to ASHRAE, CIBSE or other acceptable protocol.
	Noise and acoustics (D5)		Air temperature and relative humidity (D3)	
	Intent	*Simulation integration*	*Intent*	*Simulation integration*
	-To ensure that primary occupancies are designed to ensure a satisfactory level of acoustic performance.	-Model acoustic strategies that predicted reverberation time in seconds, as indicated by design characteristics.	To ensure acceptable temperature and humidity control within established ranges per climate zone, to provide on-going monitoring of thermal comfort performance and the effectiveness of humidification and/or dehumidification system.	-Model to confirm compliance of mechanical ventilation systems with recognized design standards such as ASHRAE or CIBSE. -Predicted ability of natural ventilation systems to maintain temperatures within an acceptable range.

TOWARDS INCREASING THE ARCHITECTURAL DESIGN QUALITY IN COMPLEX BUILDINGS

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Abstract: The paper is based on the development of the main outline of a PhD research as a continuation project of a previous master research, which had the statement below:
"Today the solutions developed for space requirements are so far difficult than the solutions of the architectural space design alternatives. As the technological developments are placed in the every level of the building construction, the process of the complex building design - for instance hospital buildings- should be included interdisciplinary design team experts. In order to coordinate the team members to execute the design in the way of expected results, the design process itself should also be designed as well. Nevertheless designing the design process will provide to realize the problems in the beginning of the design process and to recover them early. "
As a starting point for future research the questions below about the term "architectural quality" will be discussed in the paper.
- What is the architectural design quality?
- What is the quality of design process?
- What are the main issues of architectural design quality in complex buildings such as hospitals?
- What are the effects of design process quality on architectural design quality?
Based on the literature review, the answers of these questions are disscussed in the paper. The outcome of the answers of the questions will reveal the main value drivers for the architectural design quality in complex buildings.

Keywords: complex buildings, design management, hospital design, quality, quality management

1. INTRODUCTION:

"Today the solutions developed for space requirements are so far difficult than the solutions of the architectural space design alternatives. As the technological developments are placed in the every level of the building construction, the process of the complex building design - for instance hospital buildings- should be included interdisciplinary design team experts. In order to coordinate the team members to execute the design in the way of expected results, the design process itself should also be designed as well. Nevertheless designing the design process will provide to realize the problems in the beginning of the design process and to recover them early. "(Harputlugil,2005)

In the master thesis having the statement above, a new decision making model in the design management perspective was offered for the outline design of the complex buildings such as hospitals. By the decision making model; the participants of the design and their roles were overlapped with the processes through the outline design of the complex buildings. Through the studies of the master thesis it was seen that the complex buildings including too many parameters for design and designing the design process has to be classified in the context of quality in order to define architectural design quality.

This paper is to define the research project goals that will be the basis of PhD study, to find the answers to increase architectural design quality in complex buildings by design management models. The paper contents are the definition of the problem, the methodology and the context of quality through all this design processes. The aim of the paper is to discuss these subjects and try to figure out an outline as a starting point of a PhD study titled "Towards Increasing The Architectural Design Quality In Complex Buildings".

2. DEFINITIONS OF THE PROBLEM:

2.1. Quality

"Quality is like politics, sex or religion. It is something everyone understands and is convinced that he does correctly. Few would like to explain it, and discussions on it are generally short and superficial, with one or other of the participants soon changing the subject through boredom or embarrassment. We all think we understand the subject, and are all convinced that our ways are right".(Cornick,1991)

Simply quality can be defined as the target that is intended to be reached. In the literature, there are several terminology used to define the term quality.

A quality system is a method of recognising, implementing, and recording good manners of action, and an agreement of their application.(Juola,2002)

Tim Cornick (1991) says that "…from the dictionary definitions of quality the notion of some level of excellence can be seen to arise. This is the definition that most people feel comfortable with it". Another definition he made refering to the European and International Standard for Quality Systems is that quality is "the totality of features required by a product or satisfy a given need". And the statement as a result of this definition that quality is either – fitness for purpose or – conformance to (meeting) requirements.

Therefore whatever the phrase is used, quality is defined as a standart for the defining the value. To define quality as architectural design and put out definite and universal criterias for measurement is amongst of this research's main goals. Architectural design quality will be discussed under the two titles as design and process quality below.

2.2. Design Quality

"Architecture depends on Order, Eurythmy, Symmetry, Propriety, and Economy"(Vitruvius,1993)

Design quality is an area that requires better understanding and which is difficult to measure(Whyte et al,2003)

"Perhaps it is because design problems are often so intractable and nebulous that the temptation is so great to seek out measurable criteria or satisfactory performance" (Lawson B. 1980)

Defining main value drivers for architecture has been the key questions for years. Since Vitruvius, every architect has different ideas about what the value drivers must be. Value drivers defined differently according to the era, technology, culture and the society. Definition of value drivers are important to define quality and will have a basis to compare quality terms in the context of architectural design.

According to the CABE(Commission for Architecture and the Built Environment-CABE, 2005), to define quality design, value drivers are needed. Main value drivers for the architectural design can be grouped under 3 main tittles which -they have subtitles- named build quality, functionality and impact.(DQI, 2005) (fig.1). As all the value drivers as theirselves describe the basic value, the intersection of two values defines the added value to the design. Finally Architectural design quality is defined as the intersection of these three value drivers.(fig.1).

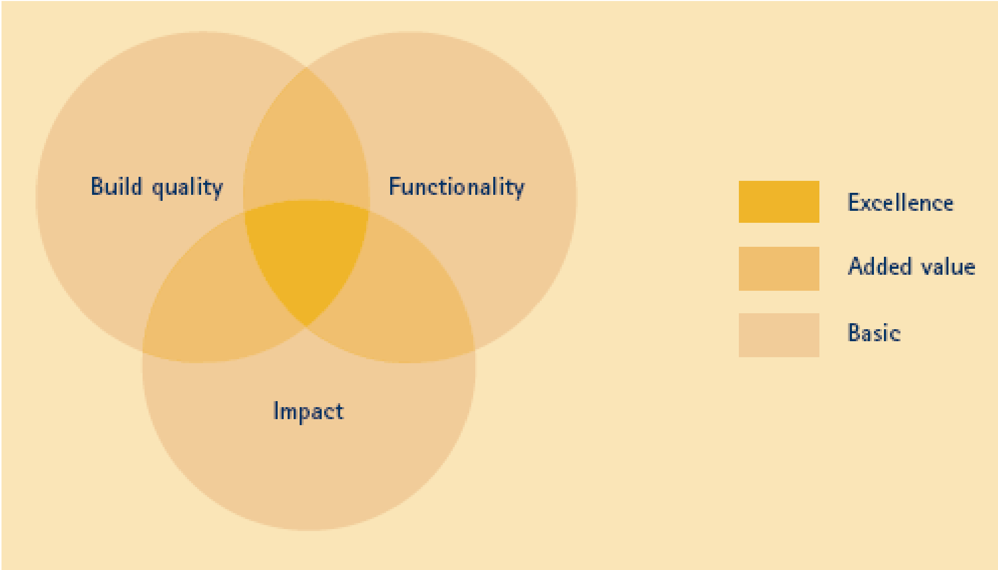

Figure 1.Architectural Design Quality(CABE)

The value drivers and their subtitles for the architectural design quality can be observed individualy in each type of buildings. The problem is who will assess the value and how it will be done. If the quality is the target intended, the realisation of the target expectations should be defined for each participant and process clearly. Therefore, defining the quality for whom and who will decide in which way is the basic problem that will be searched through this research. In order to clearify the definitions the questions below will be answered (Table.1).

Table 1.Defining Quality

Quality for whom?	**Quality how?**
User:	Spatial
Client:	Building material
Design team:	Time
Society	Function
Contractor:	Flexibility(etc.)

The assessment procedure and technique will be discussed in methodology section.

2.3. Process Quality

"Le Corbusier would have said that client, user, architect, engineer and constructor were all the same bu different."(Dickson,2003)
"Learning and developing a good design process is not an end in itself, but hopefully just a step towards producing better designs."(Lawson,1980)

The other important point of view during assesstments is to analyze the quality in design and construction processes. Design is not the sum of the processes which is only developed by the architects. The number of participants and the processes are directly proportional to the complexity of the building. As the complexity of the building increases, they increase as well. The design of the building and the construction processes are the subjects that should be considered during architectural design quality. Architectural design quality is a criteria for the constructed buildings and buildings in use. The point is the added value of the quality of design and construction processes to the quality of the whole building in use.

It is obvious that the quality of the design process does not bring the quality of the building as a whole. Nevertheless the total quality is related with the sum of the individual quality of the processes as well. It is obvious that the definition of the quality (fig.1) must be evaluated from different perspectives for the processes and design as a whole(fig2).

The basic point is questioning the effects of the sub components of the processes to the whole design quality in order to reach the total quality. For defining the quality of the processes, the indicators are needed. Through this research with the literature review different definitions of these indicators will be analyzed. Mainly the key performance indicators will be reviewed and the methodology will be examined with case studies. As a result performance of the indicators will be compared and if necessary new indicators will be developed.

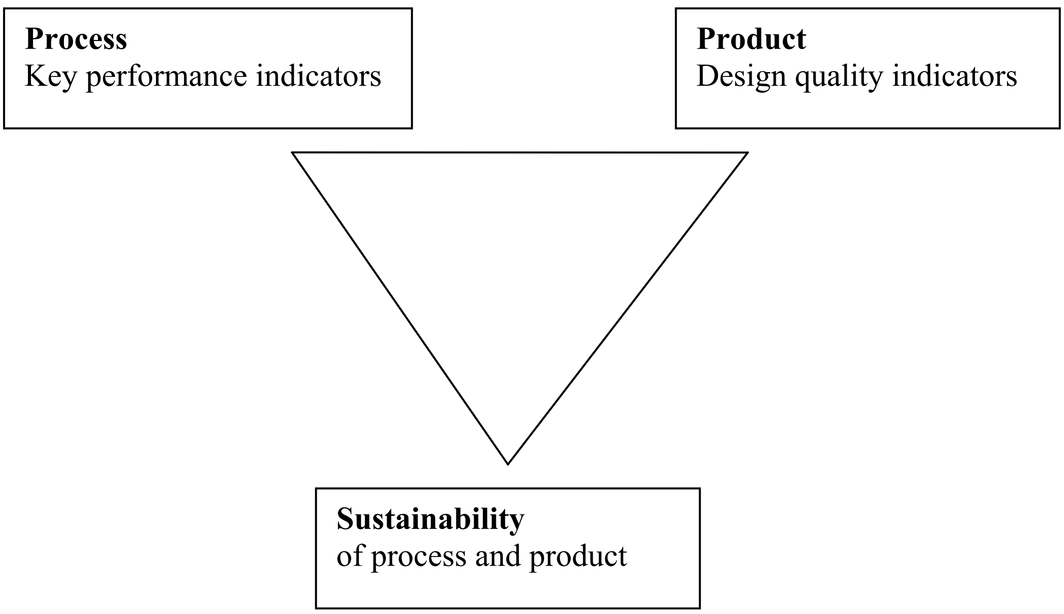

Figure 2. Process-Product and Sustainability(Prasad,2004)

2.4. Why Do Complex Buildings Need Quality?

“The problem is that buildings need to function in so many different ways. They are spatial and social, they function in terms of thermal environment, light and acoustics, they use energy and affect people’s health, they need to be constructed and are made of physical components that can degrade and need to be maintained. On top of all this they have an aesthetic and cultural role, as well as being financial investments and playing an important role in the economy. Almost all of these factors are interactive-decisions taken for structural reasons have impacts on environment or cost- but are often relatively independent in terms of the domains of knowledge that need to be applied. This gives rise to a complex design problem in which everything knocks on to everything else, and in which no single person has a grasp of all the domains of knowledge required for its solution.” (Penn A., Conroy R., Dalton N., Dekker L., Mottram C., Turner A.)

As the society and the social life develops, the spatial requirements change due to life style, needs and technology. The new definitions of the spatial requirements emerge by the time. Building gets more complicated as the number of the users, functions and needs for the spatial comfort increase. Design process of the complex buildings is much more complicated and takes much more time than the other buildings. The number of the participants of the design process is directly proportional to the complexity of the buildings. As the number of participants of the design process increase, an effective planning of design is vital for the quality. The discomfort of the whole building in usage process will be less if each of the design participants do his/her job effectively and also colloborate with other design participants through the design processes. Since the reasons told an effective planning through the design process and management is needed. As the complexity of the buildings increase the importance and need for management of the design is essential.

One of the reasons for this research is the lack of quality criterias in the decision making model offered in the master thesis, for the complex buildings which design processes were overlapped with the participants of design with an offered organization. So that this research study is to to make a step forward for the decision making model to bring out quality with the effective design management.

3. HYPOTHESIS

Under the consideration of all the statements above, the research question that will be discussed for PhD work is;

- What are the main issues of architectural design quality in complex buildings such as hospitals and the effects of design process quality on it?

Design of the complex buildings are composed of a number of different processes and different professions as participants. The quality of each individual process will bring the total quality of whole spatial design. Spatial quality is not only a functional or dimensional quality but whole quality of all considered parameters in each processes. Based on this idea, the proposed hypothesis is “The architectural design quality of complex buildings depends on not only the solutions of spatial requirements but also added values defined by the stakeholders as owners, design team members, users, etc. The total quality of architectural design should be inquired within the quality of each individual processes.”

Within this research this hypothesis will tried to be verified.

4. FUTURE METHODOLOGY

As methodology the quality criterias for the present buildings will be observed, the effects of them will be analyzed. In the analyzing period the indicators of the quality will be observed and pros and cons of them will be revealed. To reveal them; interviews and questionnaires will be made with the design participants and with the users (the doctors-the nurses-the patients etc.). The term quality will be defined for each of the users in different serving area of the hospital. All the interview and questionnaires will be placed in spider diagrams to compare the results. Thinking that spatial and aesthetic values are changable from time to time and technology, possibilities of creating a universal criteria for the architectural design quality will be searched. This research will be held in Türkiye where this PhD will be studied. Considering the changes in the result may vary from culture to culture and society to society, to have universial criterias for the architectural design quality and compare the changes in the societies, the same interviews and questionnaires will be tried to be applied in different countries. With the indications, the design management models with the case studies will be compared according to the success levels of the quality.

The aim of this research which will be the basis for PhD study is not only to increase the architectural design quality with the offered design management models but also discussing the present solutions of hospital architecture and bring out new spatial solutions in order to increase architectural design quality.

5. CONCLUSION (Preliminary Conclusion And Future Work)

As a result with this research it is aimed to find out new indication systems which will evaluate the complex buildings in the perspective of quality in universal norms from beginning of the design till the usage of the buildings. With these indication systems it is aimed to increase architectural design quality with the design management models which will be offered where all the participants of the whole design (the client-architects-engineers-professionals-etc) will agree and can be applied through all the design processes. Depending on the research, the new design managament model offered will be the adaptation of the present systems or a new one will be developed.

This research aims to define architectural design quality and increasing of it in complex buildings through offered design management models with all the design processes and aims to be the basis of the PhD study titled "Towards Increasing The Architectural Design Quality In Complex Buildings".

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VARIATION IN HOUSING DESIGN: IDENTIFYING CUSTOMER PREFERENCES

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Abstract: Housing suppliers in different countries are exploring ways to deliver high levels of customization in housing design. To produce this variety economically, it is important to know how customers prioritise the different parts of a house design. For parts with a great variety need several alternative solutions could be created in advance while parts with a low variety need can be produced as standard solutions for all homes, hereby taking advantage of economies of scale. This article presents the findings of a survey about the variation needs among potential buyers of new houses in The Netherlands. A priority listing of housing attributes in terms of variation need could be derived. This listing is of paramount importance for building developers who consider offering customised housing. Also the trade off relationship between customer value of variety and maximum price that can be asked for a customised housing proposition is examined. This article concludes with suggesting some future directions of research.

Keywords: customer preferences, house building industry, mass customisation.

1. INTRODUCTION

Companies are being forced nowadays to react to the growing individualization of demand. Previous studies have suggested that if companies want to meet these customers' needs overtime better than competition, they should offer a large variety of products (Dertouzos, 1989; Kahn, 1998; Mac Duffie et al, 1996; Stalk and Hout, 1990; Halman et al, 2003). More variety will make it more likely that customers find exactly the options they prefer. In considering the implementation of product variety, companies are also challenged to create this variety economically. Thus, making enterprises more customer centric efficiently has become a top management priority in most industries (Tseng and Piller, 2003).

Also in the housing industry one might notice an increasing demand for variety. Recent research about construction firms in countries such as Japan (Gann, 1996; Barlow et al, 2003, Noguchi, 2003), USA (Kendall, 1999), Great Britain (Ball, 1999; Ozaki, 2003;) and The Netherlands (Van den Thillart, 2004) shows that several firms are exploring ways to deliver high levels of customisation in housing design. This without increasing the price too much and losing the advantages of serial, project-wise, production (Wolters, 2001). To produce this required variety economically, it is important to know how customers prioritise the different parts and elements (such as bathroom, kitchen, roof type etc.) of a house design. For parts with a great variety need several alternative solutions could be created in advance. Potential buyers will successively select the one that best fits their own requirements. Parts with a low variety need however, can still be produced as standard solutions for all homes, hereby taking advantage of economies of scale.

Notwithstanding its importance, there is still a lack of knowledge when it comes to product choices that customers make in a mass customisation configuration (Dellaert and Stremersch, 2005). More specific, while interest in mass customised housing solutions becomes more widespread (e.g. Barlow, 1999; Barlow et al, 2003; Noguchi, 2003) still the prioritisation of housing attributes in house design customisation is unknown. This study therefore focuses on investigating how potential new home buyers in The Netherlands prioritise the different parts and elements in a house design from the perspective of getting a variety of alternative solutions to select from.

The structure of the rest of this article is as follows. In the research methodology section we explain the successive steps that have been followed in conducting a vignette based survey among potential new home buyers in The Netherlands. This section is followed by an analysis of the vignettes using Saaty's clustering method (Saaty, 1982). In addition to the vignettes, respondents also had to prioritise 35 housing attributes on the level of importance to get customised solutions. In the data analysis section the housing attributes are presented and sorted according to the relative importance of expressed customisation needs. In this section we will also present the relationship that has been found between the price offered for specific housing propositions and their appreciation effect on potential buyers of new houses. The housing attributes are further explored with factor analysis in order to verify the levels of housing decomposition found in literature. Finally in the last section, we will elaborate on the contributions and limitations of this research and suggest future directions of research.

2. RESEARCH METHODOLOGY

This study is based on empirical evidence drawn from a mail survey conducted in The Netherlands. A preliminary phase was spent defining our research objectives, conducting literature review as well as interviewing experts in the field of mass customised house building. After analysing current developments in the field of mass customisation in house building, the current research focused on exploring customers' priorities on variety needs in housing design. Based on the preliminary literature review and expert interviews, five levels of housing decomposition were identified. These levels are: Technical systems; Interior finish; Floor plan; House volume & exterior and; Environment; and they were used for structuring the first draft of our questionnaire.

2.1 Questionnaire design

Sometimes it is straightforward to measure priority judgements about a product or service. One can just ask the interviewee to select between two quality criteria. However, in complex decision making situations in which multiple options should be evaluated by customers, a vignette based questionnaire is preferred (Rossi, 1982; Govers, 1993; Wason et al, 2002). On a vignette, a personal or social situation is represented by some short descriptions. The descriptions comprehend the most important factors in the priority decision-making process and each description contains a well-defined stimulus component. Vignette-based studies are superior to direct-question-based studies because vignettes better approximate real-life decision making situations (Wason et al 2002). In our questionnaire design process, we followed the steps as suggested by Govers (1993): identification of relevant characteristics, creation of vignettes and collection and analysis of data. In our case the relevant characteristics consist of the five levels of housing decomposition as pointed out before. Choice alternatives at each of these levels increase customer value to some extent. The purpose of this study has been to elicit the relative weights of these choice alternatives. In this study vignettes are used to describe hypothetical housing propositions. These propositions are represented by the five levels of housing decomposition. Potential buyers of new houses had to score several vignettes with respect to the level they preferred this proposition. Table 1 outlines the levels of housing decomposition and the values linked with these levels (stimuli).

Table 1. Description of vignette characteristics

Level of housing decomposition	Value
A Technical systems	1 Choice 2 No choice
B Interior finish	1 Choice 2 No choice
C Floor plan	1 Choice 2 No choice
D House volume & exterior	1 Choice 2 No choice
E Environment	1 Choice 2 No choice

The respondents also had to score each hypothetical situation under different price conditions. This ensures that the price constraint is built into the choice experiment. A six-point semi-labelled rating scale was used for scoring the criteria (see "Appendix 1); this is a so-called forced-choice response scale. Such a scale forces the respondents to decide whether they lean more towards the "very good" or "very poor" end of the scale for each vignette. Figure 1 presents an example of a first-order vignette.

Vignette no. 1: Imagine the following housing proposition:

Participation in designing your future home <u>demands a lot of time, money and effort</u> from the customer as well as from the professionals such as the housing developer, architect and the construction company. Therefore: <u>the more variation is demanded, the higher the costs in general will become.</u> A standard home is a home that's offered without any variation.

\+ You will have **a say** about **technical systems (**such as the type of heating (wall or floor) and the number and location of the sockets, switches and water taps).
- You will have **no say** about the **interior finish** (such as the type of kitchen, washbasins and toilet, the floor - and wall finish and the door hardware (locks and latches).
- You will have **no say** about the **floor plan** (such as position and size of the living-, bed- and toilet rooms, kitchen and doorways).
- You will have **no say** about the **volume of the home and the exterior finish** (such as the size of the home, the type of roofing and the façade design).
- You will have **no say** about the **environment** (such as plot layout, parking lots and pavement of the neighbourhood).

1 = I evaluate this housing proposition as very good,
6 = I evaluate this housing proposition as very poor

Fig. 1. Example of a first-order vignette

A first order vignette defines one negative statement and four positive statements. A second-order vignette defines two negative statements and three positive statements, and so on. Maximizing the number of vignettes to be judged weighted against the respondents' time and concentration. Therefore it was decided to present to each respondent ad random sets of ten vignettes. Respondents evaluated a total number of 15 vignettes. In addition to the vignettes we included 35 attributes in the questionnaire. These attributes are related to the five housing decomposition levels. For each attribute respondents were asked to score the relative importance to be involved in the housing design process.

2.2 Data collection

After constructing the questionnaire it was pilot tested within a group of four experts and ten non-experts. The group evaluated each question for clarity, specificity and representativeness. After small improvements the first draft was made ready to be sent out. The sampling frame consisted of 304 potential buyers of new houses. Their addresses where obtained with the help of a large Dutch real estate office. First we sent a letter to all 304 potential customers. In this letter we explained the meaning of the research, and we notified the respondent about a confirmation call a week later, to ask whether or not the respondent was willing to participate. Second, phone calls were made to each potential respondent. About 110 customers were reached to whom the meaning of the research was clarified. We also informed them that the survey would be anonymous; 86 persons agreed to participate while 24 refused. The sampling frame consisted of 304 potential buyers of new houses minus the 24 persons who refused to participate. This resulted in 82 respondents, giving a return rate of 27 percent, which is about average for a postal survey. The sample population represents the group of potential buyers of new single-family homes in the province of Utrecht in The Netherlands. Buyers of other homes such as apartments were not included within our sample population. To test our research for non-response bias, 20 non-respondents were shortly interviewed. The test did not show significant consequences of non-response for our survey estimates. The confidence interval of the survey results is 0.1 and the confidence level is 0.95. This means that the survey results approximate the true populations' mean with a confidence level of 0.95 and a confidence interval of 0.1.

2.3 Data Analysis and Results

After data collection we performed three types of data analysis. First we determined for the five levels of housing decomposition how customers prioritise these levels in terms of having a say in the design decision making process. The relative weights were calculated by using Saaty's clustering method (Saaty, 1982) for the respective vignettes. In a next step we determined the relative importance of expressed customisation needs for the 35 housing attributes that were included in this study. Finally we performed a regression analysis to determine the trade off between the potential price that can be asked for specific customised housing propositions and their effect on the way how potential buyers (re)evaluate such propositions.

Allocation of weights

To calculate the relative weights assigned by customers to the five levels of housing decomposition, we applied as explained before, Saaty's clustering method (Saaty, 1982). Clustering is a way to improve the consistency of estimations, in case respondents have to evaluate many or complex options. Besides this, clustering can dramatically decrease the number of estimations needed. The next procedure was followed (see also table 2):

- i = a, b…e, this is the first-order vignette with a variance of attribute i;
- ij = (a..e)(a..e) this is the second-order vignette with a variance of attributes i and j;
- In
- *Table 2* the varied attributes are indicated by a + sign.

Table 2. Weighting method for calculating priorities

	Attribute (i)					Vignet (ij)	Mean score	Normalized mean score		Weights				
	a	b	c	d	e		step 0	step 1		a	b	c	d	e
1st order vignettes	+					a	0,88	0,03		0,03				
		+				b	1,94	0,08			0,08			
			+			c	1,7	0,07				0,07		
				+		d	2	0,08					0,08	
					+	e	0,91	0,04						0,04
						Average weight 1st order vignettes				12%	26%	23%	27%	12%
2nd order vignettes	+	+				ab	2,35	0,09		0,003	0,007			
	+		+			ac	2,15	0,08		0,003		0,006		
	+			+		ad	1,72	0,07		0,002			0,005	
	+				+	ae	1,15	0,05		0,002				0,002
		+	+			bc	2,27	0,09			0,007	0,006		
		+		+		bd	2,28	0,09			0,007		0,007	
		+			+	be	1,62	0,06			0,005			0,002
			+	+		cd	1,7	0,07				0,004	0,005	
			+		+	ce	1,33	0,05				0,004		0,002
				+	+	de	1,35	0,05					0,004	0,002
						Total	25,35	1	step 3 (w_i)	0,010	0,026	0,020	0,022	0,008
						Average weight 2nd order vignettes (w)				12%	30%	23%	26%	9%

Attribute (i)		
a	technical systems	+ customer has voice in specific attribute (i)
b	interior finish	
c	floor plan	
d	house volume & exterior	
e	environment	

Step 0: The mean score of the first order vignettes S_i and second order vignettes S_{ij} are derived from the individual customer scores.

Step 1: The normalized mean score S_i and S_{ij} is calculated by $S_i/(\sum S_i + \sum S_{ij})$ and $S_{ij}/(\sum S_i + \sum S_{ij})$. The normalised scores are denoted by respectively $\hat{S}_i$ and $\hat{S}_{ij}$.

Step 2: The normalised attribute-scores $\hat{S}_i$ are multiplied by the matching normalised attribute-scores $\hat{S}_{ij}$ for the scores with corresponding $i = a, b, .., e$.

Step 3: The weights w_i are calculated by $w_i = \sum_{j=a}^{e} \hat{S}_i \hat{S}_{ij} / n$ for $i = a, b, .., e$. The final priority vector w is calculated by normalisation of w_i : $w = w_i / \sum_{i=1}^{n} w_i$

The customers’ weights from table 2 are illustrated in figure 2. As can be concluded from this figure, customers evaluate the interior finish as the most important level of housing decomposition; it has a weight of 30%. Floor plan and the volume and exterior of the home have a weight of respectively 23% and 26%. The environment and technical systems are the least important levels with a weight of respectively 9% and 12%. The homogeneity of the participation levels has been measured by Cronbach’s alpha (0.7933). This Cronbach’s alpha is sufficient to confirm the five levels of housing decomposition as a subscale.

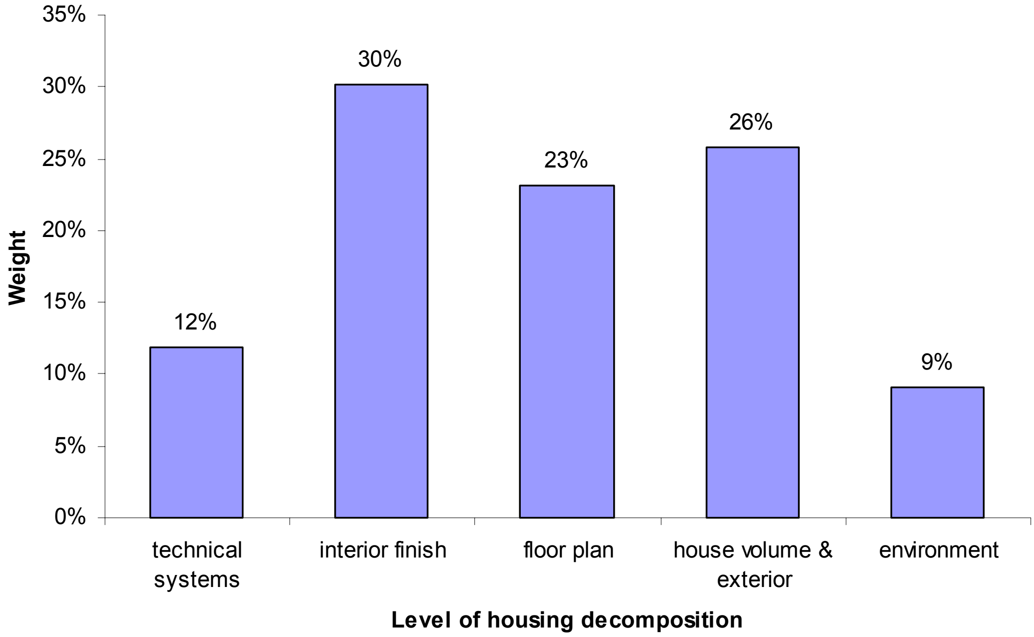

Fig. 2. Customer priorities in levels of housing decomposition

Relative importance of housing attributes

A characteristic of a hierarchy is that it consists of levels. The five levels of housing decomposition together form the highest hierarchy in this study. These levels were further decomposed into 35 housing attributes. Besides evaluating the proposed vignettes, respondents were also asked to score the relative importance of each housing attribute on their value of offering a customised solution. Figure 3 shows the 35 attributes sorted according to the relative importance for potential buyers of new homes of getting customised solutions.

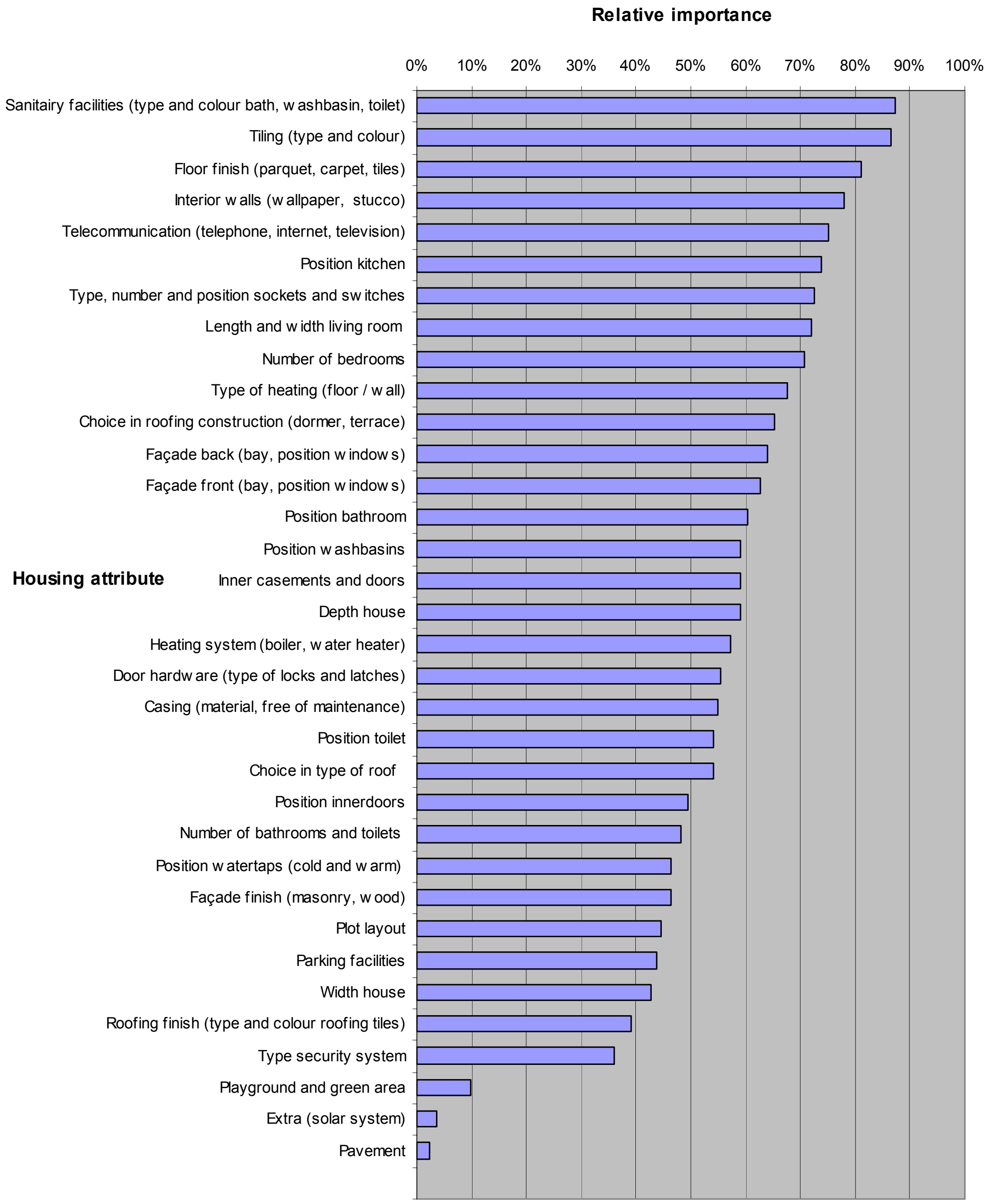

Fig. 3. Housing attributes: Relative importance for potential buyers

The attributes with the highest relative importance appear to be part of the level of housing decomposition "Interior finish" while the five least important attributes, except for the attribute roof finish, belong to the level "Environment".

Trade off between price and added value of customised solution

Respondents also had to rank each housing proposition under different price conditions. This allowed us to estimate the trade off between the price asked for a housing proposition and the added value from the perspective of the potential buyer. Figure 4 illustrates this price-value elasticity for the five distinguished levels of housing decomposition. The curves in figure 4 were determined by interpolation of our data. Using the regression analysis method we noticed that our data show an exponential fit; where the intercept was fixed at 0. Since the respective equations (see table 3) all show great resemblance, we assume the trade-off between price and customer-value to be similar for all five levels of housing decomposition.

Table 3. Regression model of Price - Customer Value trade off

Level of housing decomposition	Equation trend lines	R-squared
House volume and exterior	y = 4,3281e-4E-05x	R2 = 0,9966
Interior finish	y = 4,2881e-4E-05x	R2 = 0,9929
Floor plan	y = 4,0094e-4E-05x	R2 = 0,9998
Environment	y = 2,8164e-5E-05x	R2 = 0,9833
Technical systems	y = 3,3019e-6E-05x	R2 = 0,9626

In our questionnaire we further asked for the maximum amount of money a customer was willing to pay for the housing proposition that would best fit his or her needs. The results show that averagely a customer is willing to pay € 23.333 extra for the perfect housing proposition compared to a house in which no variation is offered. This amount is represented by the vertical axis in figure 4.

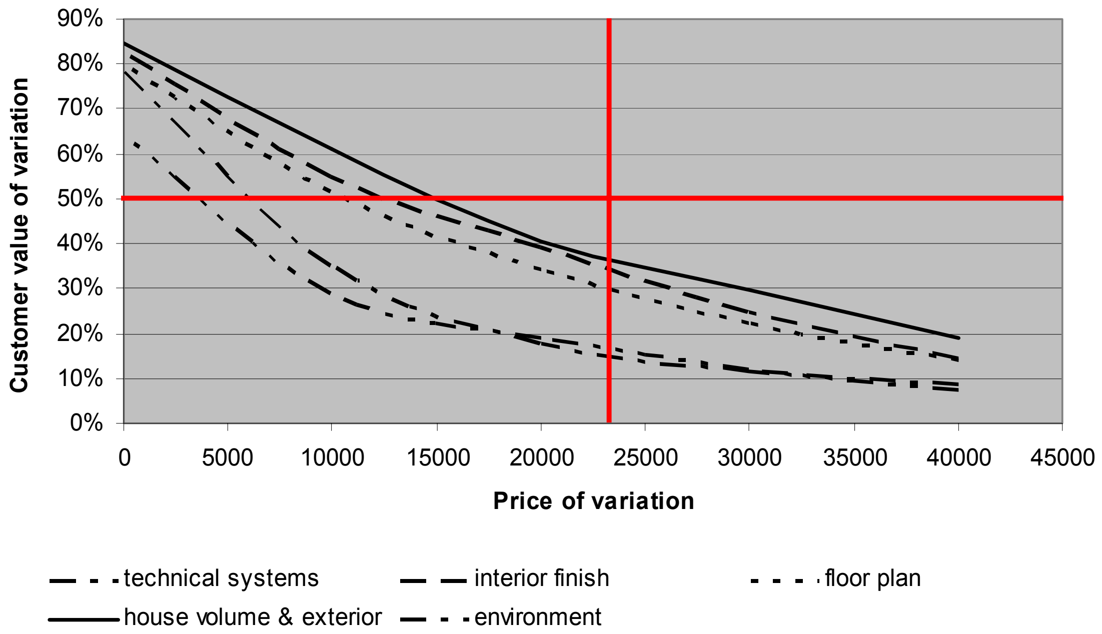

Figure 4. A Price-Value trade off in customised housing propositions

From the Price - Customer Value trade off relationship one might deduce that the minimum value to satisfy a customer is 50%. This limit is shown in figure 4 by the horizontal axis. The points of intersection between the price-value curves of the respective housing propositions and the lower limit indicate the maximum price for which each proposition remains acceptable. The difference between this price and the maximum sum a customer is willing to pay for his "perfect package" forms the opportunity-sales for the supplier. The supplier can add options to the package up to the maximum amount of money the customer is willing to pay.

2.4 Explorative factor analysis

To verify whether the hypothesized five levels of housing decomposition could empirically be confirmed we conducted a factor analysis. To determine the appropriateness of a factor analysis an overall test for significance of the correlation matrix is performed. This measure of sampling adequacy (MSA) falls with a value of 0.689 in the acceptable range (>0.50). The basic idea behind the factor analysis, in our case a principle component analysis (PCA), is that it may be possible to describe a large set of input attributes in terms of a smaller number of underlying components. These unobserved components capture most of the information or variation contained in the larger set of observed attributes. To interpret the PCA solution we tried to find labels expressing the contents of the factors. As the factors are unknown a priori, we labeled the factors indirectly by means of the attributes' factor loadings (r). After labelling, it is possible to verify whether these factors correspond to our initial hypothetical levels of housing decomposition.

In literature (Habraken, 1998; Kendall et al, 2000) it is claimed that five to six levels of housing decomposition exist, see table 4.

Table 4: factors found in literature

Habraken	Van Randen	Kendall
Major arteries	City structure	Urban structure
Roads	Tissue level	Urban fabric
Building elements	Support level	Base building
Partitioning	House allocation	Fit-out
Furniture	Infill level	Furniture and Equipment
Body and utensils		

Therefore we set the number of factors to extract to five. To make the PCA output more clearly to facilitate the interpretation of factors, we performed a Varimax Rotation. Varimax rotation performs an orthogonal rotation in which factors are forced to be uncorrelated (Conway & Huffcutt, 2003). However, if the factors correlate, this method is likely to produce distorted results. The alternative, oblique rotation, does allow for factor correlations. We performed both a Varimax as well as a Promax rotation. The results show highly similar pattern and factor structures, indicating that the assumption of uncorrelated factors matches the data. A cut-off score of r = 0,5 was considered reasonable for inclusion of a variable in interpretation of a factor. A first PCA with Varimax rotation yielded five factors with an Eigenvalue above 1,5 and which explained 65 percent of the variance of all 35 attributes. There was a clear dip between the eigenvalue for the first (8.6) and second factors (3.1). We repeated this PCA procedure two times with exclusion of those attributes with r smaller than 0,5. In total seven attributes where eliminated because of a poor association with the other attributes within the specific constructs. Retained in the final factor structures were five factors and 28 attributes with factor loadings of greater than 0.5.

Table 5: rotated component matrix after Varimax rotation

Rotated Component Matrix(a) after deleting 7 variables with r < 0,5

	Component				
	1	2	3	4	5
Position bathroom	**0,801**				
Position kitchen	**0,779**				
Length and width living room	**0,777**				
Position toilet	**0,752**				
Number of bedrooms	**0,730**				
Number of bathrooms and toilets	**0,666**				
Choice in roofing construction (e.g. dormer window)	**0,563**				
Position washbasins	**0,556**				
Door hardware (type of locks and latches)	**0,555**				
Façade back (bay, glass, position windows)	***0,520***		***0,514***		
Sanitairy facilities (type and colour bath, washbasin, toilet)		**0,855**			
Tiling (type and colour)		**0,841**			
Interior walls (wallpaper, stuc)		**0,776**			
Floor finish (parquet, carpet, tiles)		**0,745**			
Type of kitchen		**0,730**			
Façade finish (masonry, wood, other)			**0,862**		
Façade front (bay, glass, position windows)			**0,631**		
Pavement			**0,586**		
Width dwelling			**0,569**		
Casements (material)			**0,524**		
Type, number and position sockets and switches				**0,866**	
Water (combi of los)				**0,745**	
Type of heating (floor / wall)				**0,704**	
Telecommunication (telephone, internet, television)				**0,623**	
Type of alarmsystem				**0,515**	
Inner casements and doors					**0,660**
Position innerdoors					**0,611**
Choice in type of roof					***0,508***
Alpha	**0,90**	**0,87**	**0,80**	**0,78**	**0,54**
Alpha after deletion of italic loading	**0,87**		**0,76**		**0,59**

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 20 iterations.

The five factors accounted for 65% percent of the total variance of these 28 attributes. An overview of these factors and corresponding factor attributes and loadings is given in table 4. Factor I: “floor plan” consists of nine attributes that reflect floor plan issues, the respective factor loadings range from r = 0.52 to r = 0.80. This factor comprehends the issues such as: position of the kitchen, bathroom and toilets; the length and width of the living room, the number of bedrooms; and more notably also the design of the back façade loads heavily on this factor, so we might argue that customers think of the back façade as a floor plan issue, rather than of an exterior finish issue. Factor II: “interior finish” consists of five attributes that reflect interior finish issues, with variable loadings from r = 0.73 to r = 0.86. This factor refers to the issues: type of tiling, sanitary facilities, wall and floor finish and type of kitchen. Factor III: “exterior finish” consists of exterior finish issues with factor loadings ranging from r = 0.52 to r = 0.86. Attributes such as façade, width dwelling, and casements form part of this factor. Also the attribute pavement loads high on this factor. Factor IV reflects issues concerning “technical systems”; it has five loadings ranging from r = 0.51 to r = 0.87 on type, number and position of sockets and switches, water system, type of heating, telecommunication and type of alarm system. Factor V: “inner doorways” is a new factor and reflects issues about casements and inner doors. Also the variable door hardware has a relative high loading on this factor. Curiously enough also choice in type of roof loads high on this factor.

From this factor analyses it follows that in the mindset of the customer five factors concerning variation in housing design exist. One of the factors derived from theory “environment” could not be confirmed with this analysis; another factor however, “inner doorways” was added as a factor.

After labelling, an estimate of internal consistency for the factors, the scale reliability coefficient Cronbach’s alpha, was computed. These estimates are shown in table 4. The alpha's of the factors were larger than 0.78, except for the new factor labelled as "inner doorways". This level concerns positions of inner doors and type of doors & casements. Cronbach's alpha of this construct appeared to be 0.59 (after deletion of attribute choice type of roof), after adding the item door hardware this alpha increased to 0.73; therefore this attribute can be included in this factor as well. Because attribute "façade back" loads both on the first and third factor, we recalculated alpha for the first and third factor, after dropping this attribute, the alpha's slightly decreased in value but still remain acceptable. The results show that choice in back façade loads on the factor interior finish, the front façade has comparable loadings on both the level of interior finish as on the level of exterior finish. So, customers think different of the back façade then of the in front façade, this has consequences for the way variation in these attributes is offered.

3. CONTRIBUTIONS, LIMITATIONS AND FUTURE RESEARCH

The objective of this study has been to explore how potential new home buyers prioritise the different parts and elements in a house design from the perspective of getting a customised versus a standard solution offered. Based upon the findings of this study we will discuss the contributions and limitations of this study and suggest some directions for future research.

A main outcome of this study is the priority listing of housing attributes as presented in figure 3. This priority listing is of paramount importance for all building companies who offer or consider offering customised housing. Building developers may conclude from this listing what potential buyers regard as being the most important housing attributes of getting customised solutions. This priority listing will help building developers in decision making about the right balance between the level of variety (such as different types of bathrooms, kitchens, roof types etc.) to be offered versus the need to standardise and produce economically.

Although people in general prefer to have the opportunity to select from options, they will however be less inclined if this option also means an increase in price. A second principal contribution of this study has been the development of a model to deduce the trade off between customer value and price of housing proposition. The difference between customer value and price can be used to measure the incentive for the customer to buy. To outperform competitors, it is suggested that housing suppliers could follow a strategy of increasing this difference.

Based on an explorative factor analysis, we conclude that customers have five levels of housing decomposition in mind when they think of variation in housing design. These are the levels: floor plan, interior finish, exterior finish, technical systems and inner doorways. The environmental level is no longer part of this decomposition because there was no factor that could be labelled this way. Further analysis, specifically confirmative factor analysis (Netemeyer et al, 2003) must be conducted to strengthen these conclusions.

The moderate sample size could potentially limit the power of the statistical techniques used. A rule of thumb in factor analysis is a ratio of respondents to variables of at least 4:1. Nevertheless, if communalities are high, recovery of population factors in sample data is normally very good, almost regardless of sample size (MacCallum et al, 2001). In our case, average communality is 0.672. This is rather high and therefore we do not worry about the moderate sample size of 82. In addition, some opportunities for further research can be derived from certain limitations of our research. First, this study has been conducted in The Netherlands. One might question to what extent the results will also be fully applicable in other countries. Repeating this research also outside The Netherlands will reveal to what extent potential buyers of new houses in other countries differ in prioritizing attributes in house design. Another limitation concerns the method used. Major advantage of the vignette method is that it has characteristics similar of an experiment and that it therefore approximates real-life decision-making situations. A weakness of the method however, is that the number of vignettes grows exponentially with the number of attributes and corresponding levels. Therefore only a limited amount of attributes can be investigated at a reasonable amount of costs (Gibson, 2001). Furthermore in our research we excluded house renters from our sample. We wonder to what extent our results can also be generalized for the house rental sector. This knowledge is of importance for housing corporations who are increasingly adopting more customer centric rental policies. They differ from private housing suppliers in a sense that they explicitly also have to take into account future rentability of their houses. Finally it must be noted that a limitation in our research concerns a lack of insight in the customer value of packages of options under different price conditions. In practice a housing supplier offers packages of variation at the different levels of housing decomposition at the same time. Such a strategy maximizes customer value and minimizes the matching price. In order to offer the right package, we need to enlarge insights in the way customers value possible packages of variation as a function of the matching package-prices. These packages are similar like multi attribute product alternatives and can therefore be analysed using techniques such as conjoint analysis.

An important consequence of the need to offer a variety of modules and components is that building companies will have to become capable in modularising their product portfolio. However, although methodologies have been developed recently for evaluating the applicability of modules and product platforms in different industries (e.g. Martin and Ishii, 2002), so far no systemic methodologies have been applied and tested in the specific setting of the house building industry. It is suggested therefore to initiate research that could provide insight about successful methods to define and implement modularisation concepts in the building industry and investigate also its implications for the building supply chain.

Filling the aforementioned gaps in literature would be an important contribution, both from an academic as well as from a managerial point of view. We are positive that our research has started on answering these pending issues by narrowing the focus for further research but also by suggesting expanding the investigation to other countries. This will broaden our state-of-the art knowledge about how to build customised houses economically.

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Appendix 1: Questionnaire Customised Housing

Customer oriented house building is nothing more than building what the customer asks for. The customer may participate in for instance the design of:

- Environment; examples are paving, parking lots and playing fields;
- Skeleton and exterior finish; examples are the volume of the dwelling and choice of type of masonry;
- Floor plan; examples are position of bedrooms and the number of bedrooms;
- Interior finish and materialisation; examples are tiling and the finish of interior partitions;
- Technical systems; examples are electro technical systems and type of heating system.

Housing developers and construction companies want to effectively act upon customers' needs. We would be glad to here your opinion about variation in design.

We thank you for your cooperation!

General questions

If you would buy a new house, which price category would the house be part of? (amount of money in €)

Up to 100 000	100 000 – 200 000	200 000 – 300 000	300 000 – 400 000	400 000 or more
[ ]	[ ]	[ ]	[ ]	[ ]

Have you ever bought a newly built house before?

Yes	No
[ ]	[ ]

What house would like to buy?

Detached	Semi-detached	Corner house	Row house
[ ]	[ ]	[ ]	[ ]

What is your age category?

0-25 years	25-35 years	35-45 years	45-55 years	55-65 years	65 +
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

What is your family type?

Single family	Pair without children	Pair with children	Single-parent family
[ ]	[ ]	[ ]	[ ]

What is your income category?

Up to 10 000 Euro	10 to 20 thousand Euro	20 to 30 thousand Euro	More than 30 000 Euro
[ ]	[ ]	[ ]	[ ]

Example of vignette related questions

For each proposition please indicate how you judge these fictive situations:
1 = I mark this situation as very good**,** **6** = I mark this situation as very poor**.**

Sums of money are in €.
Participation in designing your future home demands a lot of time, money and effort from the customer as well as from the professionals such as the housing developer, architect and the construction company. Therefore: the more variation is demanded, the higher the costs in general will become. A standard home is a home that's offered without any variation.

Vignette no. 2: Imagine the following housing proposition:

Participation in designing your future home demands a lot of time, money and effort from the customer as well as from the professionals such as the housing developer, architect and the construction company. Therefore: the more variation is demanded, the higher the costs in general will become. A standard home is a home that's offered without any variation.

- You will have **a say** about **technical systems (**such as the type of heating (wall or floor) and the number and location of the sockets, switches and water taps).
+ You will have **no say** about the **interior finish** (such as the type of kitchen, washbasins and toilet, the floor - and wall finish and the door hardware (locks and latches).
- You will have **no say** about the **floor plan** (such as position and size of the living-, bed- and toilet rooms, kitchen and doorways).
- You will have **no say** about the **volume of the home and the exterior finish** (such as the size of the home, the type of roofing and the façade design).
- You will have **no say** about the **environment** (such as plot layout, parking lots and pavement of the neighbourhood).

1 = I evaluate this housing proposition as very good, 6 = I evaluate this housing proposition as very poor

How do you evaluate this housing proposition with respect to the offered participation, if you pay:	**1 = very good,** **[1]**	**[2]**	**[3]**	**[4]**	**[5]**	**6 = very poor** **[6]**
40 000 more than for a standard home?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
30 000 more than for a standard home?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
20 000 more than for a standard home?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
10 000 more than for a standard home?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
5 000 more than for a standard home?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
0 more than for a standard home?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

In total respondents were presented fifteen vignettes consisting of five first-order vignettes and ten second-order vignettes.

Additional questions

Please read following list and indicate how important variation in the different attributes is for you. Score each attribute and mark it with a cross.

Explanation score, pay attention!
1 = I think participation in this option is very important;
3 = I think participation in this option has a neutral importance;
5 = I think participation in this option is absolutely not important.

		How important is participation to you? 1 = very important, 5 = not important				
Code	**Name**	**1**	**2**	**3**	**4**	**5**
A.	**Environment**					
a.1	Plot layout	[ ]	[ ]	[ ]	[ ]	[ ]
a.2	Parking facilities	[ ]	[ ]	[ ]	[ ]	[ ]
a.3	Pavement	[ ]	[ ]	[ ]	[ ]	[ ]
a.4	Playground	[ ]	[ ]	[ ]	[ ]	[ ]
B.	**Volume and exterior finish**	**1**	**2**	**3**	**4**	**5**
b.1	Width dwelling	[ ]	[ ]	[ ]	[ ]	[ ]
b.2	Depth dwelling	[ ]	[ ]	[ ]	[ ]	[ ]
b.3	Choice in type of roof	[ ]	[ ]	[ ]	[ ]	[ ]
b.4	Choice in roofing construction (e.g. dormer window)	[ ]	[ ]	[ ]	[ ]	[ ]
b.5	Façade front (bay, glass, position windows)	[ ]	[ ]	[ ]	[ ]	[ ]
b.6	Façade back (bay, glass, position windows)	[ ]	[ ]	[ ]	[ ]	[ ]
b.7	Façade finish (masonry, wood, other)	[ ]	[ ]	[ ]	[ ]	[ ]
b.8	Casements (material)	[ ]	[ ]	[ ]	[ ]	[ ]
b.9	Roofing finish (type and colour roofing tiles)	[ ]	[ ]	[ ]	[ ]	[ ]
C.	**Layout house**	**1**	**2**	**3**	**4**	**5**
c.1	Length and width living room	[ ]	[ ]	[ ]	[ ]	[ ]
c.2	Position kitchen	[ ]	[ ]	[ ]	[ ]	[ ]
c.3	Position bathroom	[ ]	[ ]	[ ]	[ ]	[ ]
c.4	Position toilet	[ ]	[ ]	[ ]	[ ]	[ ]
c.5	Position inner doors	[ ]	[ ]	[ ]	[ ]	[ ]
c.6	Number of bedrooms	[ ]	[ ]	[ ]	[ ]	[ ]
c.7	Number of bathrooms and toilets	[ ]	[ ]	[ ]	[ ]	[ ]
		How important is participation to you? 1 = very important, 5 = not important				
D.	**Interior**	**1**	**2**	**3**	**4**	**5**
d.1	Interior walls (wallpaper, stucco)	[ ]	[ ]	[ ]	[ ]	[ ]
d.2	Tiling (type and colour)	[ ]	[ ]	[ ]	[ ]	[ ]

d.3	Sanitary facilities (type and colour bath, washbasin, toilet)	[ ]	[ ]	[ ]	[ ]	[ ]
d.4	Inner casements and doors	[ ]	[ ]	[ ]	[ ]	[ ]
d.5	Floor finish (parquet, carpet, tiles)	[ ]	[ ]	[ ]	[ ]	[ ]
d.6	Door hardware (type of locks and latches)	[ ]	[ ]	[ ]	[ ]	[ ]
d.7	Type of kitchen	[ ]	[ ]	[ ]	[ ]	[ ]
d.8	Position washbasins	[ ]	[ ]	[ ]	[ ]	[ ]
E.	**Equipment**	**1**	**2**	**3**	**4**	**5**
e.1	Type, number and position sockets and switches	[ ]	[ ]	[ ]	[ ]	[ ]
e.2	Telecommunication (telephone, internet, television)	[ ]	[ ]	[ ]	[ ]	[ ]
e.3	Type of alarm system	[ ]	[ ]	[ ]	[ ]	[ ]
	Type of heating (floor / wall)					
e.4	Water (combined or separate)	[ ]	[ ]	[ ]	[ ]	[ ]
e.5	Extra (solar system)	[ ]	[ ]	[ ]	[ ]	[ ]
e.6	Position water taps (cold and warm)	[ ]	[ ]	[ ]	[ ]	[ ]

ADAPTING ADVANCED ENGINEERING DESIGN APPROACHES TO BUILDING DESIGN – POTENTIAL BENEFITS

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ABSTRACT: A number of industries continuously progress advancing their design approaches based on the changing market constraints. Examples such as car, ship and airplane manufacturing industries utilize process setups and techniques, that differ significantly from the processes and techniques used by the traditional building industry. One important difference between the building and other industries is that no prototypes are trialed and tested before manufacturing. This fact causes the design stages to be highly iterative without implementing prototype performance data into the global design process. Evolutionary design i.e. is one technique that aims to adapt the biologic process of evolution to engineering. This technique could have the potential benefit of reducing the design iteration from concept creation to construction. The paper identifies possible differences between the industries and the analysis of the benefits from adapting Evolutionary design to concept creation, evaluation and optimization based on building performance criteria. This paper summarizes the latest research findings documented in subject related literature. Furthermore the iterative character of building design will be detailed by stating key results from design team observations. The final conclusions will indicate reasons why techniques as evolutionary design were not yet successfully integrated to building design.

Keywords: Building design process, Design spiral, Evolutionary computing, Point to point design, Set based design,

1. INTRODUCTION

When stripped down to its basics a parallel can be drawn between industries designing and manufacturing cars, ships, airplanes and buildings. Their basic commonality is to manufacture a product which complies with the client's expectations and requirements.

Whilst the functions the end - products have to fulfill differ significantly, the techniques applied to find solutions to the stated design problem show similarities.

Exemplary, a building need to fulfill the following minimum functions depending on its proposed use: provide a place to shelter, celebrate, work or worship, and withstand the forces of nature.

A ship needs to keep the water outside, float upright in water, steer straight, have some mechanism for propulsion, accommodate crew and passengers, and allow for storing everything that must go aboard.

Cars need to move forward when driven, allow for changing the direction, and accommodate diver, potential passengers and everything that needs to be taken.

Airplanes need to be able to maintain its structural integrity when being driven through air, accommodate crew and passengers allow for storing everything that needs to go aboard and have elements present that stabilize and control the angle of motion.

In order to enhance the product efficiency and to minimize the design effort,
processes have been formulated consisting of a number of sequences. One feature, common to all industries listed, is the identification of the design requirements as a first step and making the product available to the client as the last step. In between those corner stones the processes used vary significantly across industries.

Whilst the building and airplane industry use point to point design processes, the ship manufacturing industry uses a spiral design process and one rather unconventional scheme is used by the car industry which is referred to as set based design.

The main differences can be identified when considering the number and purpose of design sequences and the consideration of design iterations.

By reflecting on the practical integration of concept optimization in other industries the paper aims to identify potential benefits to building design, where it is rarely used.

2. METHODOLOGY

The work presented is a result of a number of research activities such as literature review and design team observations.

During the review of subject related literature the authors considered literature used for educational purposes, when limited knowledge was available as in domains like car, ship and airplane design.

The focus of the review lay on identifying commonalities and differences between design process schemes and the latest techniques used or proposed to enhance the design process efficiency.

The second scientific measure was the observation of one building design team meeting. As one meeting is not representative to understand the design process used by an entire industry more are planned for the future. As this research is an ongoing process the section usually titled conclusion has been titled preliminary conclusion.

A third measure used was conducting interview with 15 international building design practitioners to gain knowledge about the current design practice.

3. BRIEF BUILDING SYSTEM DESIGN HISTORY

It is common knowledge that the need for shelter against the climate conditions is as old as the human species. However the level of quality for planning and erecting structures to work, live, celebrate or worship changed dramatically over the centuries accommodating issues as hygiene, safety, thermal comfort etc.

Considering thermal comfort in more detail, until the industrial revolution passive measures as overhangs, natural cross ventilation etc. were the only means to cool spaces providing comfortable internal conditions and therefore integrated into the design. Electric power, first available in the late nineteenth century, enabled the move towards mechanically assisted means of conditioning spaces. This technology was understood as a great opportunity by building designers to overcome the traditional restrictions set by the ambient conditions. Subsequently, every design became feasible separating the design effort to achieve appropriate form, function and comfort. Independent of the regional climate i.e. large areas of façade glazing at each orientation, lightweight building constructions, deep plan buildings etc. were considered possible design solutions.

The development was brought to abrupt hold with the energy crisis in the early 70`s. The energy consumption of buildings was suddenly considered a huge potential to reduce the economies primary energy demand. The need to reduce the energy consumption caused the building industry to reconsider its design approach away from disintegrated designs using fully mechanical systems towards combinations of passive and mechanical systems forming partly integrated design solutions.

As part of the development the strict hierarchy between design team members had to be broken up to give way to more flexible design procedures and to allow for performance based rather then prescriptive design.

4. DESIGN PROCESS

In theory, the design process describes a series of actions and/or operations undertaken to solve a design problem. In consideration of the perspective chosen for this research it typically results in the manufacturing of a product, which could, in the context of this paper, be a car, ship, airplane or building.

The process is typically structured forming a procedure with a start and finish to complete the design task. Its structured character enables to sequentially collect and produce design information as an aid for making design decisions. (Lamb, 2004)

The sequences or design stages making up the design process depend on the end - product. The processes described below differ in the number and purpose of the design stages and the integration of design iterations.

4.1 Building construction– Point to point design process

Simplified, the building design process, as appoint to point approach, comprises of. A number of seven important design stages as indicated in table 1. The process is of rather generic character with design iterations taking place in between the design stages depending on the appropriateness of potential design solutions towards the client's expectations and design brief.

Figure 1 below shows two flowcharts, firstly the design stages and secondly, separated from the first, potential design iterations. Design iterations have the potential to increase the building costs and should therefore best being avoided.

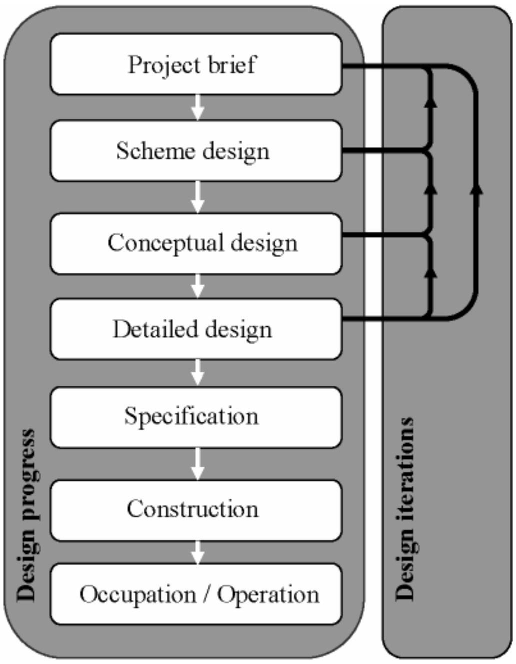

Figure 1: Building construction – Point to point design

When interviewing international design professionals it was stated that they experienced the design process a rigid and inflexible. Other comments dedicated to the conceptual design stage was that design optional are discarded to early to truly understand their benefits leading to local optima's rather than global optima's.

Table 1: Building design stages (RIBA)

Pos.	Design stage	Explanation
1	Project brief	Definition of objectives and requirements
2	Scheme design	Feasibility check of different options
3	Conceptual design	Main system selection concept development
4	Detailed design	Development and integration of design elements to provide build and operate design solution
5	Specification	Production of site drawings, product specification and construction resource documentation
6	Construction	Translation of design documentation into finished product, testing and commissioning
7	Occupation	Product handover, Design participants performance evaluation

4.2 Ship design – Design spiral

The ship design process shows commonalities and differences when compared with building design. Whilst the order of the traditional process stages compare nicely with the building design process: Design statement, first; concept design, second; preliminary design, third; and detailed design, last; the integration if design iterations differs significantly.

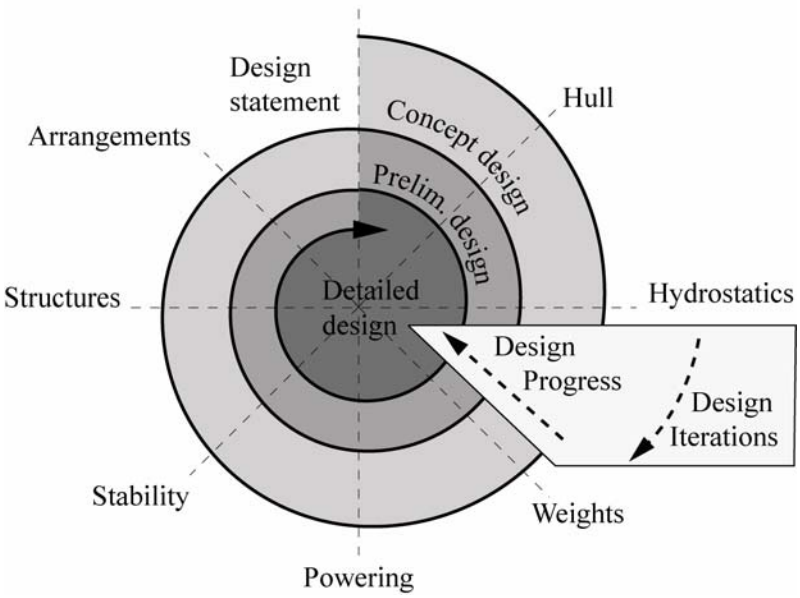

Figure 2: Ship design process – Design spiral

Figure 2, indicates that design iteration are considered part of the design process as each design element as hull definition, hydrostatics etc. are revisited at each design stage. The success of the performance based design is evaluated using a measure of merit starting at the very early design stages. Typically design optimization is used already during concept design as trade offs between the design elements influence the ships final performance.

Table 2: Ship design stages (Hollister, 1994)

Pos.	Design stage	Explanation
1	Design statement	Purpose and mission of vessel, owner requirements, definition of measure of merit, design constraints
2	Concept design	Feasibility check of design options, option optimization
3	Preliminary design	Calculation and trade off evaluation of hull shape, arrangements, weight, structure and performance prediction
4	Detailed design	Production of workshop drawings, product specification and templates
5	Construction	Translation of design documentation into finished product and testing
6	Delivery	Product handover

4.3 Airplane design – Point to point design process

The airplane design is referred to as a highly iterative process. Once the requirements have been established a specification is drawn up leading straight into the conceptual design stage. Even so the design process is sketched as a point to point flow chart the stages conceptual, preliminary and detailed design involves many different design disciplines one relying on the output of the other.

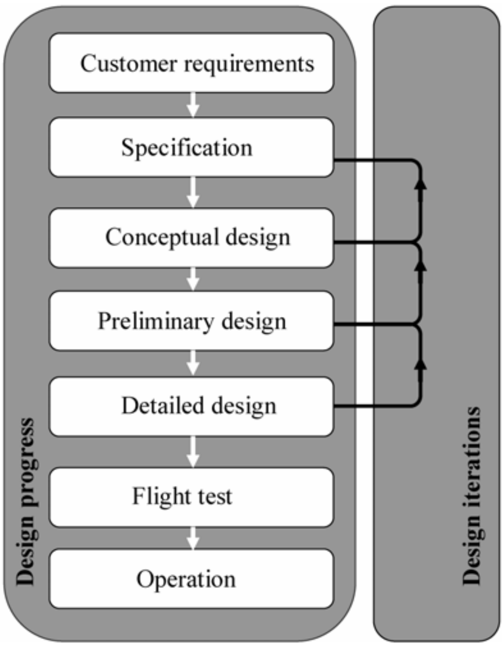

Figure 3: Airplane design process – Point to point

The results of the first prototype manufactured during the detailed design stage are fed back into the design as part of the product optimization approach. Multidisciplinary optimization techniques are used during the conceptual and preliminary design stage where different design options are considered and worked out in more detail. (Antoine and Kroo, 2004)

Table 3: Airplane design stages

Pos.	**Design stage**	**Explanation**
1	Customer requirements	Statement of intend.
2	Specification	Production of design requirements based on market/operation analysis research and most importantly customer requirements.
3	Conceptual design	Main system selection concept development and evaluation.
4	Preliminary design	Development and integration of design elements to provide build and operate design solution.
5	Detailed design	Production of workshop drawings, product specification, construction resource documentation. Results: Construction Authorization and First Prototype.
6	Flight test	Extensive product testing and certification.
7	Operation	Product delivery, maintenance and support.

4.4 Car design– Point to point design process

The traditional car design process is usually sketched the same way as for buildings and airplanes using a point to point flow chart.

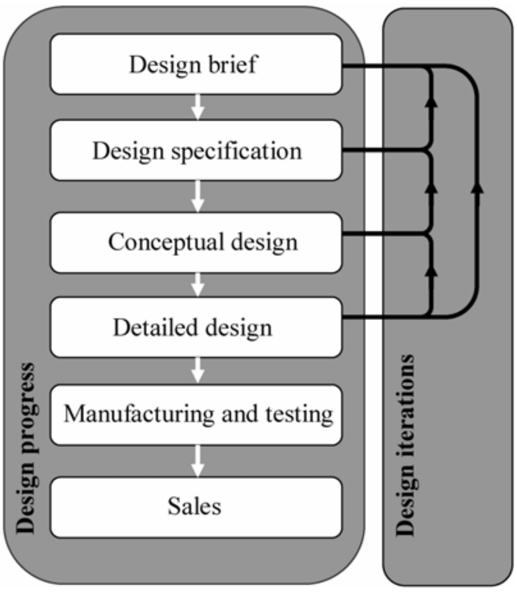

Figure 4.1: Traditional car design process – Point to point

However as it is true for the airplane design, design iteration can not be avoided and are accounted for. Figure 4.1 indicates design stages already known from processes used for the design of buildings, ships and airplanes: conceptual design and detailed design. As can be noticed the design stage called preliminary design is missing. However, the tasks previously accommodated in the preliminary design stage have been distributed across conceptual and detailed design. Prototypes are tested during the detailed design stage and the results are fed back into the design for system integration evaluation and optimization.

Table 4: Car design stages

Pos.	Design stage	Explanation
1	Design brief	Statement of intent to design and manufacture a specific vehicle.
2	Product design specification	List of design requirements containing results from customer market surveys and competing products analysis.
3	Conceptual design	Concept generation and evaluation by brainstorming and matrix evaluation. Result: Outline of design proposal.
4	Detailed design	Production of manufacturing drawings, product specification and prototypes to test system integration.
5	Testing and manufacturing	Extensive product testing for certification and manufacturing
6	Sales	Market introduction

4.5 Car design– Set based design process

The set based design accredited to Toyota comprises of the same design stages as other industries concept, preliminary and detailed design.

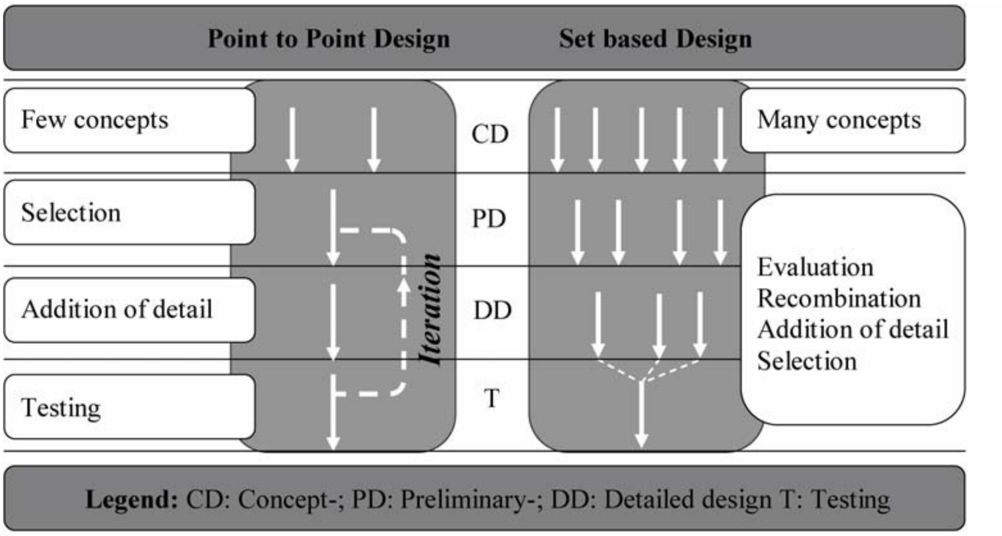

Figure 4.2: Progressive car design process – Set based design

However, it delays the selection of the favorite design concept to the testing of prototypes. By doing so thereby allows to gradually narrowing the solution set towards a more global optimum. A great number of design teams work concurrently on detailed design solutions. The weakest solutions will be eliminated at the end of each design stage and the most favorable sets recombined, modified and detailed. (Parson et all, 1999) Thus costly design iterations can be avoided.

5. DESIGN PROCESS COMPARISION

Considering the design process schemes from the perspective of the building construction industry commonalities as well as differences can be noticed. The focus lays thereby on the number and purpose of the design stages present and the integration of design iterations.

5.1 Commonalities

1) All product design processes start with documenting the design requirements.
2) The three core design stages present: conceptual, preliminary and detailed design are present in all design schemes. A few of the schemes referred too, might use different names or allocate the subtasks of one stage to a number of others.

5.2 Differences

1) Whilst building and ship industries typically only produce unique products the airplane and car industry manufacture a great number of replicates.
2) All but the building and ship industry trial prototypes and feed the information back to the detailed design stage.
3) The set based picks up on the potential disadvantages of point based design processes finding a feasible solution but not necessarily the global optimum, thereby extinguishing the need for design iterations.

6. BUILDING DESIGN OPTIMIZATION

Many references were found stating research activities in the field of multidisciplinary design optimization in car, (Schenk and Hilmann, 2004), ship, (Brown and Thomas, 1998) airplane, (Antoine and Kroo, 2004) manufacturing. However, multidisciplinary design optimization in building design is still in its early stages.

Disciplinary specific optimization activities are known by Michalek et al (2002) in architectural design and by Wright et al (2004) in mechanical engineering.

When considering the safety and performance product requirements one is attempted to order the products referred too as follows, starting with the lowest requirements for buildings, ships, cars and airplanes with the highest. The order might be questionable however it indicates potential parallels with respect to research efforts invested into multidisciplinary design optimization.

6.1 Architecture

Michalek's work focuses on automating the optimization process of the buildings topology and layout with respect to architectural design. Algorithms dedicated to topology and geometry optimization were implemented to support the layout generation in the architectural conceptual design process. This optimization process used includes two stages:

1. Optimization of geometry: modeling units in defining different user types, sizes, dependencies, number and areas of windows added to the units etc. Opportunities like minimizing heating, cooling and lighting costs are optionally available.
2. Optimization of topology: finding the best set of relationships between rooms in a space.

The combination of these two algorithms supports the identification of the mathematical geometric optimum under predefined constraints.

6.2 Mechanical Engineering

Wright dedicated his research efforts to the concept generation and optimization using genetic algorithms applied to mechanical systems and their control mechanisms. His published research was furthermore dedicated to investigating the feasibility of applying more than one assessment criteria simultaneously to the search for the mathematical optimum. Exemplary, the designer has the possibility to assign a weighting factor to assessment criteria such as thermal comfort and system efficiency. The weighted sum will than form a single design criterion which will result in the best discipline dependent most suitable solution for the specific problem area. The implementation of different value drivers or assessment criteria for design concepts is called multi-objective genetic algorithm (MOGA).

7. PRELIMINARY CONCLUSION

Even so the design process used by the construction industry is the eldest in between the four considered it became visible that it is not the most advanced.

The three different design processes identified: point based, set based and design spiral show a great diversity across the industries. Whilst all processes have the three core stages in common: conceptual, preliminary and detailed design they differ significantly in considering design iterations. Whilst the process of re-examination is the traditional character of design it should be recognized as an integral part of the process. However, as design iteration add to the building costs it the common practice to reduce their number to a minimum.

The physical extend of the building product makes prototyping and testing difficult. However, theoretically considered valuable performance evaluation is missing when compared to car and airplane manufacturing. One potential option could be to extend post occupancy evaluation exercises to check if the design requirements have been met.

The set based design shows the great benefit to overcome issues such as design decisions taken to early. However it might not be applicable to the building industry in its full extend as delayed design decision cause the danger of hindering the process.

Design team integration is essential to optimize design concepts during the design process as the optimized concept dedicated to one particular design discipline might cause others to redesign their concepts.

In order to successfully optimize design concepts early during the design process it is essential to integrate the multidisciplinary design teams. Each disciplinary representative is required to have at least a basic understanding of the requirements of the other participating engineering disciplines.

8. FUTURE WORK

The authors will arrange further design team meeting observations to gain a clear insight to project team setups and responsibilities.

Effort has been invested to use discipline specific multi objective design optimization. However little is known about efforts to combine multidisciplinary objective for a holistic concept optimization. The literature review will therefore be continued to identify algorithms to contribute to this area.

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ERGONOMICS METHODS APPLIED TO HEALTHCARE ARCHITECTURE

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ABSTRACT: Designing a healthcare facility without giving sufficient consideration to the users who will perform their activities in it may lead to dysfunctional workplaces. Some ergonomic methods can be used to provide key information to designers so that better decisions can be made to achieve a safe and efficient healthcare environment. The project uses ergonomic methods to review hospital drawings produced over 20 years ago. This paper describes two ergonomic methods used to look at the single bed space in hospital design. Data were collected from: 1.) Observations of clinical activities in local hospitals using Hierarchical Task Analysis, which helped the researcher understand clinical activities in detail; 2.) Simulation of clinical activities in the bed space mockup using Link Analysis to look at spatial relationships within a defined area, and then determine the optimal dimension. The final outcomes will include recommendations to be used for the efficient design of hospitals.

Keywords – Ergonomic methods, hierarchical task analysis, hospital design, link analysis.

1. INTRODUCTION

Although it has been known for some time that architectural design could benefit from ergonomics / human factors, hospitals, as a complex system where there are various users of equipment, products and treatment / care environment, are still often designed without giving sufficient consideration to the users who will perform their activities in it, leading to dysfunctional workplaces (Villeneuve, 2004). Some ergonomics methods can be used to provide key information (for example, user-needs analysis and task analysis) to designers of hospitals so that better decisions can be made in design and planning to achieve a safe and efficient healthcare environment.

1.1 Background

In the early 1980s the Department of Health and Social Security (DHSS) developed an ergonomic database made up of data sheets, which contained a large number of drawings that "give the space requirements for activities and other ergonomics information relating to the use of spaces within hospital and health buildings" (Hilliar, 1981). The relevant data sheets were then attached to the DHSS's published Health Building Notes (HBN) series to act as guidance for the design of new hospitals and the adaptation of old buildings, and encouraged those involved in hospital design to think in terms of the relationship between a user and a particular component and other components located within a room to produce a more efficient planning of space.

Since the majority of those ergonomic drawings were initially developed over 20 years ago, questions have been raised about whether they are capable of reflecting changes in clinical practice and medical technology; whether the people involved in hospital development, e.g. architects, use the drawings while developing designs and whether the drawings work with respect to the functionality and usability of care and treatment environments.

1.2 Research aim

The project funded by NHS Estates is reviewing the drawings by looking at the highest repeating unit in hospital design i.e. the single bed space in single rooms and multi-bed bays based on acute adult wards and intensive care units (ICU) in terms of four key clinical activities: manual handling, resuscitation, disability access, and infection control.

2. METHODOLOGY

The project has passed through the following phases:

1. Literature review of studies concerned with the development and use of ergonomic drawings in healthcare in the context of changes in clinical practice over the last 20 years.
2. Expert interviews to elicit the views of architects, healthcare planners, and facilities managers, etc about the use of ergonomic drawings and patient rooms.
3. Anthropometric benchmarking to collect data on the dimensions and layouts of single bed rooms, multi-bed bays from 5 sites built within the last 10 years. The data were then used to set up the full-size mockups for laboratory based simulations.
4. Observations in single patient room and multi-bed bay at hospitals; and then simulations of nursing tasks for different layouts to collect and analyse data using hierarchical task analysis (HTA) and link analysis (LA).
5. The final data analysis will bring together the anthropometric and task analysis data in a comparative review and produce recommendations for revised and new ergonomic drawings.

From the literature review, we found that although NHS Estates regularly update the HBNs, very little research-based evidence is available to provide a rationale for the changes in the recommended dimensions. From the literature it is difficult to find out whether the ergonomic drawings work and whether architects use ergonomic information extensively while designing (Lu and Hignett, 2005). From the expert interviews preliminary findings suggest that architects have not used the drawings as guidance consistently or historically, and that most would prefer a simpler form of design guidance.

The researchers visited 5 sites (recruited from 25 hospitals) built or refurbished in the last 10 years and measured bed spaces in both adult acute wards and intensive care units. We have found many of these dimensions are less than the HBN recommendations (Lu and Hignett, 2005).

We observed nursing tasks on the ICU at a local hospital for one week and on acute adult wards at second local hospital for 4 weeks to understand the tasks in more detail. These data were used to design the task scenarios to be “enacted” in the mockups to test the different bed spaces during simulation phase.

At present the simulation work is nearing complete, and the following data analyses are on-going.

2.1 Task analysis methodologies

Since healthcare is a relatively new area of practice for ergonomics, we propose there are methodologies from other safety critical environments which have been developed in the last 20 years that could be used for the review of existing ergonomic drawings as well as the development of new ergonomic envelopes.

In this paper, we describe task analysis methodologies applied to collect and analyse data during field observations on an ICU and simulations of the ICU bed spaces in an experiment laboratory at the university.

2.2 Ethical issues and paperwork preparations

As all research in the NHS should be reviewed and approved by the ethics and research governance committees. We submitted the documents before the observations and simulations. The documents included the completed application forms, the research protocol, different participant information sheets and consent forms (for nurses in observations and simulations respectively and patients in observations), we were granted approval after 5 months. The researchers have also had honorary contracts for working at both hospitals.

2.3 Observations

As aforementioned, in order to investigate how the tasks of manual handling, resuscitation, infection control and disability access were carried out and what was really going on in the bed space during such a task, 1 week of observations were undertaken.

2.3.1 Study setting and subjects

The observation areas were sited in the cardiac intensive care unit (CICU) at an acute hospital of around 520 beds from University Hospitals of Leicester NHS Trust which provided a range of in-patient, day case and outpatient services. The subjects were nursing staff and post-op patients on the CICU.

As patients on the unit were very vulnerable and most of them were unconscious in the first 2 –3 hours after they were brought from the operating theater, they were approached (under the guidance of nursing staff) on the day before their operation and provided with an information sheet to explain the project, what they would be invited to do, and what their own rights were, etc. If they agreed to permit the observation of nursing tasks, they were asked to sign a consent form.

The nurses were approached, given a different information sheet and asked to sign the consent form on the observation day.

2.3.2 Data collection

As the researcher/observer (JL) had little experience of conducting observations in a clinical environment, a pre-pilot and a pilot were undertaken on the CICU on two days respectively:

- to test and develop the initial observation protocol and data collection sheets;
- to practise observations of nursing tasks;
- to become familiar with the unit and nurses;
- to get a general perspective of nursing tasks and the equipment used.

A one-week observation was then carried out based on the revised protocol. Data collection on each day was undertaken during the morning shift from 0800am when the shift handover was normally complete till 1900pm when the next shift handover started. The researcher positioned herself at the end of the corridor of the unit where the bed spaces on both sides of the corridor were in sight so that the researcher could be aware of what tasks might occur in a certain bed space. Meanwhile, the nurses who allocated a participating patient were advised in advance on what kind of tasks the researcher would like to watch so that they could give notice before they started the relevant tasks in order to alert the researcher.

The observations were recorded by taking notes manually without any image recording due to the ethical requirements. As well as literal descriptions of the process of the task, the recorded data also included:

- the purpose of the task;
- the clinical area under observation;
- start and finish time of the task;
- where the observer was positioned while observing;
- all the participants;
- the sketch of the layout recording other details of observed area, such as the position of equipment, furniture, devices;
- lines drawn on the layout sketch briefly recording movements of components or elements of the observed area.

An observation diary was kept to record general information and additional data not recorded on the data sheets.

Although the researcher and nurses tried to ensure that the researcher recorded as many tasks as possible, some tasks were still missed, for example, concurrent tasks where the researcher had to choose one to observe and “abandon” another one. An order of priority was established for: new tasks, different nurse(s), and female patients (since fewer female patients were available). However some of the participating patients felt too uncomfortable (physically or psychologically) to let the researcher stay round the bed space to watch. In this situation the researcher stopped the observation when the shadowed nursing staff was attending to them and restarted the observations when the nurse indicated that it was appropriate to approach them or when the nurse went to another participating patient.

By the end of the observation period a total of 31 nursing tasks were recorded with 28 nurses providing care and treatment to 25 patients involved (Table 1).

Table 1. Overall data presentation of ICU observations

Tasks observed	Number of times tasks observed	Duration （mins）	No. of nurses involved	Patient's condition
• Washing, shaving a patient, changing bed sheets	1	40	2 – 3	Awake, dependent
• Washing a patient, changing bed sheets	14	30 – 40	2 – 3	Asleep/awake dependent
• Checking a patient's rectum / anus	1	5 – 10	1 – 2	Asleep
• Repositioning (moving / sliding) a patient on the bed	5	5	2 – 3	Asleep/awake dependent
• Washing, dressing, and moving a patient from bed to chair or wheelchair without a hoist	3	20 – 40	2 – 3	Awake, less dependent
• Dressing and moving a patient from bed to chair or wheelchair without a hoist	4	20 – 30	2 – 3	Awake, less dependent
• Moving a patient from chair to wheelchair	1	5	1 – 2	Awake, less dependent
• Transferring a patient from bed to bed	1	10	2 – 3	Awake, dependent
• Front chest X-ray with mobile X-ray machine	1	10 – 15	2 – 3	Asleep/awake dependent

2.3.3 Data analysis

The researcher used Hierarchical Task Analysis (HTA) for the data analysis. HTA is a technique to analyse data by breaking a task down into sub-tasks until a stopping point is reached when the task cannot be further broken/described (Shepherd, 2001). It was used to re-describe the recorded data to arrive at a detailed understanding of what nursing staff were required to do and how they accomplished their tasks (Figure 1). These data showed the individual variance in a specified task by different nursing staff and identified generic task components which were used to develop the simulation scenarios.

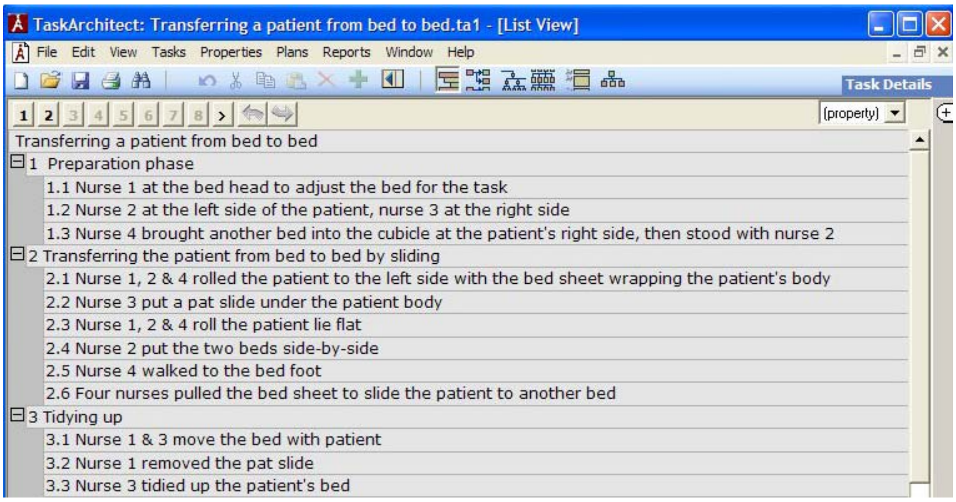

Fig.1. Example of HTA for transferring a patient from a bed to a 2nd bed

During the observational data analysis, the technique of link analysis was used to 1.) look at spatial relationships by recording and analysing movements between components, i.e. nursing staff, equipment/device and furniture within a bed space, and 2.) identify which task occupied more space, where the area with the higher density of activities were (Figure 2), to help the researchers decide which tasks to simulate.

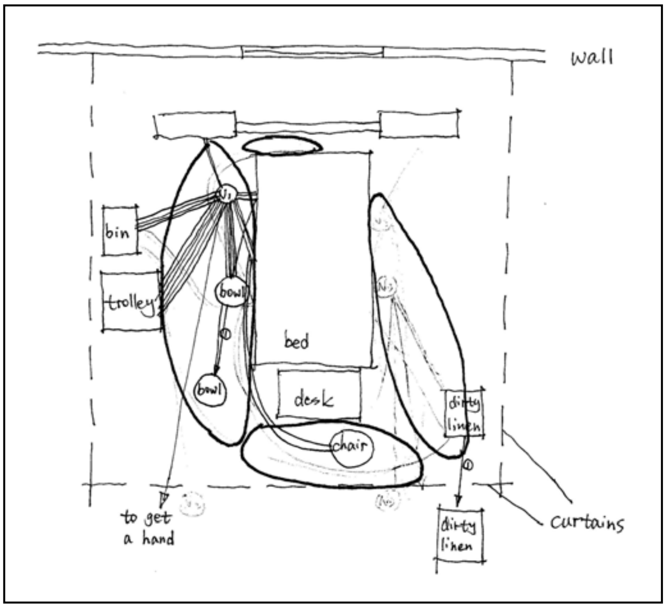

Fig.2. Link analysis of washing a patient and changing bed sheets

2.3.4 Summary of observational data

1. Items of equipment/furniture within a bed space on the observation site were found to be placed in similar positions to the sites visited during anthropometric benchmarking.
2. No tasks of resuscitation occurred during the observations. However, at the beginning of the project, the researcher attended training sessions for basic/advanced life support, and conducted pilots with experts in resuscitation and

manual handling to revise the research proposal. So these data were used to inform the simulation scenario.

3. The performances of infection control and disability access were analysed as sub-tasks, e.g. hand hygiene during clinical tasks.
4. The tasks of washing a patient and then change the bed sheets were the most frequently observed during the field data collection.
5. The bed head was the area occupied least during the tasks, while the side of the left hand shelf, i.e. the patient's right side, where the bin and the nurse trolley were located, was the area most occupied during the tasks.
6. Although no observations of nursing staff were made using a hoist, the researcher noted, and was advised, that the hoist was used quite frequently to move patients on the unit.

2.4 Simulations

2.4.1 Study setting and subjects

The simulations were designed to test the different bed space layouts and dimensions measured at hospitals during site visits. They were undertaken in full-scale mockups built at Healthcare Ergonomics and Patient Safety research Unit (HEPSU) laboratory of Loughborough University. The participants were the nursing staff from CICU at UHL.

A poster about nurse recruitment was displayed on the CICU notice board a few weeks before the start of the simulations. The researcher had informal conversations with nurses about the simulations during the observations and gave a verbal invitation to them to participate. The participating nurses were given the simulation information sheet and asked to sign the consent forms on the day of simulations.

2.4.2 Data collection

As with the observational phase, a pre-pilot and a pilot were undertaken at the lab on two days respectively with the help of nursing staff from the hospital:

- to review the observational data, and provide essential clinical information which the researcher wasn't able to access during the observations, e.g. the resuscitation task;
- to discuss and determine the tasks to be simulated;
- to review the simulation scenarios produced by researchers based on the observational data, especially to determine what and how the participants were going to perform, how many participants would be needed for a task, what equipment would be used, and the start and end points of the task, etc.;
- to improve the mockups;
- to test and improve the simulated equipment made out of cardboard;
- to set up and test the video cameras;
- to walk through the mockups with the tasks to be simulated to determine the number of sessions and nursing staff required for the simulations.

After the pilots, the following 3 tasks were chosen: 1.) washing and dressing a patient, and then moving them from bed-to-wheelchair by a hoist; 2.) resuscitating a patient, and 3.) transferring a patient from bed to another bed. Four ICU bed space layouts were tested based on the data collected from site visit phase.

The researchers built the bed space mockups using the same layout and same size as those measured at the site visits. Different colour tapes were used to mark the floor to represent the boundaries of the different bed spaces. The researchers marked additional parallel lines at 20cm intervals on both sides of a boundary line to record and measure the exact space required for nursing tasks (Figure 3).

Three sessions were run in three days with 15 participating nurses. Each session had 2 groups of nurses, giving a total of 6 groups testing the layouts by repeatedly performing the above 3 tasks.

Data collection was undertaken by video recording for further analysis.

2.4.3 Data analysis

Link analysis was used to record the 1.) movements of components, i.e. nursing staff, equipment/device and furniture; and 2.) participants' (nursing staff's) movements among equipment/device, furniture and the simulation mannequin (patient) according to video footages. AutoCAD was used to draw the link diagrams as output to convey spatial information and the result of each layout tested.

Figure 4 shows the link analysis result of a bed space for the task of transferring a patient from a bed to another bed. Additional data analysis is being carried out and will be presented in future publications.

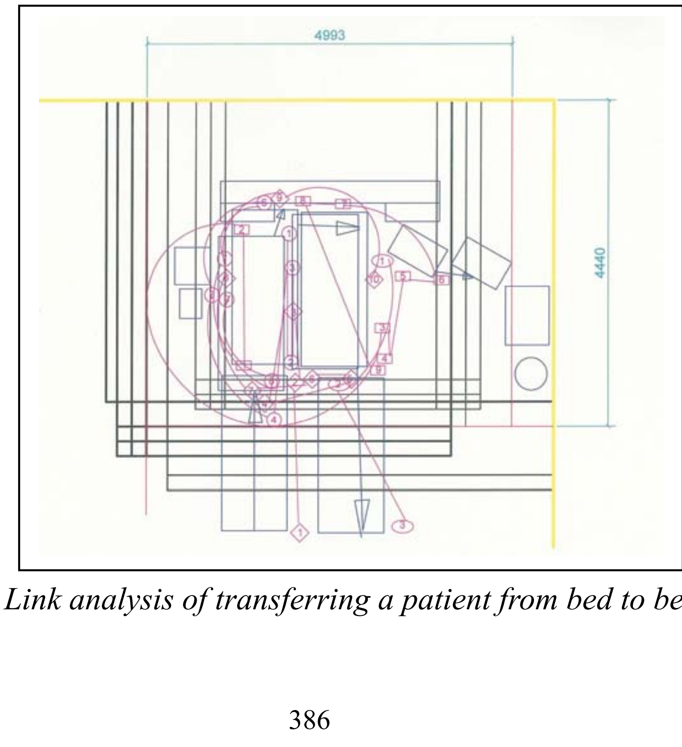

Fig.4. Link analysis of transferring a patient from bed to bed

3. DISCUSSION

Although the researchers built bed space mockups with the same layout and the same size as those measured during the site visits, mockups will never be equal to the real world. For example, cardboard equipment and a dummy patient were used to represent real medical equipment and a live patient. It was hard for the participating nurses to perform the tasks manipulating simulated elements/components with the same effort and posture as they did in their workplace. Next, participants might not have the same emotional response when performing a task in the mockup as in their workplace. For example, nurses may do a real resuscitation task with some emotional stress (Kozer et al, 2004), but as participants they may have performed the task without any pressure. This could lead to the loss of some procedures or actions which may affect the physical environment. Ideally, mockups should be built in a real clinical environment with the real equipment / elements to give the participating nurses a more realistic setting.

Participants' awareness of being observed or videoed may change their behaviors (Smith et al, 1993) and affect the space required. Next, due to the lack of walls or curtains as space boundaries in the mockup, some participants might have been so sensitive to the lines on the floor that they restricted their movements and couldn't concentrate on carrying out the tasks. On the other hand, some participants might have forgotten about the wall or curtain boundaries so they stepped out or moved the equipment/furniture further than they needed to. Both of the above situations could lead to bias of the results. During the simulations, we have therefore used lightweight screens mounted on the casters to represent the walls and curtains. The participants were reminded of the space boundaries but could easily push the screens when they needed more space to carry out the tasks.

As Stanton (1983) said "badly positioned equipment in theoretically adequate overall space would prevent the room from being used as intended", a limitation of simulations was obviously that the simulations were carried out within layouts, which were taken from the site visits and might not have been optimal.

4. CONCLUSIONS

Villeneuve (2000) suggested that ergonomics would complement architecture rather than competing with it, so ergonomic methodology has a lot to offer architects and building planners. To produce a research-based or user-centered design, a detail knowledge of work processes within a defined space/area is needed. A range of ergonomic methods including task analysis and user-needs analysis could be used to provide this information (Rutter, 1996).

This study validates the transfer of task analysis methodologies for other safety critical service industrials for use in the healthcare industry. A protocol for the future revision and testing of NHS Estates ergonomic drawings can therefore be developed.

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aRCHITECTURE or ARCHITECTURE?

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ABSTRACT: Postmodernists believe that modernism had concerned itself exclusively with the formal and visual aspects of architecture and had ignored invisible means which buildings (re)create. Based on this idea, postmodern architecture theorists tried to unmask the operation of ideological forces in the built-environment. However this attitude has made architecture an intellectual subject in the last few decades, but it has also caused a problematic position for the boundaries of architecture. This paper will examine the controversial status of architecture and will show that: firstly this status is the result of demolishing distinction between culture and non-culture and secondly this trend might lead to a resolution of architecture into intellectual discourses and technical practices. It will be argued that the definition of architecture, as something more than the practice of building-making, is a variable dependent on the function of institution in relation to the culture as a whole, and therefore we must shift our discussion from the *boundaries* to the *relationships* between architecture and other modes of cultural production.

Keywords – architecture, culture, institution, postmodernism, university

1. INTRODUCTION

Having problematized the way science views itself and the legitimacy of its producers of inference, the philosophy of postmodernism has often challenged the way by which we understand notions, categories and meanings.[1] However such premises have caused postmodernism to find a sceptical characteristic, but its more crucial argument has been that the structure of signifying elements and the surfaces from which any statement emerges is not an *enclosed* system, as opposed to the closed system pasteurized by structuralism. It means, in Foucauldian explanation for example, that there should be a link between discursive formation, the institutional conditions in which it becomes a practice, and the products of that practice.[2]

Such theories would seem to have made two important effects at once: first, they have generated a great deal of debate about and investigations into the relations between cultural products, such as architecture, and their social context. The second feature of these theories is how they efface some key boundaries or separations. This former is close in meaning to what Jameson calls 'the erosion of the older distinction between high culture and so-called mass or popular culture.'[3] But perhaps more importantly, this *condition* makes it increasingly difficult to draw a line between high art and commercial forms.

What this investigation underscores is precisely a shared concern between architecture and other cultural institutions in specifying what is of value to them. Our hypothesis is that we can not refine our problem in specifying what is architecture and what is not, without understanding the cultural situation of the current societies. A rather similar indication of such problem can be found in other cultural institutions, as this paper will show. Viewed in this way, the next challenge, which has still remained in the margin, would be how to regulate the relationship between architecture, as one cultural system, and other cultural systems.

2. THEORETICAL PRELIMINARIES, AIMS AND OBJECTIVES

Investigations concerning the cultural dimensions of architecture, for quite a long period, have often concerned themselves with the notion of style as 'reflection' of a particular culture. But the major aim of this paper is to approach architecture as a cultural system. To meet this goal we will juxtapose corresponding episodes rarely been approached as compatible parts of the same picture. We have tried to show that similar conditions, theories and concerns have surrounded the discourses about the function of architecture in relation to the community on the one hand, and the task of an institution, such as the university in relation to the society, on the other hand.

This correspondence is because of the institutionalized state of architecture, but at the same time, it shows us that there are other realms where more advanced research to redefine the relationship between the institution and the society is taking place, and we can exploit and borrow their findings. The logic enabling us to infer in this way is that all phenomena such as architecture and institution have a common root in the legitimacy of the reasons they use.[4]

The narrative of this investigation begins, as do so many narratives about architecture with modernity. As a reaction against tradition, modernity had a constructive and a deconstructive task. These two conflicting and interdependent modes of modernity, on the one hand tried to disprove the basic traditional values, and to promote a rational way of life, on the other hand. The considerable achievement in this procedure was that modernity could put itself forward as an alternative source of beauty. Importantly, this enabled modern artists to categorize what is modern art and what is not. Therefore it is no surprise that in *History of the Modern Styles of Architecture,* (1873), Fergusson deliberately used Architecture with capital 'A'.[5] Since then, modernity generated a particular set of regulations to distinguish architecture from non-architecture (lower core).

At the same time, modernity increased the number of fields influential on architectural practices and enriched the aspects which architect could resolve. So that, there is currently a plurality of discourses which have made it too problematic to specify what can be called Architecture with capital 'A'. We mean by **a**rchitecture the way in which different cultural systems interrelate and give form to the built world. In contrast, **A**rchitecture is that mode by which the built form relates to any cultural system outside itself. The second is a normative process, while the first is not a direct product of any institutionalized design practice.[6]

We will begin trying to highlight the debates about the degree of autonomy that architecture should have. Then we will focus on the university as an institution to test the hypothesis that is there any link between discourses surrounding these two heterogeneous cultural institutions. Having depicted the problematic face of culture in the current societies, this paper will outline an idea that *might* be applied to architecture.

Then the very fundamental question that must be answered in advance is: are we basically able to make a demarcation between what is architecture and what is not? It is an important question. Especially if we remember that a great deal of non-architectural discourses have moved into the traditional boundaries of architecture in the last few decades. Then, an important query that should be responded is: do we essentially need something called **A**rchitecture? To answer this, as the paper will show, we have to be able, in our current society, to categorize what is culture and what is not. Because, the definition of architecture, as something more than the practice of building-making, is a variable dependent on the assumptions we consider for the function of institution in relation to the culture.

However this study will explore architecture as an institution, but it is not searching for a metaphor or even a model for architecture. Because as a cultural system, architecture could and should have its own inner relations to formulate the range of factors to be considered and the manner in which they become determinant, but what this investigation might yield is a paradigm to regulate the relationship between architecture and other external structures.

3. ARCHITECTURE AS A CULTURAL INSTITUTION

The conception of architecture as an institution is not a new idea. In the field of art, this idea was propounded by avant-garde movements; however it was not invented by them. But the autonomous status of art in general, and architecture in particular, in developed bourgeois society, was only criticized after the avant-garde movements. As a reaction against art for art's sake (*l'art pour l'art*) the 20s avant-garde persuaded the objective of autonomy (from cultural institutions, clients and previous artistic views). This pursuit of autonomy was taken as some fifty years later, by, among others, the New York Five and the Italian/Swiss Tendenza.

The avant-garde movement was linked to the modernism because of the critical/deconstructive side of the logic of the modern movement, even though it was one of the major foundations on which modernism was based. What is mostly ignored is that the social role and function of these two movements was extremely different. This would be understandable if we remember that modernism was a movement against tradition, while the avant-garde was an attack to change the institution art and the mode in which autonomy functions. That is why in art, modernism was concerned with 'certain basic characteristics of artistic production'[7], while the avant-garde's concern was the interrelation between art and society.

The characteristics of this interrelation have been a controversial point anthropologically, theoretically and historically. For some thinkers, like Adorno, art *resists* society indirectly, and it does not reflect on and communicate with the society.[8] In contrast to this social approach towards art, Derrida argues for an intellectual self-assured practice understandable for a small number of people.[9]

In his book on *Theory of the Avant-Garde,* based on an analysis of Dadaism and Surrealism, Bürger argues that the avant-garde was concerned to end the autonomy of art as an institution.[10] He regards the tendency of aestheticism to *l'art pour l'art,* in the nineteenth century, as a symptom of increasing autonomy of art as an institution and a system in society as a whole. The result of art becoming an autonomous institution was that it became socially isolated and therefore unable to influence social movements. Interestingly, the problem of the autonomy of art, for Bürger is not art's apartness from society due to its 'nature' or in the artist's imagination. But the problem is the complexity of autonomy, 'a category whose characteristic it is that describes something real (the detachment of art as a special sphere of human activity from the nexus of the praxis of life)….the autonomy of art is a category of bourgeois society that both reveals and obscures an actual historical development.'[11] Therefore, the avant-garde's goal was not the integration of art with bourgeois society and its rational plans. It aimed rather for an alternative for the existing order.

Despite differences in perspectives, the basic thought structures of the avant-garde movements are identical in very interesting ways. That is an idea of 'the still unbecome, still unachieved homeland.'[12] The homeland (*Heimat*) is the place where the duality between human beings and the world has been demolished. It is also seen as the place where utopia is achieved.

The anticipation of the realization of utopia was the fundamental concern of art as well. 'The best works of art present one with a foreshadowing of that utopian moment, not literally – because the future *Heimat* cannot be depicted in every detail – but as the outline of a promise…Art is a laboratory in which events, figures, and characters are tested for their utopian potential.'[13] Thus, architecture as 'an attempt to produce a human homeland'[14] was of great importance, whereas the ultimate characteristics and promises of this homeland were merely outlined insubstantially.

It is a crucial point that the avant-garde's concept of art is based on the conception of art as an institution, rather than a discipline. Therefore while Bürger highlights the notion of autonomy, we want above all to focus on the idea of an institution. Hence, to get to know the changing nature of the concept of the institution, we believe the University as an institution is the best setting to examine the converging common aspects which has been the characteristics of an institution. Because, the University has been a place to search, define and test the human homeland.

4. THE UNIVERSITY: AN INSTITUTION WITH A REVISED MISSION

While the ideologically embodied avant-garde movement was *referring* institution 'art' to a perfection which was not concrete, the same attempt was taking place in reorganizing the function of the institution itself. Readings argues that the generic characteristic of the modern University is to have an idea that functions as its referent. The modern University, according to him, was initially guided by the Kantian concept of *reason*. In this paradigm, each discipline sought its own purity, what is essential to it. Because of its nature, there was a perpetual conflict between established tradition and rational inquiry which leads towards a universally grounded rationality.

The big paradox which was never resolved in Kantian version of the university is how to unify reason and the state, knowledge and power. This modern institution which was founded on the *autonomy* of reason, forbade any direct social effect.[15] As an institution, it couldn't be autonomous. Problematically if it is not autonomous, then reason departs. The problem of this autonomous idea of a modern institution is redefined by Schiller (1759-1805) as 'the difficulty of how one is to move from the 'state of nature' to the 'state of reason' without destroying nature. The answer for him was briefly through culture as a process of aesthetic education.'[16] Consequently in this second edition of the University as a modern institution, art intermediates between the passive determination of reason by nature and the active determination of nature by reason. This institution is not to abandon tradition, but it worked through in order for its true meaning to be understood.

So it is not a coincidence that a significant shift from philosophy to literary studies as the major discipline took place in the nineteenth and twentieth century; because as Readings argues, philosophy is the true representative of rationality, while literature is the identity of a culture. It is literature rather than philosophy that ties *people* together, since philosophy tends to be more *elitist*. In this among, art is a proper mediator to boost the communication between the two.

5. THE CORRESPONDING IDEAS

Understanding this tension between these different levels of concern – i.e. elitism an anti-elitism - is necessary to find out why a postmodern building should be 'one which speaks on at least two levels at once: to other architects and a concerned minority who care about specifically architectural meaning, and to the public at large, or the local inhabitants, who care about other issues concerned with comfort, traditional building and a way of life.'[17]

Two points are of great importance if we are to understand the philosophical discourses about postmodernism. Firstly to know that there has been a correspondence between art and institution, as the avant-garde movement propounded. And secondly, to recognize that a culture-driven form is a very underlying image of all different movements which we identify as the resources of what we call postmodernism.

Conversely, if we compare the basic premises of modernism and the avant-garde on the one hand and, the two structures of the University briefly outlined on the other hand, then we will recognize a correspondence between modernism and the University's rational form, and also between the avant-garde and the cultural type of the University. Epistemologically, this correspondence is a significant event. Because, it enables us to have a wider understanding about the mission that art must fulfil in relation to the society as a whole. It means that, there is a shared idea behind the avant-garde movements in art and the institution – as manifested in the University - stemming from culture's unifying function. In a word, while 'Rational Architecture', for instance, was pursuing an autonomous architecture made out of architect's purified elements and its elements only, 'Cultural Architecture' was looking for the way by which the architecture can take on an indirect function for the society.

6. CULTURE FACING CRISIS

When in 1983 Hal Foster revised his book *The Anti-Aesthetics*, he renamed it *Postmodern Culture.* However that was just a simple change of title, but it might direct us to the deconstructive *content*[18] of the postmodernism. Calinescu argues that such a culturally critical position in relation to the basic values of modernity, such as progress and rationality inherited by postmodernism, is one of the faces of modernity itself. [19] The point now is that it has recently found a position *against* modernity.

This problematic and paradoxical position of culture in the postmodern theory was intensively revealed by Jean Baudrillard for the first time. Emerging out of a Marxist tradition, he emphasizes on the dominance of the sign value in understanding the world, against a traditional use-value system. The fact that our culture is producing something quite different from traditional cultural settings: museums, monuments, galleries, libraries, cultural centres..., Baudrillard argues in '*The Beaubourg-Effect: Implosion and Deterrence*', indicates that the culture is no longer tied to specific exchanges or to determinate needs, but to a kind of total universe of signals. A key concept in Baudrillard's theory is *Beaubourg* which is an attempt by the elite to introduce culture to the masses. He approaches our present society, as a world saturated by images and communication, where objects and discourses no longer have any firm *referent* or grounding.[20] He considers architecture as the embodiment of a paradox deeply embedded within the contemporary cultural condition.

In this condition, where the culture has shifted to the anti-culture, it is no accident that Tafuri in *Towards a Critique of Architectural Ideology* calls to return to form without utopia; and Adorno writes that art can only be loyal to humanity through inhumanity toward it.[21] It is also why the term postmodernism was accompanying from the beginning with the terms such as 'complexities and contradiction'. All of these episodes unmask the reality that culture no longer has a specific content. It means that 'culture no longer functions as a specific referent to any one thing or set of things'[22]. In other words, while every thing in postmodernism paradigm is culturally determined, as it is affected by the avant-garde cultural interests, culture itself ceases to mean anything as such.

7. THE SKETCH OF AN IDEA

If we accept that that culture no longer has a specific content, then it could be concluded that the reason that we can not clearly set architectural products aside from the ordinary products of the practice of building-making is because of the current tendency to refer the function of architecture to culture, rather than considering architecture as a practice in relation to culture. So a big challenge that will emerge is how to examine, in this condition, the relationship between architecture and what has been traditionally non-architecture. Our proposal is that we must revise the paradigms we have used to make a claim for the function of architecture.

Writing on the idea of the University, Bill Readings has argued, 'we should seek to turn the dereferentialization that is the characteristic of the posthistorical University to good advantage. That is to say, we should try to think what it may mean to have a University that has no idea, that does not derive its name from an etymological confusion of unity and universality'.[23] This perspective could be readdressed to the context of architecture to believe that, although the lack of a single source of basic knowledge made architecture a problematic discipline in the period of modernity, architecture could be a leading discipline within the postmodern dereferentialized idea of knowledge. As such, the premise of this paper would reflect that our architecture now should not try to be driven from the escapism of a stubborn referential point, but we should try to think what it may mean to have an architecture that has no idea, that does not derive its name from an etymological confusion of unity and universality. In other words, a dereferentialized reappraisal *might* show architecture a way forward.

What makes this paradigm adaptable to architecture is that architecture is an institution. An institution can generate a particular paradigm of supplementary constraints for the statements to be declared admissible within its bounds.[24] This deals properly with what architecture really is. Architecture possesses the characteristics of an institution, because it 'frames' the possibilities.

8. CONCLUSION

In this investigation we did not seek to marshal a detailed analysis of the discourses surrounding both architecture and the university (as an instance of an institution). We did seek to highlight a set of correspondences between these two systems of cultural production, considering the critical position of culture itself.

Examined as a cultural system, our contention is that **a**rchitecture becomes **A**rchitecture when it takes on responsibility for working out the latent contradictions of the culture, when it offers to incarnate an idea that will resolve these contradictions. In other words, 'Beauty today can have no other measure except the depth to which a work resolves contradictions. A work must cut through the contradictions and overcome them, not by covering them up, but by pursuing them.'[25]

In this case, non-architecture, which is the context of most contradictions, begins actively to involve and to be involved in architecture, and consequently will affect architecture due to two characteristics: first, because of its freedom from the historical values of directional process and second, because of its freedom from priori goals or ends. That entails to propose an architecture with no idea, and to call for remodification of what is architecture and what is not architecture. We must therefore now shift our discussion of architecture from the *boundaries* between architecture and non-architecture to the *relationship* between architecture, as a mode of cultural production, to other cultural systems.

9. REFERENCES

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[18] if we could basically believe that there is any sort of content in it

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THE IMPORTANCE OF THE SPHEROIDAL FORM IN ARCHITECTURAL MORPHOLOGY; FOCUS ON THE GREATER LONDON AUTHORITY BUILDING (CITY HALL)

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ABSTRACT: This research paper sets out to explore the following research question: "what importance does the elliptical shape and spheroidal form offer when utilised in the design and construction of the tall office building in order to achieve energy efficiency?" This involves the exploratory case study of a spheroidal building, the Greater London Authority (GLA) building. The Greater London Authority building has been acclaimed as being energy efficient, with claims of 75 % reduction in its annual energy consumption compared to a high specification office building. This claim is explored to better understand the nature of the spheroidal form in construction. The Greater London Authority building appears to have achieved a high level of energy efficiency but a number of problems have been reported. However, it is not clear how many of these problems are associated with its morphology.

Keywords – Energy efficiency, Greater London Authority building, Spheroid

1. INTRODUCTION

1.1 Reason for focus on the Spheroid Form

The focus on the spheroid form is predicated on important factors that have been identified from literature reviewed:

"… a sphere is already efficient: it encloses the most volume with the least surface." (Baldwin, 2004 p. 1) "…as the most economical shape for containing matter, the sphere's perfect form has fascinated the minds of men for millennia. From planets to raindrops, nature adores the sphere." (Sautoy, 2004 p. 2) "…the sphere is a special case of the spheroid in which the generating ellipse is a circle." (Wikipedia, 2004)

"…another problem with sphere shaped building is thermal expansion and contraction. The sphere is the worst possible shape for that. Not only is it a single surface, but it also has constant curvature in all directions. A prolate spheroid or oblate spheroid would do better than a sphere, having different curvature in different directions." (Ambrose, 2002 p. 53) (refer to fig. 5 and fig. 6 for prolate and oblate spheroid illustration and section 2.2 for their definition)

The following deductions are derived from these factors: the first and second factors suggest the sphere as being the most efficient way of enclosing volume and this provides the opportunity to accommodate as much gross floor area as possible with the least surface area available. This minimises surface area exposure to external climatic conditions and permits minimal use of energy to control internal climatic conditions. The third factor identifies the relationship between the sphere and the spheroid; however the fourth factor identifies two types of spheroids (refer to fig. 5 and fig. 6) and suggests that they perform more satisfactorily in thermal expansion and contraction than the sphere. The reason for focus on the spheroid form pertains to its quality of volume enclosure efficiency, which hypothetically suggests its potential in tackling the research problem.

2. LITERATURE REVIEW

2.1 Statement of the Research Problem

"The question of what shape a building should be is one of the most fundamental issues that confront an architect." (Hawkes, 1996 p. 36) The importance of this statement is predicated on two factors, which are related, one is the factor of energy efficiency and the other is the factor of cost efficiency, with the latter being a derivative of the former. Factors one and two are identified as issues in two questions; "What shape should a building be to reduce heat losses?" (Martin and March 1972 p. 57) and "What shape should a building be to reduce its cost?" (Martin and March 1972 p. 67) Further, from literature reviewed five important factors have been identified:

"The Energy Review (PIU, 2002) highlights the need to improve energy efficiency in buildings and recommends action to deliver a phased transition to low energy commercial buildings through the development of the Building Regulations." (Wade et al, 2003 p. 1)

"Within the commercial sector, offices, together with warehouses and retail premises, are a significant contributor to energy use and carbon emissions. From these three sub-sectors, offices seem to offer the greatest potential for action to achieve significant savings: the range of technical solutions is not too large as the nature of energy service demands in offices is relatively homogenous…." (Wade et al, 2003 p. 4) (refer to table 2) The pie chart in figure 3 (refer to fig. 3), "shows that space heating makes the largest contribution, of about 58%, to the total annual consumption of delivered energy of these office premises. A further 15% results from lighting, followed by 7% from computers and computer accessories, and 5% from water heating. The remaining 15% comes from a variety of energy uses including cooling, catering, fans, and small power equipment." (Mortimer et al, 2000 p. 715)

"The rapid growth in energy consumption in offices over the last three decades reflects expansion in floor space, and increased heating, lighting, IT and air conditioning (A/C) loads in individual buildings." (Wade et al, 2003 p. 5) Mortimer et al, (2000) collaborate this statement by summarising results for the sample of eighty-four office premises in which a relatively good correlation between total annual consumption of delivered energy and gross external floor area is suggested (refer to fig. 1 and refer to fig. 4). "Hence it can be concluded that energy use in offices is related, quite clearly, to floor area. [In fig. 1 and fig. 2] The gradient represents part of this relationship which in this case indicates that total annual consumption of delivered energy increases by about 500 GJ yr^{-1} for every additional 1000 m^2 of external floor area." (Mortimer et al, 2000 p. 715)

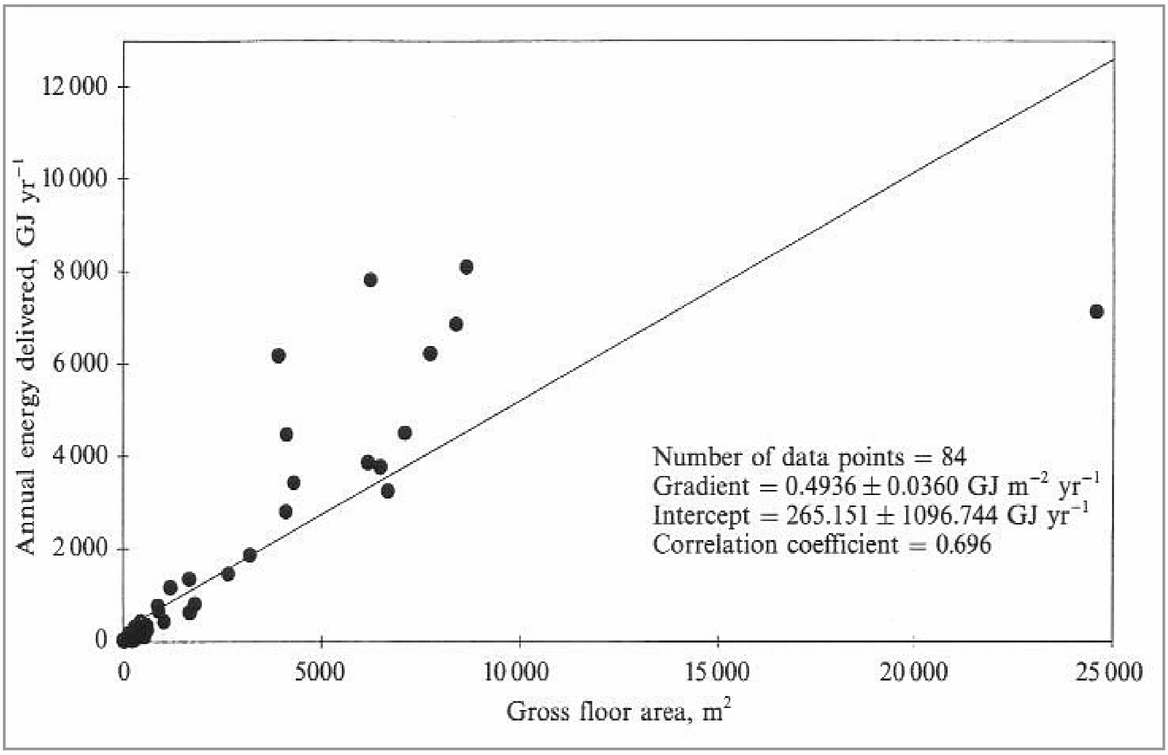


Fig. 1 Variation of total annual consumption of delivered energy with gross floor area for office premises (Figure source: Mortimer et al, 2000 p. 714), where the gradient indicates that total annual consumption of delivered energy increases by about 500 GJ yr $^{-1}$ for every additional 1000m^2 of external floor area thus suggesting a relatively good correlation between delivered energy and external floor area

"One commonly cited reason for the lack of investment in energy efficiency in buildings is that energy represents a small percentage of total occupancy costs, and therefore it is given little attention. However, in offices, particularly air conditioned ones, energy and the maintenance of heating and cooling equipment comprises a significant proportion of service charges." (Wade et al, 2003 p. 13)

"In 2000, A/C office buildings had an average annual service charge of £53.82 per m^2, compared to £37.24 for non-A/C buildings (Jones Lang LaSalle, 2001) (refer to table 1 and fig. 2). Thus, in A/C offices energy itself represents 16% of total service charges; by including maintenance of heating and A/C systems this brings the proportion up to 35%. These are significant proportions, and therefore one might expect that tenants would be interested in lowering energy consumptions in their premises." (Wade et al, 2003 p. 14)

Table 1. Service charges in UK offices by component percentages in 2000

	A/C	**Non A/C**
Energy	16 %	11 %
Heating and A/C maintenance	19 %	9 %
Other	65 %	80 %

Based on Jones Lang Lasalle (2001) (Table source: Wade et al, 2003 p. 14), where in 2000, A/C office buildings had an average annual service charge equalling £53.82 per m^2, which is higher than the £37.24 for non-A/C buildings

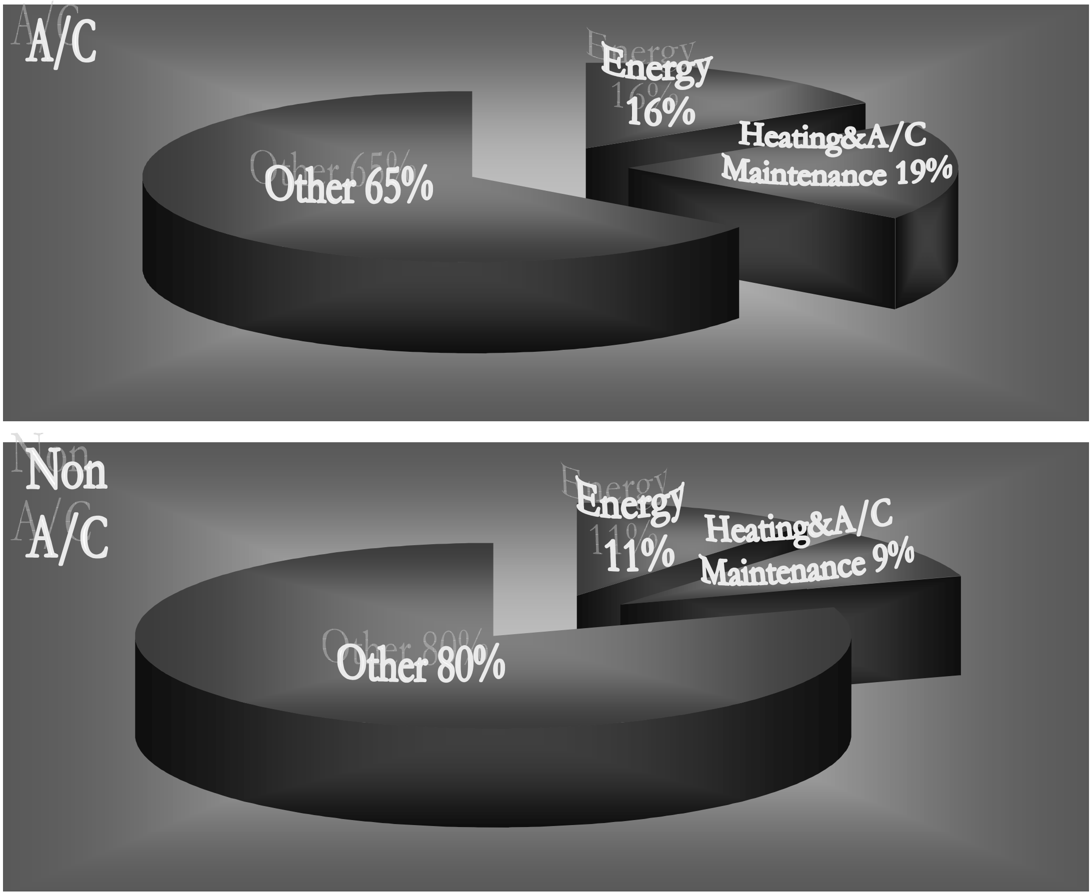


Fig. 2 Service charges in UK offices by component percentages in 2000 Based on Jones Lang Lasalle (2001), where in 2000, A/C office buildings had an average annual service charge equalling £53.82 per m^2, which is higher than the £37.24 for non-A/C buildings

Table 2. Energy consumption and CO_2 emissions in UK commercial offices

	Heating	Hot water	Catering	Light	Cooling	Small Power	IT	Other	Process	Unknown	Total
Fossil fuels (PJ)	46	5	3	-	-	-	-	-	-	-	**54**
Electricity (PJ)	5	0	3	16	11	2	12	2	3	0.3	**56**
CO_2 (kT)	3680	469	370	2238	1319	250	1031	184	7	121	**9669**

(Table source: Wade et al, 2003 p. 4) where table depicts the homogenous nature of energy service demands in offices, despite consumption and emission levels, thus indicating potential for significant savings

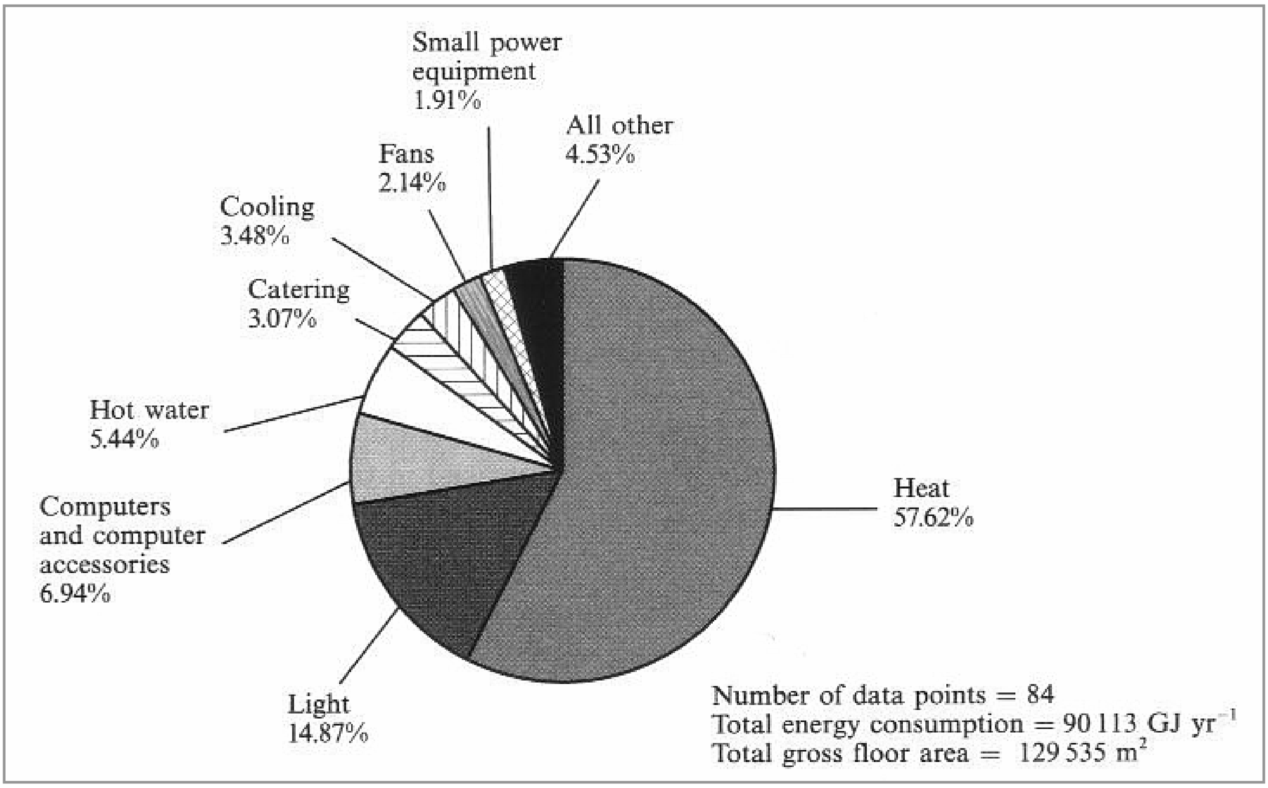


Fig. 3 Aggregated annual energy consumption by application for office premises (Figure source: Mortimer et al, 2000 p. 715), where space heating makes the largest contribution, at ≈ 58%, to the total annual consumption of delivered energy of these office premises

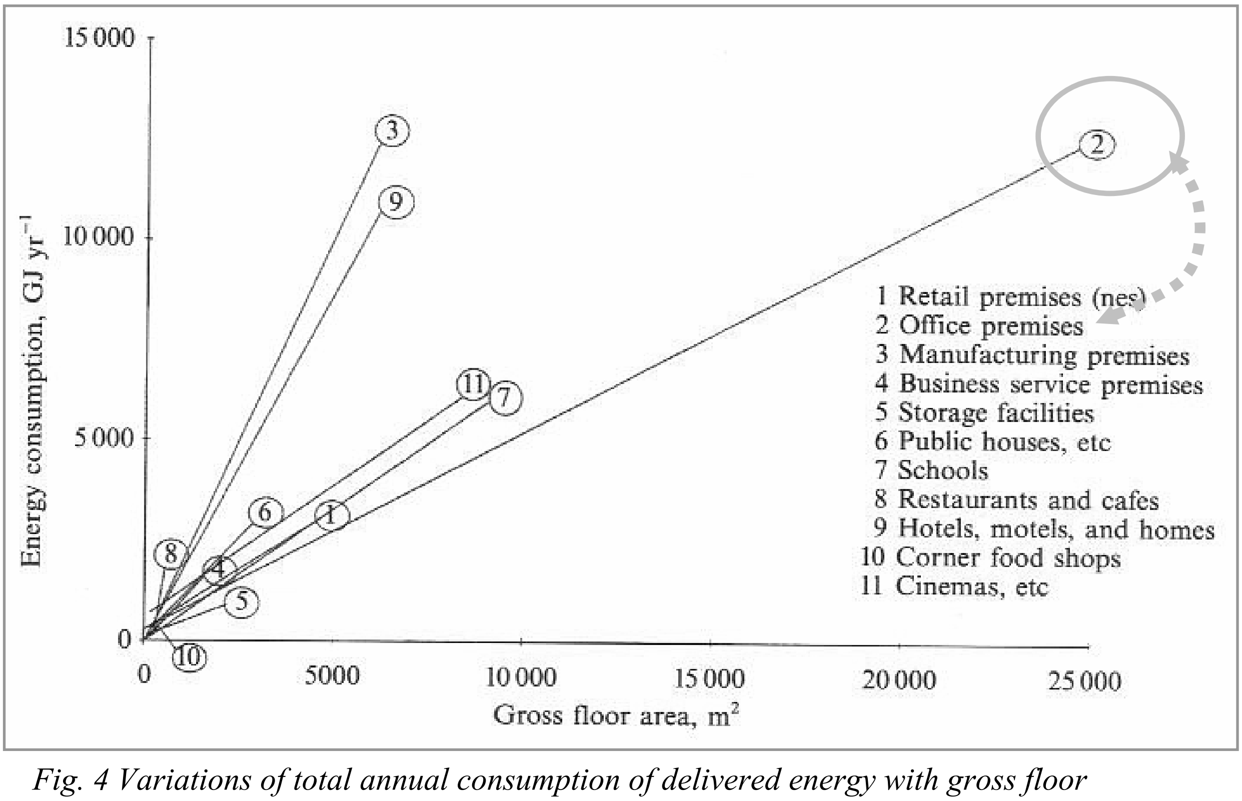


Fig. 4 Variations of total annual consumption of delivered energy with gross floor area for activity categories (Figure source: Mortimer et al, 2000 p. 718), where the gradient indicates a relatively good correlation between delivered energy and external floor area

In researching the problem of energy efficiency in tall office buildings, this paper focuses on the spheroid form, and its nature, as well as potential will better be understood through knowledge of its concept.

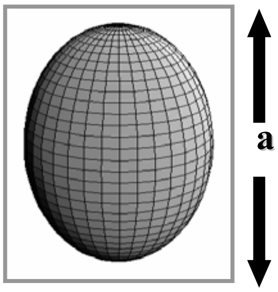
2.2 The Spheroid Form Concept

Wikipedia (2004) defines a spheroid as a quadric surface in three dimensions obtained by rotating an ellipse about one of its principle axes. Further, Ambrose (2002) identifies two types of spheroids; one is stated as a prolate spheroid (refer to fig. 5) and the other as an oblate spheroid (refer to fig. 6). A prolate spheroid is obtained by rotating an ellipse about its major axis (refer to fig. 5) and has morphology similar to that of the Greater London Authority Building (refer to fig. 7). An oblate spheroid is obtained by rotating an ellipse about its minor axis (refer to fig. 6) and has morphology similar to that of a geodesic dome, such as the US Pavilion at Expo '67 (refer to fig. 8). The volume and surface area of a prolate and oblate spheroid are influenced by eccentricity of the ellipse (e), as well as by major axis length (a) and minor axis length (b) (refer to table 3). Wikipedia (2004) further describes a sphere as a special case of the spheroid in which the generating ellipse is a circle, while a spheroid is a special case of an ellipsoid, where two of the three major axes are equal.

Table 3. Volume and Surface Area data for a Prolate and an Oblate Spheroid

Spheroid Type	**Volume**	**Surface Area**
Prolate Spheroid	$4/3\ \pi\ ab^2$	$\pi\ (\ 2a^2 + b^2/e\ 1n\ (\ 1 + e/1 - e)\ )$
Oblate Spheroid	$4/3\ \pi\ a^2b$	$2\pi b(b + a \cdot \arcsin(e)/e)$

Where e is eccentricity of the ellipse = $(1 - (b^2/a^2))^{1/2}$, a is the major axis length b is the minor axis length



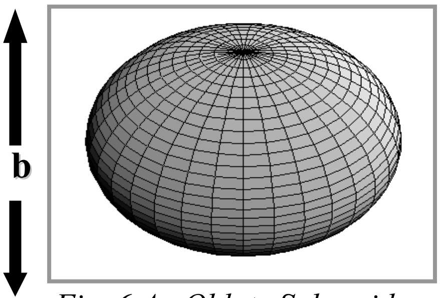


Fig. 5 A Prolate Spheroid *Fig. 6 An Oblate Spheroid*
(Image Source: http://en.wikipedia.org/wiki/Spheroid)

Fig. 7 Greater London Authority Building *Fig. 8 US Pavilion at Expo '67*
(Image sources: GLA and Image Gallery Biosphere Expo 67 US Pavilion)

The theoretical focus on the spheroid form has necessitated the first author's investigation of this form in practice as represented by the exploratory case study of the Greater London Authority building (City Hall London).

3. CASE STUDY

3.1 Greater London Authority building (City Hall London)

On the 23rd of July 2002, the New City Hall, known as the Greater London Authority (GLA) building was officially opened by Her Majesty, the Queen, and was heralded as a solution to the issue of environmental efficiency in tall office buildings. However, concerns have arisen regarding its claims of energy efficiency.

The design and construction of the Greater London Authority building led to the emergence of arguments relating to the actual and perceived problems, as well as benefits associated with the use of the spheroid form in attempting to achieve environmental efficiency in tall office buildings.

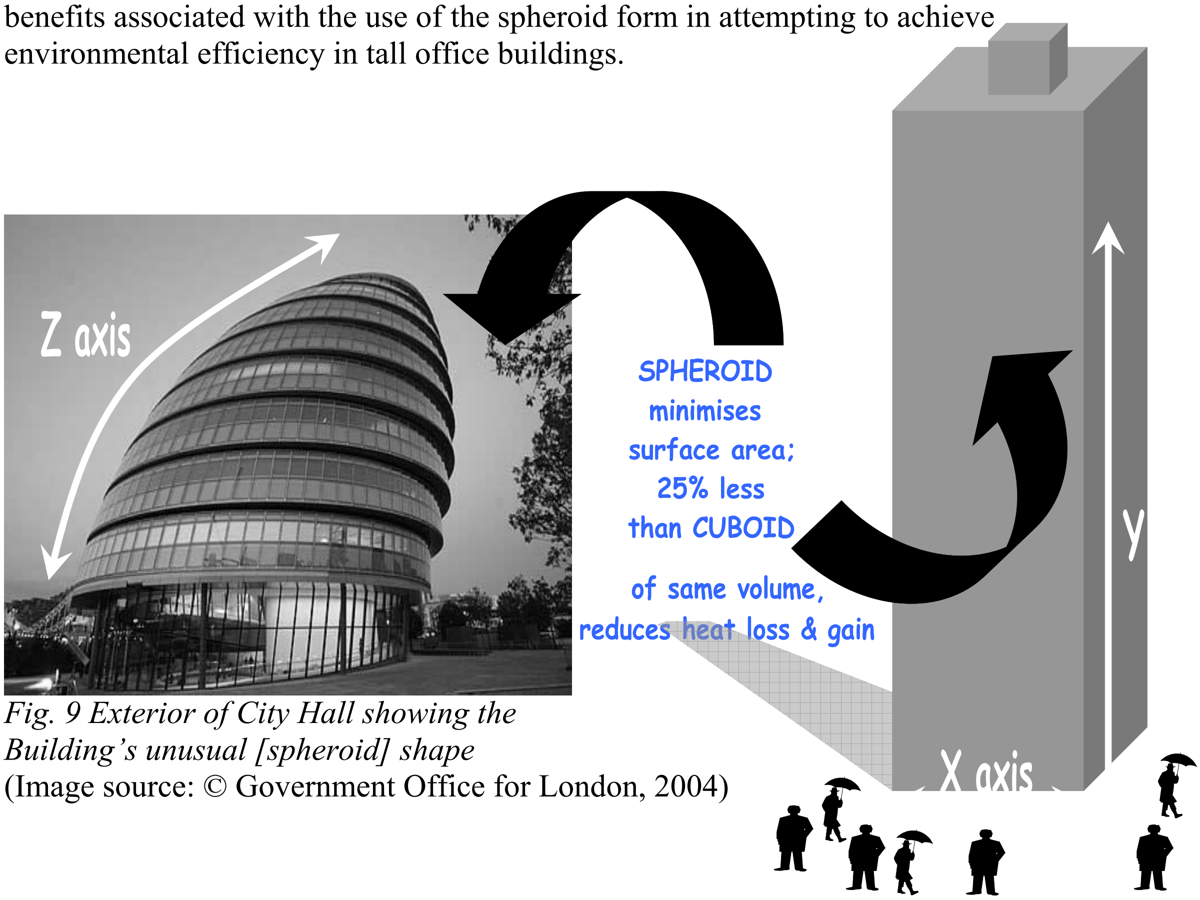


Fig. 9 Exterior of City Hall showing the Building's unusual [spheroid] shape
(Image source: © Government Office for London, 2004)

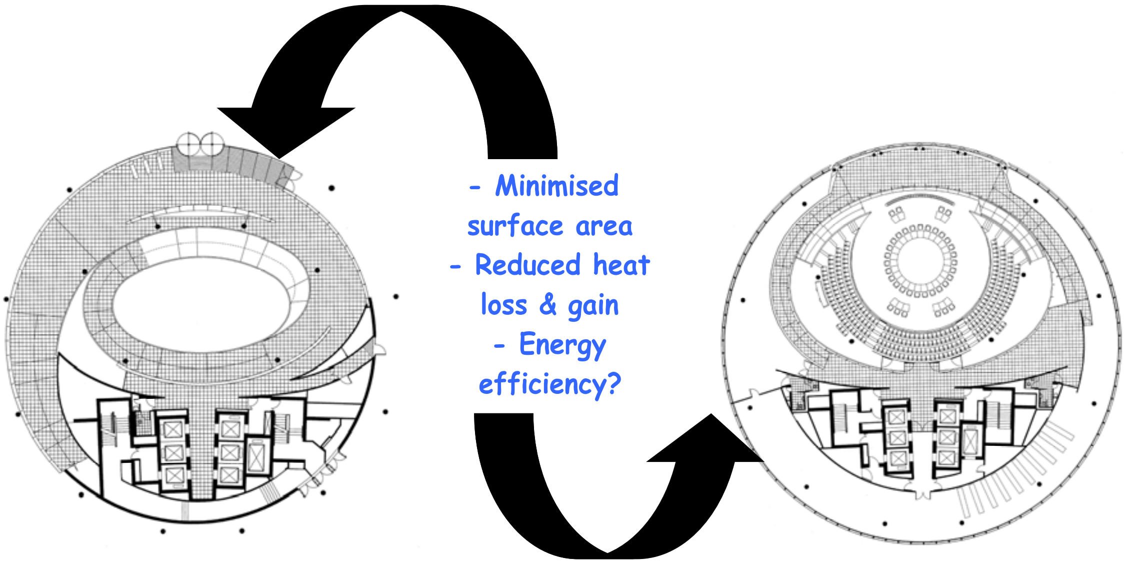


Fig. 10 GLA Building's Ground floor plan
(Image source: © Foster and Partners)

Fig. 11 GLA Building's 2nd floor plan
(Image source: © Foster and Partners)

According to (Powell, 2002, p. 1), "for Ken Shuttleworth of Foster and Partners, 'the starting point of the project was to reduce the energy load of the building by 75 percent.' The headquarters of the Greater London Authority, to be known as City Hall, is nothing if not environmentally responsible, a practical demonstration, the architect claims, of the potential of sustainable design in a world city where, so far, that concept has made a negligible impact."

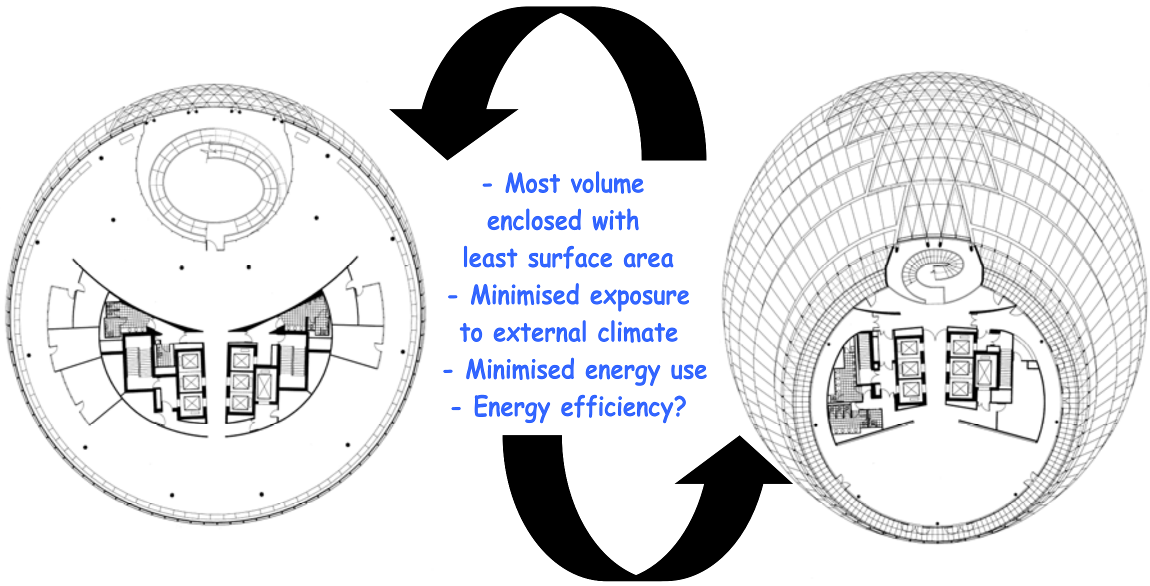


Fig. 12 GLA Building's 3rd floor plan
(Image source: © Foster and Partners)

Fig. 13 GLA Building's 9th floor plan
(Image source: © Foster and Partners)

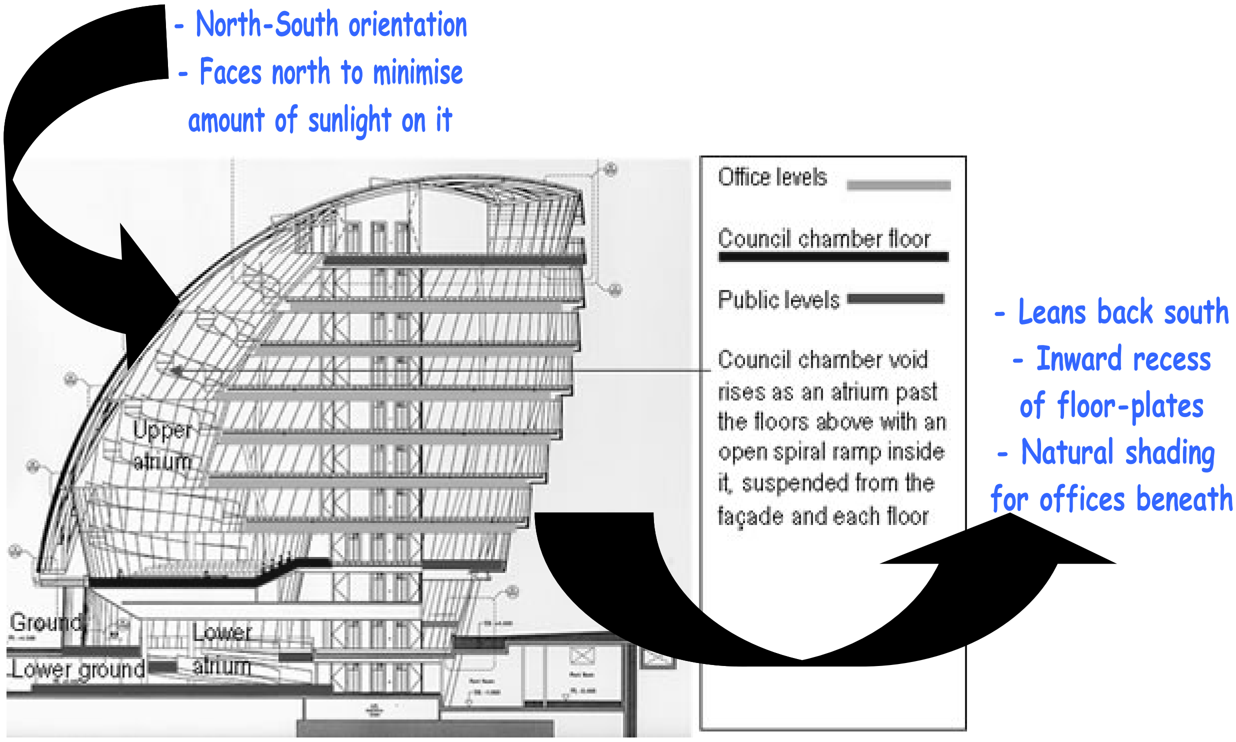


Fig. 14 GLA Building's section showing the main components of the accommodation
(Image source: © ARUP 2005)

3.2 Energy efficiency exploration of the Greater London Authority Building

"Energy consumptions for [the Greater London Authority Building's] environmental systems are less than half levels in DETR good practice office guide. (refer to table 4) The radical shape of the building minimises the surface area (approximately 25 percent less than equivalent rectangular building), is self shading and the high performance façade ensures excellent energy efficiency." (Greater London Authority 2005 p. 1)

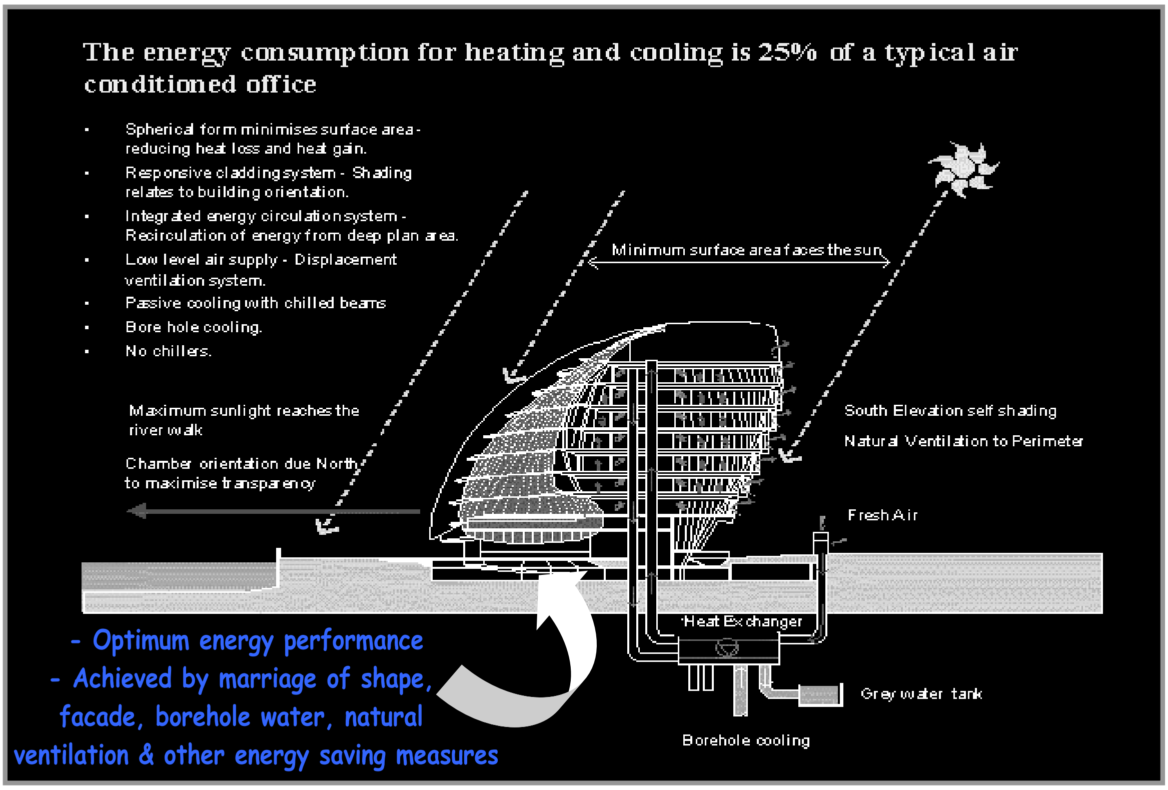


Fig. 15 Greater London Authority Building's Environmental Details
(Image source: Foster and Partners 2005)

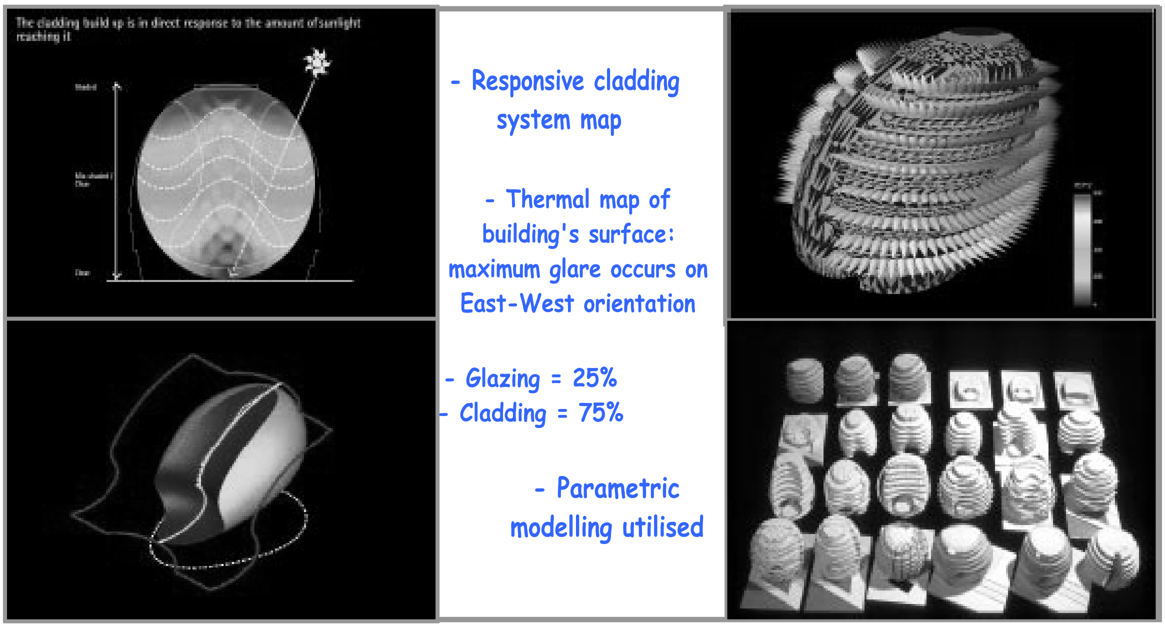


Fig. 16 Cladding system map, Thermal map, Parametric modelling, Glazing/Cladding
(Image(s) source: Foster and Partners 2005)

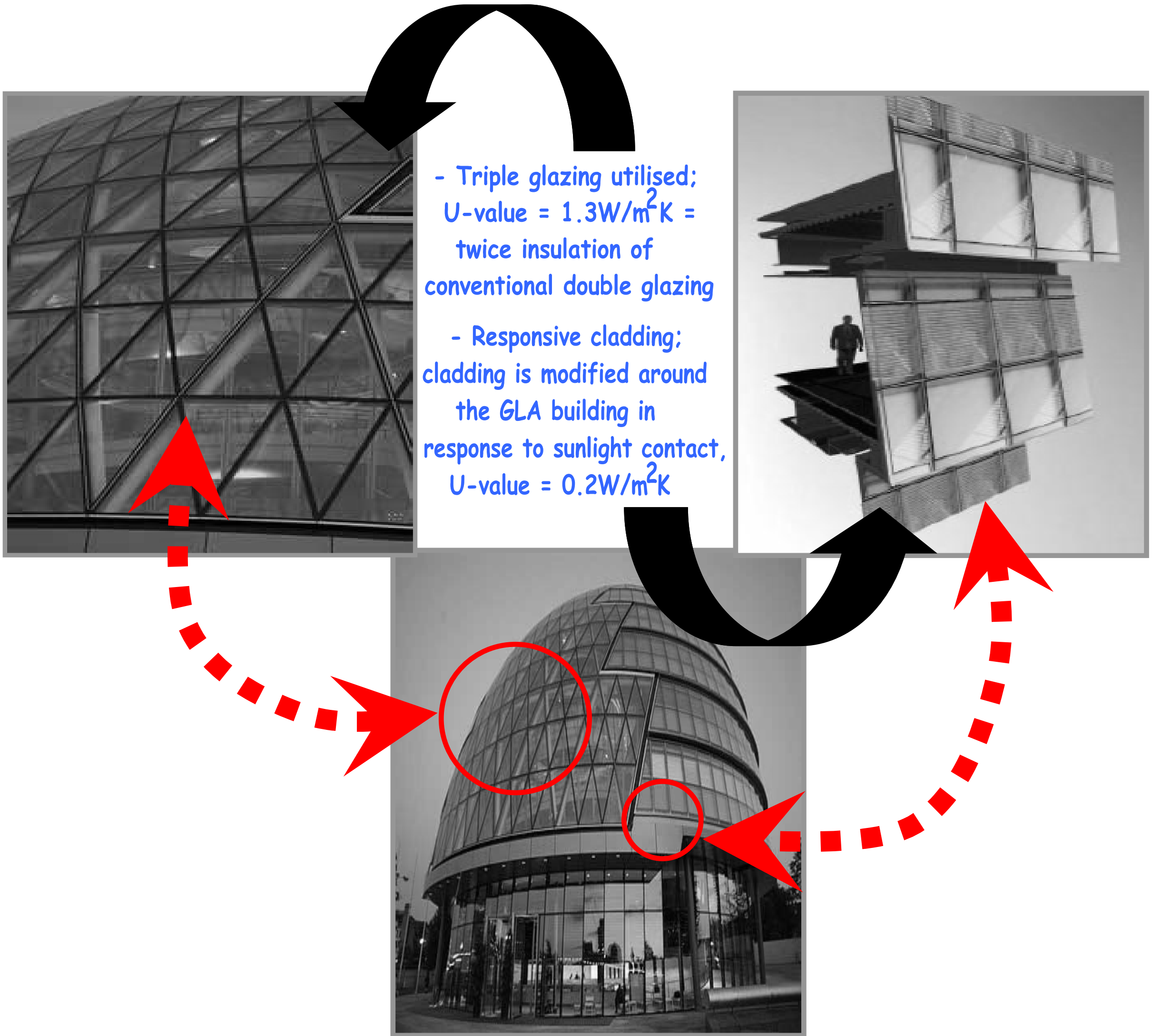


Fig. 17 Greater London Authority building's triple glazing and responsive cladding
(Image(s) source: Foster and Partners 2005)

Table 4. Typical and Good Practice Energy Consumption in Offices in the UK

	kWh/m² of treated floor area							
	Type 1		**Type 2**		**Type 3**		**Type 4**	
	Good practice	**Typical**	**Good practice**	**Typical**	**Good practice**	**Typical**	**Good practice**	**Typical**
Heating & hot water	79	151	79	151	97	178	107	201
Cooling	0	0	1	2	14	31	21	41
Fans, pumps & controls	2	6	4	8	30	60	36	67
Humidification	0	0	0	0	8	18	12	23
Lighting	14	23	22	38	27	54	29	60
Office equipment	12	18	20	27	23	31	23	32
Catering	2	3	3	5	5	6	20	24
Other electricity	3	4	4	5	7	8	13	15
Computer room	0	0	0	0	14	18	87	105
TOTAL	**112**	**205**	**133**	**236**	**225**	**404**	**348**	**568**

Based on DETR (2000b) (Table source: Wade et al, 2003 p. 7)
(Where **Office Type 1**: Naturally ventilated cellular; **Office Type 2**: Naturally ventilated open-plan; **Office Type 3**: A/C, standard; **Office Type 4**: A/C, prestige)

Mean of good practice levels = (Type 1 + Type 2 + Type 3 + Type 4) ÷ 4…equation 1
Mean of good practice levels = (112 + 133 + 225 + 348) kWh/m^2 ÷ 4 ….equation 2
Mean of good practice levels = 818 kWh/m^2 ÷ 4 …equation 3
Mean of good practice levels = 204.5 kWh/m^2 …equation 4

If the Greater London Authority (GLA) building's pre-occupancy environmental systems energy consumption is, as claimed, less than half levels in DETR (Department of the Environment, Transport and the Regions) good practice office guide, then from equations 1, 2, 3 and 4 we derive:

GLA building's energy consumption level = ½ (Mean of good practice levels) …..... 5
GLA building's energy consumption level = ½ (204.5 kWh/m^2) ...equation 6
GLA building's energy consumption level = 102.25 kWh/m^2 ...equation 7
GLA building's energy consumption level = < 102.25 kWh/m^2 …equation 8

It can be deduced from the results of equations 1 to 8 that the pre-occupancy energy consumption level claims of the Greater London Authority building is less than half mean levels in DETR good practice office guide, is less than individual DETR good practice office guide total levels for Type 1 (Naturally ventilated cellular) and Type 2 (Naturally ventilated open- plan), and is less than half levels in DETR good practice office guide for Type 3 (A/C, standard) and Type 4 (A/C, prestige) (refer to table 4 and refer to fig. 18).The Greater London Authority building's pre-occupancy low energy consumption claim can be attributed not only to its spheroid form but also to other innovative solutions, such as:

– "For cooling the building, naturally chilled borehole water is brought up 125m from the aquifer below the London clay. The boreholes use less energy than conventional chillers and cooling towers and are an economical alternative to install and maintain." (Arup 2002 p. 1)
– "The diagrid structure supports the north façade of the GLA building and is in fact the largest radiator in London. The majority of the horizontal steel elements, measuring a staggering 300mm in diameter each, have hot water coursing through them to act as a discreet heater for the atrium space that doesn't require extra fittings or pipe work installation." (Arup 2002 p. 1)
– "Detailed analysis by Arup resulted in the design of a very efficient façade. It is made up of insulated panels that reduce the solar gain, as well as heat loss to half that of a normal office building." (Arup 2002 p. 1)
– "The façade also incorporates flexible, locally controlled natural ventilation. When the natural air vents are opened, 'smart' air conditioning and heating systems deactivate themselves in the adjacent area to prevent energy waste." (Arup 2002 p. 1)

In the comparison of energy consumption levels (in kWh/m^2), based on data from table 4, in relation to the result from equations 1 to 8, we have in figure 18, **Type 1** (Good Practice) = 112 kWh/m^2, **Type 2** (Good Practice) = 133 kWh/m^2, **½ (Type 3** [Good Practice]) = 112.5 kWh/m^2, **½ (Type 4** [Good Practice]) = 174 kWh/m^2, **½ Mean** (Type 1+Type 2+Type 3+Type 4) = ½ Mean (2231 kWh/m^2) = ½ (278.87 kWh/m^2) = 139.43 kWh/m^2, **GLA building** pre-occupancy energy consumption claims (Greater London Authority building pre-occupancy energy consumption claims) < 102.25 kWh/m^2, where the GLA building pre-occupancy energy consumption claim is graphically represented as lower than the other energy consumption levels for the office types.

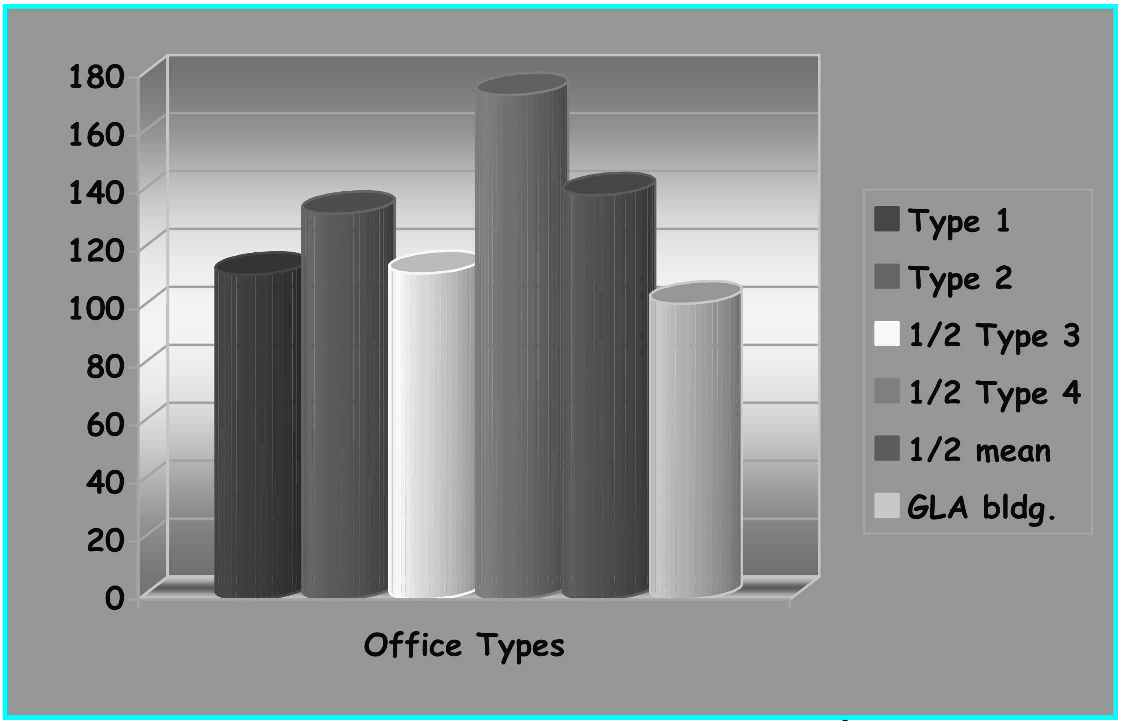


Fig. 18 Comparison of ***Energy consumption levels in kWh/m²*** *for Office Types*

The apparent energy efficiency of the Greater London Authority building, based on its pre-occupancy energy performance claims, has necessitated the first author's exploration of its post-occupancy energy performance prior to the conduction of a post-occupancy analysis at a later date in his PhD research. Some concerns have been raised relating to the energy performance of the Greater London Authority building.

3.3 Greater London Authority building's energy performance concerns

Greater London Authority building's (City Hall London's) pre-occupancy energy efficiency claims heralded it as a solution to the issue of environmental efficiency in tall office buildings. However, concerns have arisen regarding its claims of energy efficiency.

One of such concerns occurred during a question and answer session between Liberal Democrat Assembly Member, Mike Tuffrey, and Mayor of London, Ken Livingston, on the 14th September 2005. According to Ken Livingstone (2005 p.1), "recent research has shown that the energy use of City Hall is approximately 50% greater than envisaged at the design stage…"

Based on the relationship between City Hall London's Pre-Occupancy energy efficiency claims, the present DETR energy benchmark, and City Hall London's post-occupancy energy performance concerns (as confirmed by the Mayor of London), the first author will conduct a Post-Occupancy Analysis Building Use Study (BUS) at a later date in his PhD research in order to evaluate the post-occupancy energy performance of City Hall London as it relates to its spheroid form.

4. SUMMARY

This paper explored the spheroid morphology when utilised in the design and construction of the tall office building in order to achieve energy efficiency. An exploratory case study was carried out on a spheroid building, the Greater London Authority (GLA) building, focussing on its energy performance. The Greater London Authority building was acclaimed as being energy efficient, with claims of 75 % reduction in its annual energy consumption compared to a high specification office building. Its energy efficiency claims were explored in comparison to that of other office types, utilising the DETR (Department of the Environment, Transport and the Regions) energy benchmark. There appears to be disparity between the Greater London Authority building's pre-occupancy energy performance claims/aspirations, its post-occupancy energy performance, and the DETR energy benchmark for good practice energy consumption in United Kingdom offices. The Greater London Authority building's energy performance was explored to better understand the importance of the spheroid form in the architectural morphology of twenty-first century office buildings.

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DESIGN METHODOLOGY FOR INNOVATIVE ROOFS

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ABSTRACT: Traditional roofs have primary, passive, functions such as protection against rain, wind, snow etc. Nowadays, roofs are increasingly used as preferred location for additional functions such as photovoltaic systems, roof lights and safety devices. New approaches, on designing as well as assembling the roof, are necessary; tools for innovative roofs or Active Roofs. This research offers an integral approach for a domain dependant design methodology. The methodology is complemented with morphological matrices and a database structure as design tools. In order to implement and train the knowledge for the several users, 'learning by doing' workshops are proposed. The knowledge generated in this project will benefit the Building Services research and education at Technische Universiteit Eindhoven, Delft University of Technology and the TNO Building and Construction Research. The developed methodology will also be implemented in the sixth European framework program; EUR-ACTIVE ROOF-er, with partners in industry and professional organizations throughout Europe.

Keywords – Innovative Roof, Design, Integral, Methodology,

1. WHY A DESIGN METHODOLOGY FOR INNOVATIVE ROOFS?

1.1 From roofing to Active Roof: challenge for change of culture, process and products

The current situation for the roofing industry is one of delivering a specific roof covering for a building, a position in the total building process at the end of the decision-chain, with limited influence on the design- and the construction aspects. Related to his product the roofer, partly forced by his market position, only gives quality control on products and not on the total roof. Due to his role as deliverer and sub-contractor with many other participants, the roofer has a very weak position with restricted added value.

In the meantime many new products and participants are added to the building design and building process. Traditionally, the installation of accessories on roofs is the domain of roofers, having the knowledge and experience of successful mounting and integrating roof products in both new and existing roofs. However, adding new elements to a roof requires specific knowledge of both the behaviour of the product and its effect on the building envelope performance, e.g. wind load, blocking of water and snow, on the structural strength, water tightness and increased risks of condensation. It also raises significant new safety issues. In his current position, the roofer is forced to much problem solving with no influence on the process. New, more challenging, forms of organization and contracts are not easy to introduce to clients of contractors.

Related to the design-process there are many aspects which frustrate a better use of the collaboration between the roofers or roof-industry with clients and architects. First there is a lack of diverse information, language and knowledge. Secondly there are different levels of technical sophistication in the design and building process. Third aspect, if there should be a possibility to innovate; there is a lack of knowledge about innovative roof systems and how to integrate them in the building design (HBA, 1999; EURACTIVE ROOFer, 2005; Freedonia, 2005).

Referring to the current situation there is a need for change. The word Active Roof is the concept word related to these changes; the possibility or need to change the culture, process and product related to the roof. Active has in this context several meanings. *Active* roof as an innovative product. This could be in scale of the module (tile), element (prefabricated part), component (total engineered roof) or even the total building. *Active* roof with the described product possibilities means also a more active role in the process. This means other kinds of knowledge, skills, organization and responsibilities. This transformation needs changes, in graduation related to the scale of change, of culture of the roofers, the roof-industry, roof-federations etc.. Change of culture is in fact, in relationship to each other, the simultaneously step by step awareness and transformation of these several aspects. An *active* attitude of the total roof-culture is needed in order to design and construct innovative and better roofs.

Analysis of the problems to be solved gives direction to the aspects which should be incorporated into the solution(s).

1.2 Analyses for changes

During the traditional design process, mechanical- and electrical- engineers are asked to implement their design and to suggest appropriate systems, after the architect and the client agreed on a design concept. The design concept for the building can be defined as a general massing scheme, with orientation, fenestration and usually the general exterior appearance as determined by these characteristics as well as basic materials. There is a limited possibility of optimization during the traditional process, while optimization in the later stages of the process is often troublesome or even impossible (Quanjel, 2003).

Especially for the roof design this often means addition of many stand alone, mono-functional, technical equipment. This causes sub-optimal solutions for attainability, lay-out, performance and management of the equipment as well as more possible damage to the building construction and future severe discomfort. The design and performance implications, related to building in relationship with the roof, are:

- little advantage of the potential benefits offered by sustainable energy, for instance solar gain during the heating season, resulting in greater heating demand;
- little advantage of day lighting potential, due to a lack of appropriately located or dimensioned roof glazing / atria / patios, or a lack of features to bring the daylight further into the interior of the building;
- no use of the future possibilities as an additional space for extra functions and doesn't give space for possibilities to use the roof as an ecological landscape;
- more extra work, attuning and management on the construction-site, more potential failures etc. to get the necessary final quality, it means also poor working conditions (Larsson, 2001).

Presently most design approaches fail to provide solutions for real collaboration. The reasons for this are:

- the information needed is diverse, scattered, incompatible and often in different 'languages', each domain has its own meaning to components and aspects. Adequate decisions require a multidisciplinary approach, involving product and processing know-how, knowledge about logistics, legislation, architect/ customer preferences, etc.;
- various members of the design and building process have different levels of technological sophistication (e.g. prefab and computing facilities, expertise);

- the workflow (i.e. the sequence of actions and communications needed for negotiation, collaboration and optimize) underlying the design process is often unclear, which hinders collaboration (Quanjel, 2003).

Additional to the mentioned items there are two other important aspects related to the active roof. The first one is related to the roof as protector of the building structure, as the fifth façade to the comfort of the users of the building. Comparing to the development of the integrated façade-systems by the industry and the design of the building there is a clear shortage of knowledge and development for the integrated roof. This situation generates sub-optimal solutions and causes damage to installed energy systems, roof constructions, comfort of buildings and loss of energy. The second one is related to the roof as active energy-generator and the architectural- and urban design. Related to the integrated designed façades as energy-generator, there is a lack of good integrated roof –products and –components and about how the several aspects can be integrated in the early stage of the building design process. Approximately 20% of the potency of the use of sustainable energy by the roof surface as 5th façade is thereby neglected (HBA, 1999; Freedonia, 2005).

2. WHAT KIND OF DESIGN METHODOLOGY IS NEEDED AND FOR WHOM?

First of all there is a lack of knowledge and information about the design and the incorporation of innovative techniques and architecture for the roof, related to the total building. Insight into the new opportunities and skills to implement these innovative aspects into the design is needed for building designers as well as product designers. This means new knowledge, skills in designing, organization and responsibility. Poor design of products, elements or components related to the total building leads to structural problems during the life-cycle use of the building and sub-optimal use of the roof and building.

Second main influence is related to the assemblage, maintenance and safety aspects of these new products. The quality of these products as well as safety equipment for installation and maintenance is, when installed in a roof system, in many cases insufficient because there are no standards or legislation to assess their performance. At the same time, good products get poorly installed by inexperienced roofers. This leads to significant numbers of (preventable) failures from rain- and snow water ingress, wind damage and condensation (HBA, 1999; EURACTIVE ROOFer, 2005).

The main objective for a design methodology in this research project is to improve the interaction between design participants of active roofs in product development from an architects and customers perspective. This programme of requirements is on the basis of those technological product specifications that architects and customers deem to be the most important product and system benefits. The users-group varies from participants involved with engineering and constructing roofs and buildings (roofers, roof consultants, roof industry, builders and contractors), designers (roof product/component designers, design team members, architects) and clients. The methodology has to support not only the architect but the whole design team in the early phase of the design process on integrating active roofs – as energy generating integrated building components – in relationship with the product development of the active roof itself.

This variety of users requires a common framework for different information exchange with respect to the level of sophistication of each of the organisations and designers and engineers involved. Moreover, the information to be shared must be interpretable (language, terminology and definition) by all designers and engineers. These information has to fit with the decisions to be made in designing new products and systems as well as the implementation into the building design process.

The way to implement the information for the development of the roof as added value product is strongly related to that of structuring and changing the process and organization as coherent system. This leads to the following aspects which should be incorporated into the approach and result of a design methodology. These aspects are strongly related to the fact that the research is connected with the sixth research programme EURACTIVE ROOFer, with a European perspective.

In short, a domain dependent design methodology has to incorporate:

- a general outline of a data base for existing and future integrated active roof systems;
- an integral design methodology for multidisciplinary collaborative design of active roofs;
- a 'path to success model' for multidisciplinary product-innovation by process-innovation of building and product design / engineering focussed on active roofs;
- a selection matrix to support the decision making for the best active roof concept in the specific design product;
- possibilities for the analysis of comfort HVAC-design, -engineering and installing, providing a process approach that is applicable to comfort (HVAC) design, engineering and installing practice (EURACTIVE ROOFer, 2005).

3. APPROACH FOR THE DESIGN METHODOLOGY FOR ACTIVE ROOFS

3.1 Introduction

The outline of design (activities) integration is based on the integral approach as defined by Quanjel and Zeiler (Quanjel, 2003). According to them the integral approach "…represents a broad view on the world around us that continuously needs to be adapted and developed from sound and documented experiences that emerge out of interaction between practice, research and education…" This integral approach can eventually lead to integral process, team and method – all the required conditions (and parts of integral design methodology) for design and integration of sustainable comfort systems in buildings.

This integral approach encompasses the built environment from initiative to design, construction and real estate management as a seamless whole. This seems to contradict with the subdivision of the construction industry in phases, in which parties operate with opposing interests, resulting in disintegration and waste. The coordination of these independent phases, scales, decision-makings and disciplines are crucial to the creation of a built environment in which the people concerned feel comfortable. This is the core of the integral approach. Integral design is meant to overcome, during design team cooperation, the difficulties raised with the early involvement of consultants. This is achieved by providing methods to communicate the consequences of design steps between the different disciplines at early design stages. The aim is to support all disciplines with information about the tasks and decisions of the other disciplines. Supplying explanation of this information will improve understanding of the combined efforts (den Hartog, 2003).

In order to achieve the questions raised in the former paragraphs the following activities are necessary, development of:

- a critical literature review and evaluation with respect to collaborative engineering and design, e.g. Integral Design;
- a collaboration methodology at different levels of sophistication;
- a general ontology (knowledge model) for active roof design of comfort systems, possibly with a number of specific extensions in certain (project) domains;

- a workflow model, also allowing negotiation and decision making. Since design always implies multiple criteria, a method for weighing design criteria will be needed;

- an architecture of a methodology platform for the integration of information and models to support the use of active roofs in comfort system design;

- training and evaluation of the framework for the selected cases and workshops.

The Blessing model approach (Blessing, 1997) offers a methodology to achieve this goal (MacGregor, 2002). The descriptive model by Blessing is based on a fundamental understanding of design research of having a descriptive and prescriptive element. An initial descriptive study is followed by a prescriptive study and a second descriptive study. Prior to this descriptive and prescriptive core is the success criteria stage, which generates the specific method for design. It prescribes definition of criteria, which defines success of design, such as implementation of components into building design, or possibilities for active roofs.

The context of the model of designing is defined by means of a "world view". The Product – Process – Organization model (the PPO model), developed by Friedl (Friedl, 2001) Bax and Trum (Bax, Trum 2000) represents this "world view" (Ivashkov, 2004). According to the PPO model, there are four essential domains of concerns in the design situation are; the context, the organization, the process and the product domains.

The dynamics of these domains are the parts that form the life cycle of the design situation. Therefore there is a need to define the knowledge content and characteristics of the dynamics for these domains during the specific design phase (Ivashkov, 2004). This model can be used to describe and to plan different design situations.

3.2 Design typology: Methodical Design

Design is the key discipline that brings systems into being. In the engineering sciences, a lot of approaches have been developed to structure and optimise design processes: concurrent engineering, value engineering, design for manufacturability, systems engineering, quality function deployment, strategic design, etc. To develop our required model of design support and referring to the research of Blessing, an existing model from the mechanical engineering, Methodical Design, is used (van den Kroonenberg, 1992; de Boer, 1989; Blessing, 1994). The methodical design process can be described at the conceptual level as a chain of activities which starts with an abstract problem and which results in a solution. The van den Kroonenberg design methodology distinguishes several phases in the design process; problem definition (conceptual and functional design), working principle determination (configuration design) and detail design (van den Kroonenberg, 1979).

The original methodical design process is extended from three to four main phases, in which eight levels of functional hierarchical abstraction, stages can be distinguished. The contents of the layers are based on the technical vocabularies in use, technology-based layers or levels. Each layer represents an abstraction of the levels below. For a more extensive description of the models that formed the basis for the notion of technology-based layers see (Alberts, 1992). Separation is made between:

- information level, knowledge-oriented, representing the "conceptual world";
- process level, process oriented, representing the "symbolic world";
- component level, device orientation, representing the "real world";

In addition, a new level is defined: part level, parametric orientation, representing "the specification world" (Zeiler, 2005). Thus, the four levels of aspect abstraction in the descriptive model of design are described here.

- Information Level

This level deals with the knowledge of the systems by experts. One of the essential ideas behind this is that human intelligence has the capability of search and the possibility to redirect search. This information processing is based on prior design knowledge. One of the major problems in modelling design knowledge is in finding an appropriate set of concepts that the knowledge should refer to, or -in more fashionable terms- an ontology (Alberts, 1993).

- Process Level

This level deals with physical variables, parameters and processes. The set of processes collectively determines the functionality of the variables that represent the device properties. Modelling at the functional level involves the derivation of an abstract description of a product purely in terms of its functionality. This abstraction reduces the complexity of engineering design to the specification of the product's desired functionality.

- Component Level

This level describes the hierarchical decomposition of the model in terms of functional components and is domain dependent. Generic components represent behaviours that are known to be physically realisable. They are generic in the sense that each component stands for a range of alternative realisations. This also implies that the generic components still have to be given their actual shape.

- Part Level

This level describes the actual shape and specific parameters of the parts of which the components exist. Relevant technical or physical limitations manifest themselves in the values of a specific set of parameters belonging to the generic components. These parameters are used to get a rough impression, at the current level of abstraction, of the consequences of certain design choices for the final result (Zeiler, 2005).

3.3. Design tools: database structure and morphological matrices

Design problems are usually ill defined and rely heavily on domain knowledge. This implies that what constitutes a problem is highly subjective (Simon, 1973). Therefore, because the design process depends on the problem, it inevitably depends on the designer or design team too. Furthermore, as mentioned above, design problems are considered to be complex. The degree of complexity of a problem may relate to, among other factors, the number of steps required to reach a solution or to the quantity of information required. More complex problems induce cognitive processes with a more diverse character than those of less complex problems. Thus, in more complex problems the processes that monitor the overall problem solving process play more of an important role. This supports the requirement for a process-based approach to design, but also emphasises the need for flexibility in its application to adapt to the complexity of the problem. Furthermore, it underlines the importance of easy retrieval of knowledge (information) relevant to the problem and product.

The proposed tool focuses on support rather than automation, and on supporting the whole design process. A primarily problem-oriented, process-based model of design was used. The tool model of design is the morphologic matrix, which acts as the knowledge structure for the team. The model constitutes generic knowledge of a system of a design process, i.e. possible steps; relationships between the steps (based on contents rather than on the sequence of execution); and possible means to support the steps. In working with the morphologic matrix the designer(s) uses the structure given by the model to document data that evolves from or is generated in a project. In this way a designer provides the context to interpret an input. This also enables the system to learn e.g. new strategies or applications for specific means (van den Kroonenberg, 1978).

Some of the main requirements to be imposed on a re-design support tool are (Salomons, 1993):

- it must allow the designer to work both in a top-down and in a bottom- up fashion;
- both assembly and component modelling must be possible;
- incomplete geometry must be allowed;
- catalogue selection must be enabled as well as selection from standards catalogues;
- calculations and other internal applications must be allowed.

Not only geometry must be retrieved and edited. It is for example necessary to keep track of design history and design intent, especially when problems occur later on in the design process, e.g. with regard to manufacturability. The system must be hybrid in the sense of being both system and user driven. It must also be configurable depending on the application domain; this is the task of a system manager user. An end-user does the actual design work. End-users must be provided with entities that have meaning in their application domain: assemblies, components and features. End-users must also be supported by catalogues and standards tables. Not only bottom-up support must be provided to the end-user by the re-design support system, but also top-down support must be available. Ideally, it should be possible to work in a mixed top-down and bottom-up mode.

There are some results on the effects on the use of morphologic matrices in professional design teams. Due to the PhD thesis for an Integral Design Methodology (Savanovic, 2005) and developed workshops with morphological matrices as design tool, first precautionary conclusions for the effects for the use of morphological matrices can be made. They are useful:

- to structure communication, especially in more complicated design situations;
- to archive discussed proposals within design teams;
- to structure design activities within design teams, widen the field of new possibilities;
- in practice; for communication within the team, to increase the number of relevant and new design alternatives, to raise the awareness for contributions of other disciplines.

In order to increase the effect of the methodical design and that of the morphological matrices another tool is proposed; the database structure. The main reasons for introducing this additional tool are to give more insight in possibilities for active roofs. Additionally to this: to give more notions in the different aspects of design, sustainable energy, maintenance, safety and construction in relationship with the possibilities for active roofs.

This database structure is set up with specific characteristics:

- several user possibilities (roofer, industry, contractor, designers);
- several user aspects (design, sustainable energy, maintenance-safety-assemblage);
- overview and orientation for existent and future possibilities;
- easy to work in / easy to complement (new information);
- easy to deliver / supply to several participants.

To incorporate these programmatic aspects a web-site based structure is proposed. Within this structure there is a very simple first division of aspects; those related to the total building and construction (user aspects) and those related to roof characteristics (roof types, roof materials and roof composition). The web-site based structure was presented December 2005 to the several work packages of the European Research program (EURACTIVE ROOFer), and will immediately be used and completed by them. From there the structure will be an advanced and continuing mutating data-base for immediate use by the several participants. A maintenance program will be developed to insure the state of the art information will be part of the data-base structure and available for the users.

3.4. Design training: ‘learning by doing’

The impact of Donald Schön's work on reflective practice has been significant - with many training and education programmes for teachers and informal educators adopting his core notions both in organizing experiences and in the teaching content. Indeed, there is a very real sense in which his work on reflective practice has become ‘canonical’ – frequently appealed to by trainers in a variety of professional fields (Usher, 1997).

Although, working with experienced designers from different disciplines is not often done. Mostly the verification of a new methodological concept is done by experiments with student groups (Segers, 2002) or with design groups within one company (Blessing 1994). The relevance is improved by using experienced designers, as there is a major difference in approach between novice and experienced designers (Kavakli, 2001; Ahmed, 2003, Kavakli, 2003).

In the Integral Design project TVVL-BNA-TUD different concepts of workshops have been tested (Quanjel, 2003). An overall model will be chosen in the form of design task workshops. The workshops and case studies will give the possibility to evaluate the outcome of the theoretical model of the supportive process methodology for comfort (HVAC)-system design, engineering and installing. Key aspects of the subject are; generate the knowledge of methodical design, test this process methodology in the context of innovative active roofs and finally train participants to use the methodical design approach and its tools.

Within this ‘learning by doing’ approach newly developed process models are applied, tested and evaluated while professionally qualified designers carry out several design assignments in the repeated series of workshops. The workshops are seen as a self-evident way of working for the designers that occurs both in practice and during their education. However, they are not the predominant way of working in practice, where most of time the disciplines work separately and only discuss together the mutual proposals and progress. Although the workshops represent an artificial work environment, it is not experienced as such by the designers themselves. There are a number of advantages that the workshops have regarding to standard office situations: the full line-up of design team, avoidance of a ‘laboratory setting’, the possibility to gather a large number of professionals in a relatively short time, repetition of the same assignment and comparison of different design teams and their results. The openness of participants for new methods is also bigger than during the daily routine, something that can’t be emphasized often enough (Savanovic, 2005).

To that effect, case studies that are complex and innovative enough will be selected, and a series of different type of workshops with experienced professionals from the ONRI (Dutch Association of Consulting Engineers), BNA (Royal Institute of Dutch Architects), IFD (International Federation of Roofing Trades), HHD (Het Hellend Dak) and TNO (Dutch Organisation for Applied Scientific Research) will be organized to investigating the relevance of the approach:

- case studies of projects in which active roof systems elements were used optimal according to current practice; best projects;
- workshops, during which architects, climate designers and roofers will work on exercise concerning the conceptual or primarily design of a building and the effects for implementation active roof concepts in comfort systems options. Students will monitor the workshops and the results will be measured compared to criteria, which will be defined.

Due to this approach the workshops, in relationship with the implementation of the methodical design and its design tools, are a mutual system. The mutation and development will constantly shape and redefine the method of knowledge-sharing as well as the method of design and the related tools. Appropriate aspects of these 'learning by doing' approach are (Schuster, 2004):

- permanent evaluation with the practitioners and organization;
- role alteration between teacher / moderator / educational advisor;
- permanent feed back with teachers;
- discussion about the evaluation with scientific committees of expert knowledge and didactic quality.

The combination of these related tools and participants involved with the setup for the workshops will be the basis for developing thesis and research results.

4. CONCLUSION

This research is aimed at developing and evaluating a new process methodology for collaborative engineering to integrate sustainable energy in active roofs, in the conceptual phase of building design. The main research questions:

- is it possible to support the building design of active roofs as part of sustainable comfort (HVAC) systems, with a process methodology approach?
- is it possible, by using a model approach, to formulate a new methodology for both product and building design?
- is it possible, by using scenarios as a prescriptive element for design practice, the descriptive results of workshops and case studies, to create the design context in order to close the gap between design research and practice?
- is it possible, by using scenarios for the design practice, the results of expert workshops and case studies, to come to tools for collaborative engineering?

The project will result in a supportive process methodology for active roofs for integral sustainable comfort (HVAC) system design, engineering and installation. The project will give new knowledge for developing, implementing and typology-use for environmental actions using sustainable energy systems in relationship to product innovation and innovation of the building design process.

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A TOOL FOR ARCHITECTS

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ABSTRACT: Architects are already aware that the XXI century inherited ecological concerns. Although several international recommendations defended reversibility in all interventions that reduce cultural significance, and presented rehabilitation in accordance to the sustainable use of resources, architects still do perform rehabilitations that unconsider the consequences of their design decisions, regarding the preservation of both built and natural heritage.
This paper will describe the method chosen in this PhD research, as well as, part of their content, motivation, and aims. This research follows since 2004, the PhDdesign method, with a first phase of design theory, exploring the problem field and taxonomy. Then, a second phase of design production: developing, producing, and testing the tool to support architects; and a third phase of design result, validating both theory and production. This PhD research is funded by FCT, in Portugal. Prof. Ir. Post and Dr. Ir. Erkelens are respectively the main and co-promoters.

Keywords –Built heritage, Design process, Lifespan, Rehabilitation, Tool

1. INTRODUCTION

The architect, when performing as building designer, requires knowledge and experience on the most diverse fields of the building universe (e.g. social and scientific sciences), which makes it very difficult as a single individual, to manage and systematize such a universe. John Habraken defended “creativity is a lonely act” (1982), sheltered in the designer’s mental boundaries, but the design process does not necessarily need to follow the same path.

The design process can and should combine the designer’s knowledge and experience with the knowledge and experience from other experts, owners, users, contractors, principals, public and private bodies, etc.

Usually the designer follows an individual design process, but he can also be part of a team where each designer should obligatorily follow the collective design process. This is very common, especially when working in a large-scale office, because there, each designer has a particular function (speciality), which should fit into the overall designer’s functions.

Society considers architects, first, as building artists and some architects are reticent to expose their procedural methods and followed “recipes” during their design developments, because they could be contributing to their own ruin, denigrating their own professional value.

This research considers this taboo obsolete, especially because if we compare the design processes among designers and question them about their procedural stages and activities, we find that most of them follow similar stages and activities. Otherwise, most designers know most design process stages and activities, even if they do not assume to follow it systematically.

The difference is actually, in how each designer interprets, synthesizes, and evaluates all the collected data, as well as his design product, as a real simulation result of all his perceptions, aims, and convictions. To support his decision steps, among his expertise, each designer needs to consult, during his own design processes, useful “tools” to support and help him achieving the targeted goals.

2. BACKGROUND

The international expertise recommendations and charters influenced both taxonomy and theoretic design process model. The Burra Charter (1979) defended already at that time that “change[s] may be necessary to retain cultural significance, but is undesirable where it reduces cultural significance. The amount of change to a place should be guided by the cultural significance of the place and its appropriate interpretation. When change is being considered, a range of options should be explored to seek that option, which minimizes the reduction of cultural significance. (15.2) Changes, which reduce cultural significance, should be reversible, and be reversed when circumstances permit. Reversible changes should be considered temporary. Non-reversible change should only be used as a last resort and should not prevent future conservation action.”

In addition, also The Habitat Agenda (1996) presented rehabilitation in accordance to the sustainable use of resources. Article 10 stated “In order to sustain our global environment and improve the quality of living in our human settlements, we commit ourselves to sustainable patterns of production, consumption, transportation and settlements development; pollution prevention; respect for the carrying capacity of ecosystems; and the preservation of opportunities for future generations. In this connection, we shall cooperate in a spirit of global partnership to conserve, protect, and restore the health and integrity of the Earth's ecosystem.”

Article 11 reinforced that “we shall promote the conservation, rehabilitation and maintenance of buildings, monuments, open spaces, landscapes and settlement patterns of historical, cultural, architectural, natural, religious and spiritual value”.

Independently of the expertise recommendations, most designers, and built heritage intervenients have shown some inertia on facing the existing stock and its potentialities, economizing their creativity for their modern drafts in new construction. Even when intervening in built heritage, it is clear the priority given to the additions, forgetting the endless potential in the reuse or recycling of the pre-existent forms, components and materials, when they could be perfectly integrated together with the additions, stimulating with true creativity the generational dialogue.

Some designers are already concerned about reversibility in their interventions, as well as, maintaining a unique and coherent methodology in their process of design, independent from the building heritage classification, e.g. the Portuguese team Arq. Victor Mestre e Sofia Aleixo, however, it is not enough. There are still many designers, which do not value built heritage, possibly rooted in Corbusian idealisms, alienated to the reality of modern / future society.

Such alienated rehabilitation interventions subtract and waste considerable quantities of components and materials, mostly within their lifecycle, without deepening the consequences of such acts, often mischaracterizing irreversibly and considerably the intervened building. Moreover, when subtracting the pre-existence to add and shape the new existence, the fusion between remaining and added technologies and materials, gets frequently in shock, due to the incompatibilities of characteristics and to the inconsequence of irreversible details.

3. RESEARCH AIM

The aim of this research is to contribute for the increase of lifespan (past, present, and future) consciousness in rehabilitation interventions of built heritage, through the development of a design process support tool for architects, when involved in rehabilitation design developments. By re-thinking the rehabilitation design process as a coordinated set of stages, and sub-stages, replacing the traditional experience-related process by a more conscious, rational, and theory-based approach; choices and solutions for specific design problems, traditionally taken base on experience or individual thinking, can be now taken, base in technical awareness and attentive to potential alternatives.

Aiming to produce a useful, didactic, easy to use, and not time-consuming design process support tool; containing fundamental guidelines for every design phase, evaluation criteria and a technical support for architects, to better develop, assess and upgrade their own design developments; this research will pass through several test periods, to constantly verify and correct eventual faults or lacking subjects.

There is a lack of technical tools oriented towards rehabilitation design processes, and in specific towards lifespan ideologies, so we believe this study as a true contribution for architectural science. Rehabilitation interventions of built heritage can be lifespan conscious, respecting the past, implementing the present, and planning the future, independently of the building's official heritage classification. Consequently, architects will be contributing with their rehabilitation designs, for the preservation of both natural and built heritage.

4. RESEARCH METHODOLOGY

There are three main phases in this research (see Figure 1): the design theory, the design product, and the design result. The design theory includes LEVEL 1, where the background theory is presented and the problem field is explained, in order to introduce the phenomena of Heritage and Interventions; and LEVEL 2, where the theory, directly connected to the problem is framed and the definitions regarding Built heritage (what) and Lifespan rehabilitation (how) start shaping the research taxonomy.

The design product includes LEVEL 3 and LEVEL 4, where in LEVEL 3 the research focuses even more, into the case studies analyses and in the prototype development. Two architects were chosen in Portugal and the Netherlands "re-architecture", presenting their design processes of two building rehabilitations: one building classified and the other building unclassified by a Governmental Safeguard institution.

These case studies were needed to verify that conscious architects maintain their design process, in both classified and unclassified building. They do not neglect their significance to future generations, neither their condition as existing available resources.

The researcher has also developed two twin trimesters with students involved in rehabilitation designs, one in the Netherlands (September – November 2005) and another in Portugal (January – March 2006), so that the researcher could identify knowledge lacks or unnecessary information in the theoretical model, which will be the content of the prototype development (website).

The success and usefulness of this design process, when used by the students of two different countries, will verify if such design process can or cannot be used to support the rehabilitation of several building typologies, in different countries, serving only as base of further developments, always different in each building and designer.

LEVEL 4 includes the data collection and the prototype production (website). Even if the researcher has developed the global structure of both website and database, at this level, the researcher is counting with the support of an architectural student assistant to infill the database (integrated in the website) and a computer science assistant to support the materialization of the prototype.

LEVEL 5 includes the pre-test and test, regarding the acceptance of the prototype as a useful support tool. Similar trimesters to the ones developed in LEVEL 3 will be implemented, but this time, providing to the student free access to the website and its knowledge content, in order to analyze the differences regarding earlier design processes.

If the students in the pre-test, as the architects in the test show interest and declare its usefulness and contribution in the quality of the rehabilitation design this research can in LEVEL 6 (DESIGN RESULT) take its positive conclusions as well as develop further recommendations regarding remarks or faults found in all this research process.

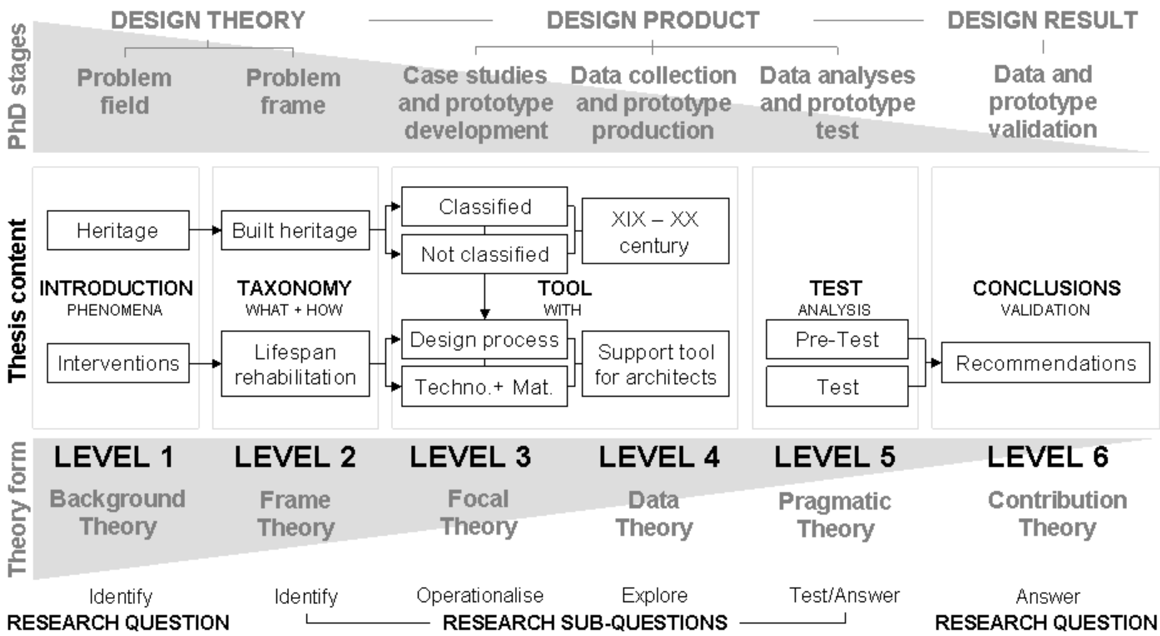

Fig. 1. PhD research design

5. TAXONOMY

5.1 What is built heritage?

Built heritage is normally target of rehabilitations with variable criteria, priorities, actions, and intervenients. Not all the buildings are equally perceived, varying according to its category, safeguard institution, town hall, political master plans, evaluation processes, etc.

In a theoretic utopia, the classified buildings are more protected in rehabilitation interventions, than any other current building, because it has been attributed to them a certain cultural value, which functions as a protection shield, if not for the entire building, at least to some relevant spaces and components.

However, what does normally happen with the current buildings, old or new, target of rehabilitation if there is no control? Should or should not they also be considered as heritage? Are or are not they also product of past generations? Do or do not have inherent cultural values?

For example, in Portugal, regarding the non-classified buildings, the intervenients in rehabilitation interventions – architects, contractors, owners, etc. – have to be the ones with a coherent ethical position regarding their design / construction decisions, because frequently many interventions do not require the municipalities' approval. Nevertheless, a question rises. How to control the intervenients and the building process in such situation? Which positions/solutions can be considered ethically correct and coherent, if society changes idealistically, from generation to generation, changing also their regent cultural values?

In the theoretical development of this PhD research, the built environment is subdivided in two sectors: the built heritage and the built newness. Built heritage is the taxonomy for all the existing buildings that passed down through one or more generations – around twenty-five years – just like an object of inheritance that a precedent generation left for the following ones. Therefore, even if not interesting by any particular reason, built heritage will always represent the daily environment of humanity and provide a sense of local continuity anchored in the past toward the uncertain future.

Associated to their inhabitants or actions, built heritage represents past traditions of architectural design, craftsmanship, and ways of living and building in their own contemporaneity. It can always contribute to the development of future incoming generations, even if not in its totality, as an existing resource of structures, components, and materials. Existing buildings should not be simply demolished without considering its resources management and assessment.

Built newness is the taxonomy for all existing buildings built by the regent generation. Remarkable buildings from this innovative sector can also be classified as built heritage, by the regent generation, however, mostly built newness, has no part in built heritage, because in fact, it has not been inherited by the regent generation. One of the possible motivations for considering built newness as built heritage can be when such a building is a true and emblematic symbol of their time. So true, that they wish to proclaim to the next generations such particular situation.

Table 1. Built heritage temporal location

<table>
<tr><th colspan="2">XIX century</th><th colspan="4">XX century</th><th colspan="2">XXI century</th></tr>
<tr><td>1850
1875</td><td>1875
1900</td><td>1900
1925</td><td>1925
1950</td><td>1950
1975</td><td>1975
2000</td><td>2000
2025</td><td>2025
2050</td></tr>
<tr><td colspan="7">Built Environment (2025)</td><td></td></tr>
<tr><td colspan="6">Built
heritage</td><td>Built
newness</td><td></td></tr>
<tr><td colspan="7">Built Environment (2005)</td><td></td></tr>
<tr><td colspan="5">Built
heritage</td><td>Built
newness</td><td colspan="2"></td></tr>
</table>

It is our belief that this built environment sub-division – if efficiently stimulated among governments and policies, stockholders, constructers and technicians – will contribute for a true change on how society perceives the built heritage, as well as, a direct influence in the actions and choices regarding built heritage interventions. Such an extreme position ends with interventions influenced by stylistic favoritisms, building categories, or other more subjective matters; because all existing buildings, built by earlier generations are classified automatically as heritage.

This patrimonial democratization has the purpose of reinforce the necessity of treating built heritage with impartiality. In such way all buildings that would not integrate the cultural values, normally attributed to heritage buildings would immediately take part of the built heritage world, because they would have, inevitably, as existent and available material resources, a very high inherent ecological value.

Figure 2 presents the cultural values network developed for facilitating the cultural values identification, by the built heritage intervenients / designers. It includes beyond the expertise values: historic, aesthetical, scientific, and social values, recommended by the Burra Charter (1979); the non-expertise values: age value theorized by Alois Reigl (1903), the economic, the political value, and the ecological value.

Evidential	Notable	Artistic	Conceptual	Technological
Educational	**HISTORIC** (authenticity)	**AESTHETICAL** (original)	**SCIENTIFIC** (rarity)	Workmanship
Management	**POLITICAL** (symbolic)	**HS** **AS** **PE** **AE**	**AGE** (patina)	Maturity
Entertainment	**ECONOMIC** (worthy)	**SOCIAL** (identity)	**ECOLOGICAL** (continuity)	Existential
Use	Allegory	Emotional	Spiritual	Essential

Fig. 2. The cultural values network

5.2 How should lifespan conscious rehabilitations be done?

This research has theorized built heritage interventions in a scale, from one to seven, dependant on their scale of impact and risk for the building. Every intervention scale has two possible sub-scales: the passive and the active approach. Focusing in the subject of this chapter, the intervention of rehabilitation was considered the intervention scale five, in-between restoration – scale four and reconstruction – scale six. Rehabilitation is an intervention that integrates actions from other types of interventions, from both inferior scale – deprivation, preservation, conservation and restoration; and superior scale – reconstruction and demolition.

Table 2 presents the global scale of intervention, sub-scales, definition and targets, regarding the categories: substance, function, performance, built and resources. As earlier referenced, the rehabilitation intervention can have a passive approach, maintaining the original or current function – reuse, but it can also have an active approach, introducing a new function – adaptation.

Even if representing different approaches, one normally more invasive than the other, both sub-scales target towards the building substance, in the relationship between the subtracted and the added reality, facing the remainings from the pre-existence towards the new existence.

By pre-existence, we define the building in the pre-intervention phase and by new existence the building in the post-intervention phase. With the purpose of improving the building performance in all its fundamental features, the rehabilitation focuses mostly in the built heritage, perceiving its forms, components, and materials as potential resources.

A rehabilitation intervention is considered lifespan conscious when respects and considers the three temporal realities during its design process: the past, the present, and the future. The past is considered when the designer plans and designs about the preservation, reuse and recycling of the pre-existence, as much as possible. In other words, the designer needs to plan in his design developments the use / destination of every pre-existent form, component, and material; independent of its classification as subtraction or remaining reality (see Figure 3).

Table 2. The scale of intervention

<table>
<tr><th colspan="3" rowspan="2">intervention</th><th rowspan="2">description</th><th colspan="5">target</th></tr>
<tr><th>substance</th><th>function</th><th>performance</th><th>built</th><th>resources</th></tr>
<tr><td rowspan="2">scale one</td><td rowspan="2">deprivation</td><td>passive
abandon</td><td>leave the building fall into decay and obsolesce, without any concern</td><td rowspan="2">subtractions</td><td rowspan="7">original or current function</td><td rowspan="3">decrease</td><td rowspan="2">environment</td><td rowspan="2">none</td></tr>
<tr><td>active
vandalism</td><td>contribute to the building's decay with destructive and intentional actions</td></tr>
<tr><td rowspan="2">scale two</td><td rowspan="2">preservation</td><td>passive
inventory</td><td>register, study and analyse the building (documental and physical)</td><td rowspan="5">remainings</td><td rowspan="5">heritage</td><td rowspan="4">decorations and traces</td></tr>
<tr><td>active
prevention</td><td>clean and arrest decay in a routine basis to control degradation</td><td rowspan="3">maintain</td></tr>
<tr><td rowspan="2">scale three</td><td rowspan="2">conservation</td><td>passive
maintenance</td><td>repair small conditional damages in the general building context</td></tr>
<tr><td>active
safeguard</td><td>repair medium damages and treat decays in the general building context</td></tr>
<tr><td>scale</td><td>restorati</td><td>passive
restitution</td><td>repair large damages and consolidate punctual fissures / lacunas</td><td>restore</td><td>forms /</td></tr>
</table>

		active reconstitution	consolidate and rebuilt lacunas according to the building aesthetics	sub. / rem. / add.				
scale five	rehabilitation	passive reuse	combine earlier / later activities, subtract the exceeding and add the required forms and components			improve		
		active adaptation			new function[s]			
scale six	reconstruction	passive rebuilding	rebuild the building partially or totally, based on historic documents	additions		replace	newness	components / materials
		active building new	build new buildings, reusing existing urban fabrics and infrastructures					
scale seven	demolition	passive reduce	demolish the building, but reuse or recycle the components/ materials				environment	
		active waste	demolish the building, without reuse or recycle the components/ materials					

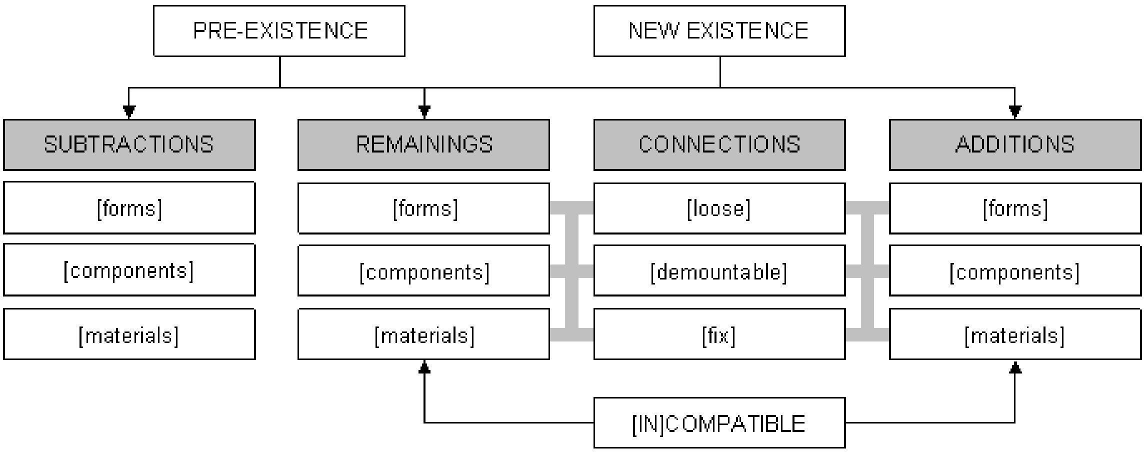

Fig. 3. The four parallel realities in rehabilitation

Normally, the architects involved in rehabilitation designs are already used to develop "reds and yellows" drawings (reds – additions / yellows – subtractions), but actually, how many designers really reflect and weight the areas drawn in yellow? Should or should not a designer have to justify consciously and plan all the building subtractions? This reasoning process is one of the baselines of this theoretic design process model; however, there are two other realities, which still lack enlightenment.

The present is considered when the designer plans the improvement of the building and environment, its significance and condition (e.g. energetic efficiency), trying to reach in the new existence the levels of comfort and economy necessary for the contemporary life. The present reality is already considered by most of the designers, however, this research defends that the true equilibrium, in rehabilitation designs, comes from the adding together of the other two realities (past and future) to the present reality.

The future is considered when the designer plans the additions in the new existence, based in the effective compatibility between the remainings and the additions characteristics. A very important factor, from the new additions, is the different connections between remainings and added components. For this reason, it has been identified particularly, as the fourth parallel reality, even if somehow it makes part of the two realities, building remainings and additions.

Often, it is possible to make formal loose additions, also in the building interior, leaving them "fixed" by their own weight. In case of building components additions, it is often inevitable to have fix connections to the remainings, however, this same connection can always be planned and designed, with dry details, fitting systems, etc.. Then the designer would only opt for irreversible solutions in extremely necessary cases.

Consequently, most of the added components can be removed or substituted if necessary, aiding maintenance activities, replacement activities, and even future interventions. Specially the interventions planed and developed by the owners / users, which the expertise can no longer control. It is not expected from a designer the possession of the entire knowledge, regarding all technologies and behaviors of every material and components available in the construction industry. Therefore, when he chooses for a solution, not always, it reveals as the adequate solution.

By only considering and planning, the additions connected to the remainings, with flexibility and reversibility; such small design decision, already brings big advantages to the design, because, in case of clear inadequacy or deficiency, components could be removed immediately and easily, without further complications.

Another fundamental factor in the decision making process of the additions, regards its effective durability versus the building service life. The designer must always think about the optimization of his solutions, and adequate his choices to this two lifecycle references.

When consciously considering the preservation of the past and controllability of the future, the designer is considerably contributing for the reduction of design mistakes, which normally emerge after the rehabilitation design is constructed or later during the use period. Case by case, this will prevent future demolitions, and consequently reduce the amount of reusable construction and demolition waste (C&DW), because then, only obsolete components, which have no other destination than incineration and landfill, are going to be wasted.

6. TOOL FOR ARCHITECTS

The tool for architects has as basis a theoretic model structuring the stages and sub-stages of a rehabilitation design process. This research "theoretic model" progressed from the theoretic model developed Roozenburg, and Eekels (1991), which has also progressed from the theoretic model develop by Jones (1963).

Jones has defined the main three stages – Analysis, Synthesis, and Evaluation – and later on Roozenburg and Eekels added two other stages to Jones's design process, Simulation and Decision. Both theoretic models, where considering the design process generally, however, its adaptation and focusing towards the rehabilitation design processes turned out quite adequate.

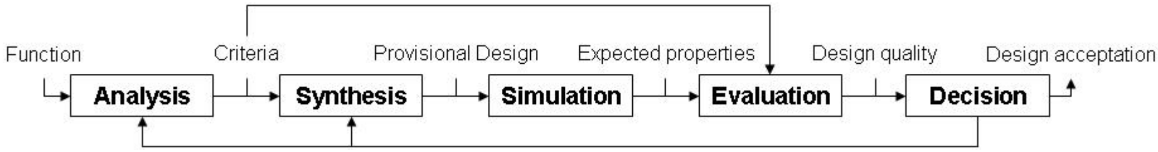

Fig. 4. The five-stage design process (Roozenburg and Eekels, 1991)

6.1 With which design process, technologies, and materials?

The design process of a lifespan rehabilitation intervention re-designs the original design process. Several differences are clearly identified; fragmentation, positioning, and relationship between the design process stages, but the most important distinction is the establishment and contents of the inherent sub-stages.

Every existing building is different; however, the design process, as long as conscious of the entire building environment, significance and condition, can be developed as an ideal model, that the designer can follow, for the rehabilitation of every existing building.

In the ideal procedure the designer involved in a rehabilitation design, will go through the design process stages and sub-stages, finding procedural, evaluative, and technical guidelines to support his rehabilitation design lifespan oriented.

Inversely to an original design process, the designer, involved in a rehabilitation design, has to deal with an existing building that had passed already through an original design process, and depending on its lifespan, through few interventions. There is an entire reality, the designer should observe, instead of merely look or ignore.

Therefore, this research develops a design process subdivided in two building lifecycle stages: pre-design and design stage, the first building-oriented (pre-existence), and the second intervention-oriented (new existence). Figure 5 presents it schematically. In the support tool, every sub-stage will have a clear explanation and guidelines suggesting common procedures.

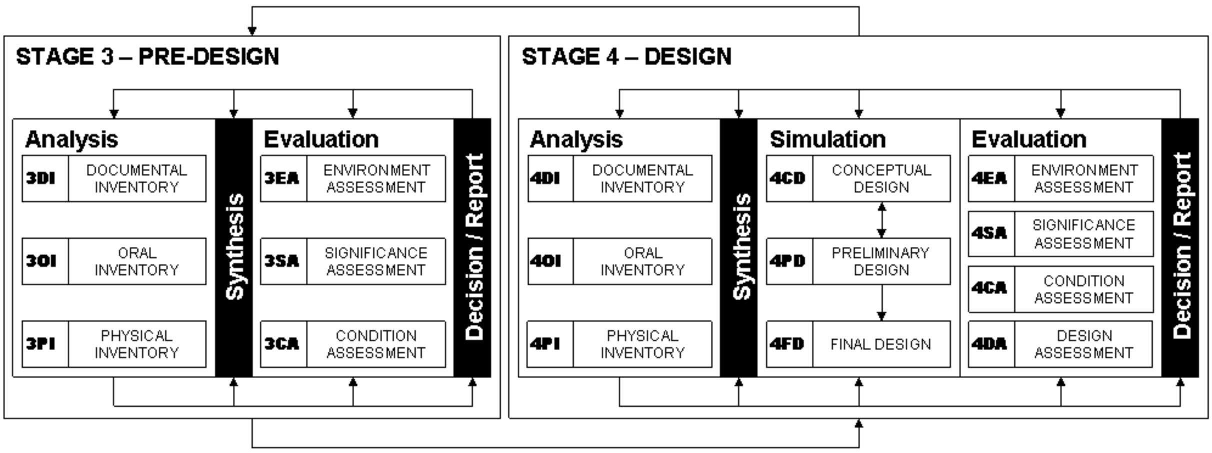

Fig. 5. The Lifespan rehabilitation design process

The intention of this research was to provide a design process, to the architects involved in rehabilitation designs, supportive in their varied sub-stages of reasoning and decision-making, but not to provide the solution to all their problems. Even if this design process already coordinates numerous sub-stages, there are certainly other sub-stages missing, especially the most specialized ones, oriented towards specific building typologies, environment, material, etc., however, this already goes beyond this research aims.

In the design stage, the designer analyzes the existing building, via the documental (3DI), physical (3PI) and oral (3OI) inventories. Then he synthesizes all important information towards the three following evaluation areas; and based on the most reliable evidences, he evaluates the building's environment (3EA) significance (3SA) and condition (3CA). The decision / report sub-stage documents the whole process.

In the design stage, the designer analyzes the rehabilitation intervention via a similar process to the pre-design stage, however, now; the analysis is requirements-oriented, confronting them with the building pre-design report. He synthesizes the most important information and starts simulating the materialization of ideas and convictions in several different periods: conceptual (4CD), preliminary (4PD), and final design (4FD).

After all the design developments, the designer evaluates the advantages and disadvantages of the chosen solutions, and can directly compare the evaluation, pre and post rehabilitation, regarding the building's environment (3EA – 4EA), significance (3SA – 4SA) and condition (3CA – 4CA). Still integrated in the evaluation sub-stage, the designer can evaluate his own design results (4DA).

In such design process, the designer can always go back and improve his solutions. The designer concludes his design process, when he finally decides specifically for a design form, technique, and materials. The decision / report sub-stage documents the whole process and respective design solutions.

7. CONCLUSIONS

The rehabilitation design process, while theoretical model has suffered several mutations, not concerning the stages itself, but mostly regarding their inherent sub-stages. First, the researcher has presented and compared the theoretic model, with the design process model of two international architecture offices, used to develop rehabilitation designs of both classified and not classified buildings. The a Portuguese architecture office was Victor Mestre │ Sofia Aleixo, in Lisbon, and the Dutch architecture office was Jouke Post, in Rotterdam.

Second, and still under development, the theoretical model is being used by students, Portuguese and Dutch, in order to find lacunas in the model, as well as, identify the stages with more importance and difficulty during the entire design process. It is the purpose of this theoretical model, to become a useful support tool (international), and that is why such periods are so important.

This design process intends to provide technical knowledge to the designer. With such support, he will be able to develop a professional work, based on the international recommendations and technical guidelines. The designer will be able to develop comparisons among solutions and develop a self-critic evaluation, regarding his ethical and technological appetencies. This design process may seem a rigid structure; however, it does not intend to force or substitute the designer's reasoning and decision-making process. It aims to provide him a theoretic model, techniques, and materials, to support his own design decisions.

We believe, that by the end of this PhD research, a prototype of the tool will be available in the internet, ready to support architects developing lifespan conscious rehabilitation designs in built heritage.

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CREATING *IMPACT* IN HEALTHCARE DESIGN: ASSESSMENT THROUGH DESIGN EVALUATION

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Abstract: AEDET Evolution (the Achieving Excellent Design Evaluation Toolkit) enables its users to undertake a design evaluation through the creation of a design evaluation profile. The Centre for Healthcare Design, its developers in the UK, recommends that healthcare design can be evaluated under three basic headings: Functionality, Excellence and Impact. The staff and patient environment of a healthcare facility can have a significant part to play in creating 'Impact'.
In the UK, there is currently a major investment programme, which represents the largest ever building programme of the National Health Service. This programme represents an opportunity to raise the quality of healthcare design. This paper is concerned with an evaluation of one element – improvements in the quality of healthcare facilities through the impact of appropriate facilities in the staff and patient environment.

Keywords: Design evaluation, healthcare design, healthcare investment, quality

1 INTRODUCTION

In the UK, the NHS is currently in the middle of the biggest healthcare investment programme in the world (over £20 billion), in partnership with the private sector.
Mental health, acute and primary care trusts and strategic health authorities are all engaged in major change projects to ensure sustainable investment into services and facilities today to meet the needs of the patients of tomorrow.
In looking at the future needs for health infrastructure, it is necessary to explore links between system change, technology change, workforce and changes to the design of the physical environment. What is certain is that the healthcare knowledge base needs to be continuously expanded.

The main areas of interest in building change are:

- What are the implications of new models of care for the design of the environment?
- What evidence is there for good design influencing healthcare outcomes?
- How can the elements of design quality be incorporated into new building?
- How can the whole life costs be balanced against the design costs?
- What can we learn from buildings that have already been built in the UK and abroad?

1.1 Innovation in healthcare building

From the first wave of PFI schemes, there are examples of innovative thinking in hospital building design in the UK and the lessons from these still need to be fully explored. There are many other examples of good environmental design for healthcare facilities – both large and small – from the UK and from abroad.

There is now evidence from clinical outcome, social studies of patient satisfaction and design field that a well designed environment improves patient outcome and reduces staff costs significantly. This can lead to the development of a business case for good design.

1.2 Therapeutic environments

It is now widely accepted that the design of the environment can enhance the healing process. The work of Lawson and Phiri (2003), in their study of the effects of hospital environment on patients and staff, has already shown that the healthcare environment plays a significant role in assisting patient recovery. Douglas and Douglas (2004) suggest that the provision of welcoming, homely spaces promotes health and well-being. The NHS Estates initiative *Improving the Patient Experience* (2004) promotes the provision of a high quality built environment to promote healthcare and NHS Estates exemplify details of particular schemes in their *Design Portfolio* (2005).

This is supported by evidence drawn from scientific studies, psychological studies and architectural theory. Quantitative studies measure physiological outcomes against single variables such as noise, temperature and views. Psychological studies show that building features have observable psychological effects on users and demonstrate, for example, that different social behaviours occur in spaces where furniture is arranged differently.

Design theories draw attention to cultural and spatial considerations giving valuable insights into the design of buildings and their context. (See Ruddock and Aouad (2005) for a review of the literature on this topic).

There is a growing body of evidence that proves the value and impact of the environment and the arts on healing. For instance, Ulrich set up controlled tests in a hospital to prove that patients recovering from surgery got better more quickly and took fewer painkillers when they could see a view through a window rather than just bare walls. (Ulrich, 1983). A study carried out at Leeds Teaching Hospitals found that improved patient environments in a newly built wing at Leeds General Infirmary, which included commissioned artworks by Tonic, the arts project of the hospital, enhanced recovery times and improved patients' perceptions of the care they received from staff (Willis, 2002). (Other examples and case studies concerning the valuable effects of the use of art in hospitals can be found in Ruddock and Aouad (2005)).

2 THE ACHIEVING EXCELLENT DESIGN EVALUATION TOOLKIT (AEDET)

The Achieving Excellence Design Evaluation Toolkit (AEDET Evolution is the latest version) has been developed by The Centre for Healthcare Design. It is a tool specifically directed towards achieving excellence in design rather than ensuring compliance with legislation or regulations.

It is designed to be used by anyone involved in the commissioning, production and use of healthcare buildings. In the context of this research, the usefulness of the toolkit for design teams, estates/facilities managers and user clients such as patient groups is apparent.

AEDET can be used in a variety of situations:

- To evaluate existing buildings in order to make comparisons.

- With plans for new buildings in order to evaluate designs.
- On ‘imaginary’ buildings in order to set standards for a brief.
- At various stages during the design of healthcare buildings.
- In terms of scale, AEDET can be used at a building scale, department scale or on a complete site scale.

2.1 Using AEDET Evolution

The toolkit has 3 layers which allow users to create a design evaluation profile:

- The **scoring** layer on which you score
- The **guidance** layer that gives more detailed help
- The **evidence** layer that points to available research evidence

Dependent upon the level of detail available, AEDET can be used to score at building or complete site scale.

Healthcare building design frequently involves complex concepts which are difficult to measure and evaluate. The AEDET Evolution toolkit evaluates a design by posing a series of clear, non-technical statements, divided into ten sections and encompassing the three key areas of Impact, Build Quality and Functionality. Figure 1 shows the ten section headings in the Excel spreadsheet used in the AEDET scoring layer.

	1	2	3	4	5
Character and innovation				●	
Form and materials			●		
Staff and patient environment				●	
Urban and social integration			●		
Performance				●	
Engineering				●	
Construction				●	
Use			●		
Access				●	
Space			●		

Source: AEDET (2005)

Figure 1: The ten sections in the AEDET toolkit

The AEDET toolkit could be a major influence, assisting Trusts and the NHS in determining and managing their design requirements from initial proposals through to post project evaluation. It forms the key agenda for design reviews, it is being used as a benchmarking tool, and forms part of the guidance for ProCure21, PFI, LIFT and conventionally funded schemes.

2.2 The creation of *Impact*

There are strong arguments for incorporating commissioned artworks into new healthcare development schemes. As already indicated, AEDET recommends that design be evaluated under three basic headings: Functionality, Excellence and Impact. (See Figure 2).

The arts have a significant contribution to make in creating impact. In particular, the arts can be used to:

- Create local distinctiveness
- Ensure that the built environment reflects individual human scale
- Meet the spiritual and emotional needs of patients and staff
- Support and improve way-finding, for example by creating landmarks at entrances and in key public spaces
- Enhance landscaping and interior design through creative use of materials and finishes
- Enhance the prestige and reputation of the NHS Trust during the redevelopment process

Source: AEDET (2005)

Figure 2: The three basic sections and the ten assessment criteria of the AEDET toolkit

2.3 Arts programmes and *Impact* in the staff and patient environment

There are already several examples of projects in NHS Trusts, which are designed to incorporate arts programmes into health facilities. One such is *Moving On,* which is an arts for mental health programme. This programme will, over the next 3 years, involve service users in working with commissioned artists to create artworks to enhance a whole wave of new buildings and facilities for mental health services across the Avon area of the Avon and Wiltshire Mental Health Partnership NHS Trust.

Moving On aims to develop integrated arts commissions to create the best possible environment for care in the new mental health facilities being developed. The impact of the programme will be assessed after three years and the evaluation will:

- Explore the impact of the arts programme on patients' and staff experience of the environment
- Explore the impact of the arts programme health and wellbeing, taking into account the diverse needs of user groups
- Explore experiences of involvement and ownership in relation to the project
- Identify the added value of arts-based interventions in the management of transitions to new buildings and services

Also, as another example, a three year *Study of the Effects of the Visual and Performing Arts* at the Chelsea and Westminster Hospital has shown that live music in the waiting area of the high-risk antenatal clinic was effective in lowering blood pressure levels of patients and that the unborn child responded to live music by significantly increasing its heart rate - a sign of well being. (Moving On, 2005)

The study also found that for patients receiving chemotherapy treatment, visual art was effective in reducing levels of depression, while live music reduced levels of anxiety.

3 THE STAFF AND PATIENT ENVIRONMENT

An important development, based on the AEDET toolkit, has been the evolution of a supporting toolkit to enable the staff and patient environment in healthcare facilities to be more fully evaluated.

ASPECT stands for *A Staff and Patient Environment Calibration Tool*. It is based on a database of over 600 pieces of research. That research deals with the way the healthcare environment can impact on the levels of satisfaction shown by staff and patients and on the health outcomes of patients and the performance of staff.

This research and the ASPECT toolkit itself are set out under 8 headings. ASPECT can be used as a stand alone tool, or it can be used to support AEDET Evolution to provide a more comprehensive evaluation of the design of healthcare environments. When used to support AEDET Evolution it enables the user to score the Staff and Patient Environment Heading of AEDET Evolution in a more detailed, accurate way.

Table 1: Scoring layer of the ASPECT toolkit

Section	Focuses on:
Privacy, company and dignity	Visual privacy Privacy for conversation Opportunity to be alone Opportunity to be with others Toilets/bathrooms are located conveniently and discretely
Views	Spaces have windows Patients and staff can see the sky Patients and staff can see the ground Calming views Interesting views
Nature and outdoors	Patients can go outside Access to usable landscaped areas Patients and staff can easily see plants, vegetation and nature
Comfort and control	Variety of lighting patterns Ease of control of artificial lighting Ease of exclusion of sunlight and daylight Ease of control of temperature Windows/doors can be easily opened Design layout minimises unwanted noise
Legibility of place	Entrance is obvious Easy to understand layout Logical hierarchy of places in the building Way out is obvious Obvious where to go to find a member of staff Different parts of the building have different characters
Interior appearance	Patient spaces feel homely Interior feels light and airy Interior has a variety of colours and views Interior looks clean and tidy Interior has provision for art, plants and flowers Ceilings are designed to look interesting Patients can display personal items Suitable floor coverings
Facilities	Bathrooms are safe Choice of bath/shower, assistance/non-assistance Religious observance can take place Live performances can take place Easy chairs and tables in patients'spaces Facilities to make drinks Vending machines for snacks Facilities for relatives' overnight stays
Staff	Convenient place to change and a safe store Convenient place to concentrate on work Places to obtain meals/snacks Relaxation area segregated from patients Access to IT Basic banking and shopping facilities

ASPECT is a tool for evaluating the quality of design in patient environments in healthcare buildings. It delivers a profile, which indicates the strength or weaknesses of a design or an existing building. Because of the nature of design, which inevitably involves tradeoffs, it may not be possible to produce a building, which has (or would have) a maximum score for all sections. Indeed, it may be the case that a high score for one statement may be scored low on another statement. The ASPECT toolkit has been devised to enable alternative designs to be measured and scored.

There are eight sections in the ASPECT toolkit, as illustrated in Table 1.

4 ASSESSING THE USEFULNESS OF THE DESIGN EVALUATION TOOLKITS

The assessment of the usefulness of both the AEDET and ASPECT toolkits is ongoing. This doctoral research is currently at the stage of developing case studies based on work with a large Mental Health Trust in the North of England. The Trust operates fifteen units of different sizes, with various functions and a variety of facilities. It delivers services to support people with mental health, learning disability and substance misuse problems.

As part of its mission, the Trust has a stated aim to create the right conditions for its staff to put patients' needs at the forefront. In this respect, evaluation of the health units is essential as it is obviously important to the organisation to ensure that a high quality environment is provided for both staff and patients.

The case study methodology on which this research is based, therefore, has two major elements:

Firstly, an evaluation of the staff and patient environment, using an adapted version of the ASPECT toolkit. The toolkit is being used as a stand alone, and will be used to score at the scale of buildings and/or whole site levels. The calibration toolkit will be used with medical staff, non-medical staff, patients and user groups.

Secondly, the perceived usefulness of the toolkit to the design professionals, facilities managers and estate managers involved in the existing and planned units will be assessed. This will involve such questions as:

- How widely is it used in the Trust?
- If used, when is it used?
    - In the design process?
    - Post-project evaluation?

The design professionals and those responsible for the construction and management of the facilities will also be asked their opinion on other potential developments in the range of evaluation tools. A project currently being undertaken in the Salford Centre for Research and Innovation (SCRI) on 3D to nD modelling, aims to: ‘enable designers and the construction industry with a tool that allows users to create, share, contemplate and apply knowledge from multiple perspectives of user requirements’. One of the objectives of the tool is to develop methodology and technology, which will facilitate the integration of time, cost and other variables such as accessibility, sustainability, lighting , acoustics and other features affecting the environmental quality of a building (SCRI, 2005). The ability to incorporate an ‘Impact’ factor into this analytical tool could, obviously, hold considerable benefits for a quality appraisal.

5 CONCLUSION

The NHS initiative *Improving the Patient Experience* expects design evaluation to be based on the use of such instruments as AEDET and ASPECT. For this PhD research, other tools used in the evaluation of the quality of facilities have been considered. For example, Todd et al (2002) used a novice-expert technique to facilitate agreement between the two groups about their respective views and rankings of attributes of a healthcare facility.

However, the flexibility of the NHS toolkits and the fact that they can be used firstly as early as possible in the design process, then repeated as appropriate throughout the development of the design, before being applied in the post-project evaluation, means that they can be used not only to inform the briefing process but also to assess the degree of compliance with the original brief.

[Notes on acronyms used in the text:
LIFT*: The UK Government's Local Improvement Finance Trust (LIFT) is a major initiative designed to stimulate investment in local primary and social care facilities.*
PFI*: The Private Finance Initiative is a programme designed to enable the delivery of the Government's investment plans for public services.*
Procure21*: On the basis of recommendations in the Egan Report, ProCure21has been introduced as a partnering framework for the Department of Health and the NHS.]*

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DISTRIBUTED SIMULATION OF BUILDING SYSTEMS FOR LEGACY SOFTWARE REUSE

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ABSTRACT: The use of integrated building performance simulation can substantially help in improving a building design with regards to comfort levels and fuel consumption, while reducing emission of greenhouse gasses. However, the traditional tools that are closed for inter-communication, limit the modeler to use of components only available within that particular package. This paper gives an overview of distributed simulation approach that can alleviate above limitation. Each program can represent only a part of a building system that is able to model, exchanging the necessary information during the execution and bridging the gaps between the tools. Several important issues closely connected with its implementation, such as synchronization, are pointed out, and the sensitivity of a model on different coupling strategies is studied. The paper concludes with highlighting the gained flexibility in modeling and simulation of building performance that arises from the distributed approach.

Keywords – building performance simulation, distributed simulation, external coupling, model reuse, software interoperability

1. INTRODUCTION

Building performance simulation (BPS) is being integrated into the design process, as benefits from its utilizations are being greatly recognized and valued (look at IBPSA proceedings ’89-‘05). Many developments and improvements of tools and the deployment of the tools are a focus of many research groups around the world. Due to the decentralized developments, each BPS tool is restricted to a limited number of systems/components it can represent, which becomes evident when one wants to model and simulate an innovative building and/or systems (HVAC, lighting, shading, vents, operable windows, thermal storage systems, embedded renewable energy systems, etc.). Some components are available in one simulation environment and the some in the other. Still, the majority of tools are legacy codes originated from the mid seventies. They are: domain specific, not reusable, large, complex monoliths that are difficult to maintain, but still useful.

Previously (Hensen 1991, and Hensen and Clarke 2000) it has been argued that in the area of system simulation there is still enormous amount of work to be done. System modeling and simulation capabilities develop very slowly and take up an enormous amount of resources (time wise and financial). An efficient way forward would be to share developments and to reuse existing component models. However, the efforts of components models reuse and interoperability issues are mostly focused on model definition phase of modelling and simulation process, as shown on Figure 1. An overview of available techniques is given in Hensen et al. (2004). For example, data model reuse may be achieved on the product model level, either by sharing (Lockley et al. 1994) or exchanging (Bazjanac and Crawley 1999) information. Even though a common product definition model eases the use of simulation tools it addresses only part of the overall problem. Additional reuse may be achieved on the level of physical process models. This can be realized on source code level or in a more generic way by expressing the models in a neutral format, such as Neutral Model Format - NMF (Bring et al. 1999) that is now integrated in Modelica (Tiller 2001). Both data and process model reuse take place before run (or execution) time as shown in the upper part of Figure 1. So far, there was no a general mechanism in building performance simulation that would enable a modeller to model across various simulation environments while exploiting advances of each.

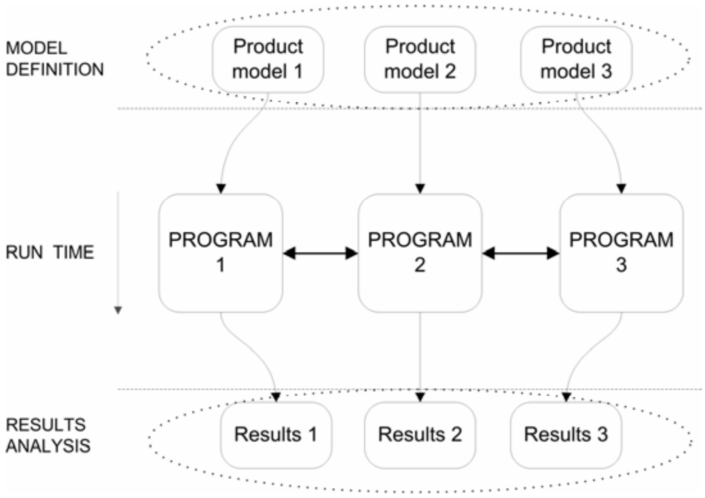

Figure 1 Reuse in different phases of modeling and simulation process

This paper introduces the concepts, background and core issues of an approach to process and data reuse by run-time exchange of information between the legacy simulation environments. In general terms, this approach in literature is recognized under the term: Distributed Simulation (DS), while the domain existing (legacy) software is referred as Commercial Of The Shelf (COTS) simulation software.

3. DISTRIBUTED SIMULATION APPROACH VS. TRADITIONAL SIMULATION APPROACH

One way to perform the simulation is to bring all component models together in a monolithic stand-alone simulation model that runs on an uniprocessor machine. That is usually done in the field of building performance simulation and it is known as program integration, where different domains are represented and simulated within the same program. The main drawback of the program integration approach is that the user is always restricted to the options/features offered by that particular program. An alternative to the traditional monolithic approach is distributed simulation. The driving motivation for distributed simulation is to integrate several separate simulations (federates) into a single simulation (federation).

Compared to the traditional approach, DS generates several advantages (Boer 2005, Ganse 2005, and Fujimoto 2005):

- reusability of already existing (legacy) COST software,
- combination of heterogeneous technologies,
- collaborative model design and development process,
- information hiding,
- scalability and fault tolerance,
- geographically distributed components, and
- reducing model execution time & more available memory.

The distributed simulation brakes boundaries between different simulations and by that introduces the potential to "pool recourses", i.e., to use the best simulation model available without being limited to those available "locally".

4. STATE-OF-THE-ART IN DISTRIBUTED SIMULATION

The concept of distributed simulation in particular has its roots in three separate communities: high performance computing community, defense community and internet gaming industry (Fujimoto 2003 and Wilcox et al. 2000).

There are two widely used architectures: client-server and peer-to-peer. In former architecture, simulation is executed on server machines, to which clients can log on from remote sites. The latter architecture does not have servers. The simulation is executed across many machines – peers. In the context of this research, we refer to the distributed simulation not only if the execution involves several computers, but moreover if there are at least two executables (federates) that exchange information in the federation run-time.

The activities enabled by the techniques and mechanisms that facilitate communication and data sharing between processes (applications) are called interprocess communications (IPC). The Figure 2 (partially taken from McGregor (2005)) shows the IPC taxonomy.

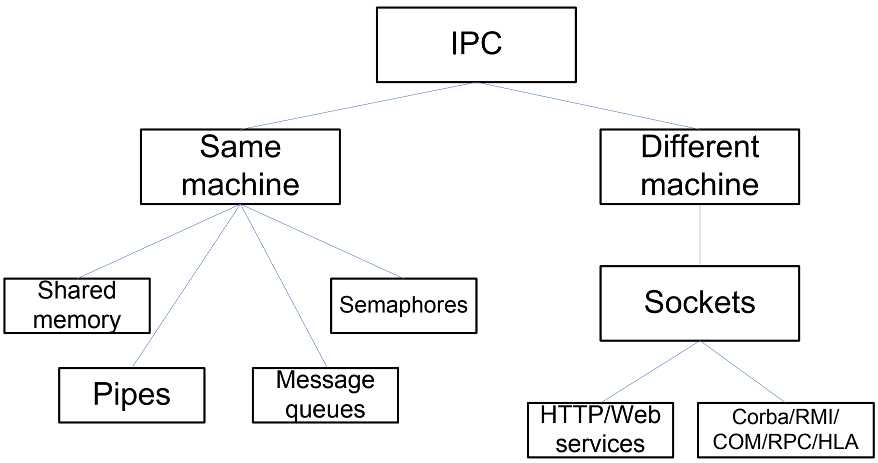

Figure 2 IPC Taxonomy (McGregor 2005)

An overview of most commonly used IPC protocols is given in Yahiaoui et al. (2003), and the reader is referred to that paper for more information. Buss and Jackson (1998) compared three higher-level architectures for distributed computing: HLA (High Level Architecture), CORBA (The Common Object Request Broker Architecture) and RMI (Remote Method Invocation) and distinguished three basic elements of distributed architectures as shown in Table 1.

Table 1: Elements of distributed architectures (HLA, CORBA, and RMI)

	Object interface language	**Object manager**	**Naming service**
HLA	*OMT*	*RTI*	*Federation execution*
CORBA	*IDL*	*ORB*	*DII*
RMI	*Java*	*UnicastRemoteObject and Naming Java classes*	*Registry Java class*

RMI uses its native implementing java language for object interface language, while HLA and CORBA define their own separate interface specifications that are distinct from their implementing languages, object model template (OMT) and interface definition language (IDL), respectively. The object manager is a backbone through which objects on all machines communicate, while the naming service is the mechanism by which clients discover the available objects on server during the computation run-time. RMI is language-specific and suitable for use with newly developed applications. Both, CORBA and HLA are concerned with legacy applications, possibly developed in different languages. However, CORBA as well as the majority of the IPC mechanisms represented on the Figure 2 (apart from HLA) are made to facilitate communication between two applications in general and not simulations in particular. As such, CORBA is not sufficient for straightforward use with simulation packages, where additional management of time and data exchange is required.

CORBA has been used in many projects in industry for integration of legacy code into distributed environment. For example, NASA Glenn Research Center (GRC) program, within NASA's High Performance Computing and Communication (HPCC), has been developing large scale, detailed simulation environment for design analysis of aircraft engines, called Numerical Propulsion System Simulation (NPSS) (Follen et al. 2001, and Sang et al. 2002). The environment focuses on three aspects of modeling capabilities, such as: integrating engine components, coupling of multiple disciplines (aerodynamics, structural mechanics, heat transfer and combustion), and engine component zooming at adequate level of fidelity. In order to use legacy FORTRAN codes developed for majority of scientific and engineering applications GRC has developed a distributed simulation environment based on CORBA. They compile and link re-engineered FORTAN code with CORBA/C++ wrapper. Only a few changes within the FORTRAN codes are necessary. A control logic module of the component is moved to the client side, while the computation module is left on the server side. This gives the client the flexibility of controlling and invoking individual iterations. However, time management issue is not addressed.

On the other side, a great effort is put in developing higher-level architectures for distributed *simulation* in particular by US Department of Defense (DoD). These efforts resulted in a standardized protocol (Aggregate Level Simulation Protocol – ALSP), a domain specific Distributed Interactive Simulation (DIS) and finally merging these results in HLA that is today considered state-of-the-art in distributed simulation and was in 2000 made IEEE standard for distributed simulation (1516).

The HLA consist of three components: 1) a set of rules that govern certain characteristics of HLA-compliant simulations (for both federates and federation) (US DoD 1998) , 2) OMT that describes the information of common interest to a group (called a federation) of cooperating federates, and 3) an interface specification (but not the interface itself) to a Run-Time Infrastructure (RTI) that provides the software environment needed by the federates to exchange information in a coordinated fashion. The rules for time and data management are clearly specified, and that is was distinguishes HLA the most from other distributed architectures.

Today, HLA is still mostly used only within defense community for military training simulators (Li et al. 2005 and Wilcox et al.2000) and in multi-player gaming (Wilcox et al. 2000, Pollini and Innocenti 2000). However, some initial actions have been made in order to adopt the standard in industry (Boer 2005, and Strassburger 2001). A vision of DaimlerChrysler is a "digital factory". Such a factory model would be able to represent and simulate the entire factory process before going to "brick and mortar" (Boer 2005) by means of consistent data management, simultaneous development of product and production and early consideration of production requirements in developments. Existing models are narrowly focused on isolated questions and only by coupling those models one can have a model of a detailed digital factory that cover all relevant causal relationships (Boer 2005, Taylor et al. 2002, and Taylor et al. 2004).

Besides DaimlerChrysler, Boeing also started to use distributed simulation (Wilcox et al. 2000). Both groups extensively cooperate with military, but they extended the use of HLA to their other aspects of business.

The broader automotive industry (Wang et al. 2005) uses distributed simulation to model supply chain management. Supply chain refers to the flow of material, information and services from the raw material suppliers through factories and warehouses to the end customer. It includes different organizations and process that all play a part throughout this journey. By using distributed simulation, each organization can develop its own simulation model, which encapsulates the information regarding that particular organization, without giving its know-how, and all independently designed models can be coupled and serve a common goal (Boer 2005, Duggan 2002, and Taylor et al. 2002).

Moreover, HLA was used in Lee (2004) to model satellite cluster management as for event based traffic simulator (Strassburger 2001, 2004).

In parallel to the initial attempts to use the HLA in the civilian domain applications, there is a delicate discussion weather or not the approach is suitable for needs outside defense community. Taylor in Taylor et al. (2002) argues that the HLA complexity that suites defense community requirements, might be in excess of relatively simple data exchange requirements in major industries, and questions the appropriateness of HLA implementations away from its original domain. In addition he raises the issue of data exchange approach standard lacking, as without such a standard there cannot be universal interoperation between COST environments. Wilcox at al. (2000) wonder weather many industrial communities either do not share, or have not yet explored the requirements to combine distributed models. Boer (2005) states that the size of projects in industry is smaller relative to the size of projects in military and that most of projects in industry will not benefit from HLA, considering costs. He argues that industry requires less complex solution. This reflects on the statement made by Paul in (Taylor et al. 2002). He argues that HLA in industry is only a solution that is looking for a "fantasy" problem and not finding one yet.

However, the implementation of either CORBA or HLA for distributed building systems simulation mainly raises difficulties when interfacing the legacy tools. The BPS tools are manly written in Fortran for which no object interface language (IDL, OMT) mappings have been defined. Much time and extra materials are necessary to overcome this difficulty as discussed in Yahiaoui et al. (2004).

By implementing a less complex IPC and formulizing the time management mechanism we believe that distributed simulation in the domain of building performance simulation can push the technology limits, enabling more flexible use of available legacy tools.

4.1. State-of-the-art in building performance distributed simulation

Some software-specific work has been done regarding the distributed simulation (run-time coupling) in the field of building performance simulation in general, i.e. ESP-r and Radiance (Janak 1997), ESP-r and Fluent (Djunaedy et al. 2003) and EnergyPlus and MIT-CFD (Zhai 2003).

In addition to the general run-time coupling developments, there are a few developments regarding distributed simulation in the domain of Heating, Ventilation and Air-Conditioning (HVAC) systems and control. Here we address some of the developments.

TRNSYS developers introduced a new type 155, defined as MATLAB connection. Matlab is launched at every TRNSYS time step as a separate process. The type 155 communicates with the Matlab engine through a Component Object Model (COM) interface. Any Matlab command (including Simulink simulations) can be run within a TRNSYS simulation (CSTB 2003). The similar approach is implemented in TRNSYS coupling with EES. TRNSYS is able to execute EES at each time step to solve a given set of equations.

A link between EnergyPlus and TRNSYS was used before EnergyPlus has obtained its own photovoltaic component model (TESS 2003). EnergyPlus module communicated information found in the EnergyPlus input file concerning photovoltaic arrays to TRNSYS. TRNSYS was then automatically launched during an EnergyPlus simulation to determine the performance of the PV array before returning control back to EnergyPlus. EnergyPlus then waited for TRNSYS to complete, then recuperated the output files that TRNSYS generates during its run and incorporated them into its native output-reporting format. The use of Windows API calls was used. However, the link is not a real distributed simulation application as there is not communication between programs on time step basis.

The assortment of efforts within the BPS domain presented show that there is a need for interoperable simulation environments. However, the research has not yet offered a general standardized framework for building interoperable simulation environments. This project has pioneered mechanisms on which the frameworks could be based.

6. TIME AND DATA MANAGEMENT ISSUES

Maybe the most important issue when discussing distributed simulation is time synchronization. To enable distributed simulation, components need to exchange data at run-time, and to synchronize their local (simulation) clocks. But, the time is in many cases the point of much confusion. There are three different types of time (Fujimoto 1998):

Physical time refers to the time in the physical system being modeled. For instance, a physical time may be as long as a year (annual building performance simulation).

Simulation time refers to the simulation representation of time. It is correlated to physical time, but the exact duration of one time unit will depend on computational algorithms and software execution speed.

Wallclock time refers to real time of simulation execution. For example, an annual (physical time) building performance simulation may be executed in 1 min (depending on software and model complexity) of wallclock time, and on the other side a CFD simulations wallclock time easily exceeds the physical time.

Time management is concerned with the mechanisms used by simulations to advance through simulation time. The discussion of synchronization and time management primarily concerns the simulation time. However, there are cases in praxis where synchronization with wallclock time is required (HIL or MIL (hardware/man in the loop) simulations). Fujimoto (1998) makes distinction of scaled real time simulations and as-fast-as possible simulations. Simulations in the domain of building performance fit the second approach (again apart real time HIL simulations (Xu et al. 2004)). For the latter approach the simulation execution does not have direct relation to wallclock time. HIL and MIL applications are not concern of this study and we will not further address synchronization with wall clock time.

In distributed simulation, federates run concurrently on potentially separate machines, each of them following its own time management scheme. However, the simulations are seamlessly dependent on each other, and the execution of one will influence the execution of the other in the corresponding federation (simulation) time. It is therefore important that the simulation clocks of each federate are synchronized with federation time, i.e. the simulation time of other federates.

Many studies dealing with distributed simulation address the issue of synchronization (Fujimoto 1998, Tacic and Fujimoto 1998, Wang et al. 2004, and Boukerche et al. 2005). They all generally tackle the event driven simulations. The simulations in the BPS field are time-stepped, where each time advance made by a federate is of some fixed duration of simulation time. The advance in federate simulation time (by this fixed stepped fashion) should not be allowed unless the federate received all data relevant for the current time step from other federates in federation. This brings us to couple of important points regarding synchronization realization:

1. each information to be exchanged must have a time stamp,
2. federate must not receive any information with time stamp less then its current simulation time, and
3. federate needs to have mechanism of determining weather all necessary to be exchanged information in the current simulation time step has been received.

We distinguish internal and external time management approaches. The internal time management indicates that the synchronization checking procedure is coded within federates themselves. On the other side the synchronization can be compassed within the inter process communication (IPC) mechanisms, applying blocking mode, for example.

There are two major groups of algorithms for synchronization (Fujimoto 2003):

- Conservative – take precautions to avoid the possibility of processing data out of time stamp order, i.e. execution mechanism avoids synchronization errors
- Optimistic – does not necessary avoid synchronization errors, but rather use a detection mechanism and recovery approach, known as roll-back. Introducing roll-back to an existing simulator requires a major re-engineering effort (Page et al. 1999) to incorporate state saving mechanism.

It is necessary to mention that several very important issues arise when building performance simulation is distributed, which has not been considered in the papers related to distributed simulation in military or automotive industry.

Firstly, we are dealing with legacy software and the major idea with which we approach distributed coupling is that we were not going to make major interventions over the original code. Secondly, distributed models can be very strongly coupled. This means that inputs for one federate are outputs of another federate, which are function of the outputs of the first federate. We call this strong interdependence: coupling with a feedback. Due to the autonomy of legacy software it is not always possible to exchange all necessary information in the current simulation time step (Trcka (Radosevic) et al. 2006) and that, results in federates that are delayed in simulation time to other federates. Weather there will be a delay will depend on the applied coupling strategy as well as on the federate system solution technique.

There are two different coupling strategies:

- quasi-dynamic coupling (Zhai 2003), or loose coupling (Struler et al. 2000), or ping-pong coupling (Hensen 1999) and
- fully-dynamic (Zhai 2003), or strong coupling (Struler et al. 2000), or onion coupling (Hensen 1999).

For accuracy constrains, the coupling strategies are closely related to time steps length. Accuracy as well as stability constraints will limit the simulation time step length in case of the first strategy. The second strategy allows longer time steps for the same accuracy, but it requires an iteration procedure to ascertain user defined convergence criteria. Hence, for the same accuracy we can either reduce time step length and apply the first strategy, or employ larger time steps with iterations between federates. Only with full dynamic coupling we can avoid time delays between federates, but that we will have to be compensated with iterations. Advantages and disadvantages of these approaches are addressed elsewhere (Hensen 1999). The difficulty of applying iterations again differs between the coupling mechanisms employed, i.e. discontinuous or continuous (see section 7) and is dependant on the nature of coupled component model (steady state or dynamic) (Trcka (Radosevic) et al. 2006).

Also, the external coupling will result in different time step variable exchange depending on which system solution approach is used (Radosevic et al. 2005). In terms of individual component models two main system solution approaches can be distinguished: *input-output based* (each component is represented by an input/output relationship), and *conservation equation based* (each component is described with time-averaged discretised heat and/or mass conservation statements which are combined to form a plant system matrix, and which are solved simultaneously for each simulation time step using either an implicit, explicit or mixed numerical scheme). Inter programs time step variable exchange will disturb the original intra time step variable exchange of the base program that uses implicit numerical scheme in conservation equation based approach. However, if explicit numerical scheme in the same approach is used the external coupling will keep the original intra time step data exchange consistent. The same applies for input-output based component modeling approach. Small coupling time steps, which are required by the chosen coupling strategy (ping-pong), will result in neglecting the discrepancy between the inter- and intra- time step variable exchange schemas and ensure the stability and accuracy of the obtained results.

Finally, this brings us to the third issue: implementation of a multi time step approach. Although it was previously mentioned that the advances in federates simulation time are made by fixed time step, some of the software in the domain implement multi time step approach to deal with a huge range of time constants within the simulated system. The federate time step that is assigned at the beginning of the simulation might be reduced during the simulation execution. This fact raises some limitations for synchronization management mechanisms. Other federates can require information to be exchanged on a global federation time step and should not receive the information that the federate employing multi time steps sends on reduced time steps. Or the federate employing multi time steps should not send the data, unless the simulation progressed for by the global time step duration.

7. SENSITIVITY OF COUPLING STRATEGY

Developments associated with this project were published elsewhere (Radosevic et al. 2004, Radosevic et al. 2005, and Trcka (Radosevic) et al. 2006). The major goal is to establish mechanisms that deal with all the issues associated with distributed simulation of legacy software from the building performance simulation field. The approach undertaken by the project is to develop components within each environment that will be used to interface other environments. Such components were developed for TRNSYS, ESP-r, EnergyPlus and several smaller stand alone programs (e.g. EARTH), respecting the developer's style in each program. The project core issues are related to data and time management (synchronization) and coupling strategies between programs relative to the accuracy and stability of the simulation results. For implementation purposes, the developed prototypes are based on peer-to-peer architecture and use named pipes (UNIX application), shared memory (Windows applications) and sockets (UNIX-Windows applications). We implemented conservative time management, as execution speed does not fall into the main focus of interest.

Two distinct mechanisms are developed, named continuous and discontinuous. In the former federates are executed concurrently and have internally build synchronization algorithm. In the latter, there is so called "base" and "external" federate. The base federate is a master federate and invokes external federate when necessary. Both mechanisms, implement quasi-dynamic coupling strategy, i.e. no inter software iterations are employed. We justify this decision by the following example, showing the results of the coupling strategies sensitivity study.

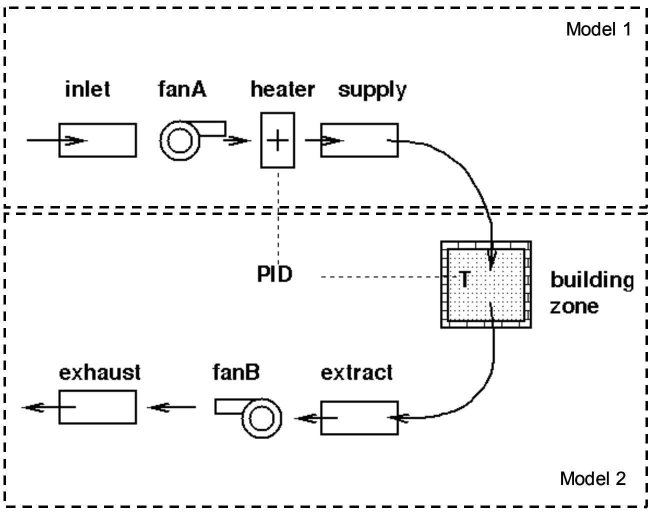

Figure 3 Simple HVAC network modeled in distributed fashion

The influence of the coupling strategy on the simulation results was investigated for different coupling time steps. For the study a simple HVAC network was used as shown in Figure 3. To assess the sensitivity of coupling strategy, the simulation output of a one-program model (i.e. assumed to be fully-dynamic coupled) is compared with the simulation output of a distributed model (quasi-dynamic coupled) of the same overall system. Several simulations were performed changing the length of coupling time step, i.e. the frequency of data exchange among federates.

The results in Figure 4 show that if the exchange frequency is high enough, the results for both coupling strategies are similar. However, if the coupling frequency is reduced, the difference between the strategies increases. For example, if the coupling time step is reduced to ten minutes, oscillation that appears due to the particular combination of control parameters, controlled system and simulation time step are much larger than if the models do not iterate. With further reduction of the coupling frequency, the difference with regard to the oscillating amplitude between the strategies is less apparent, but the phase shift due to the time delay between federates is still present.

From the example, it can be concluded that with an appropriately chosen coupling- as well as simulation time step the differences between strategies are small. The loosely (quasi-dynamic) coupled federates will produce the same quality results as strongly (fully-dynamic) coupled ones. For reasons of simplicity, the quasi-dynamic approach was chosen as the starting point for the prototypes elaborated in (Radosevic et al. 2005, and Trcka (Radosevic) et al. 2006).

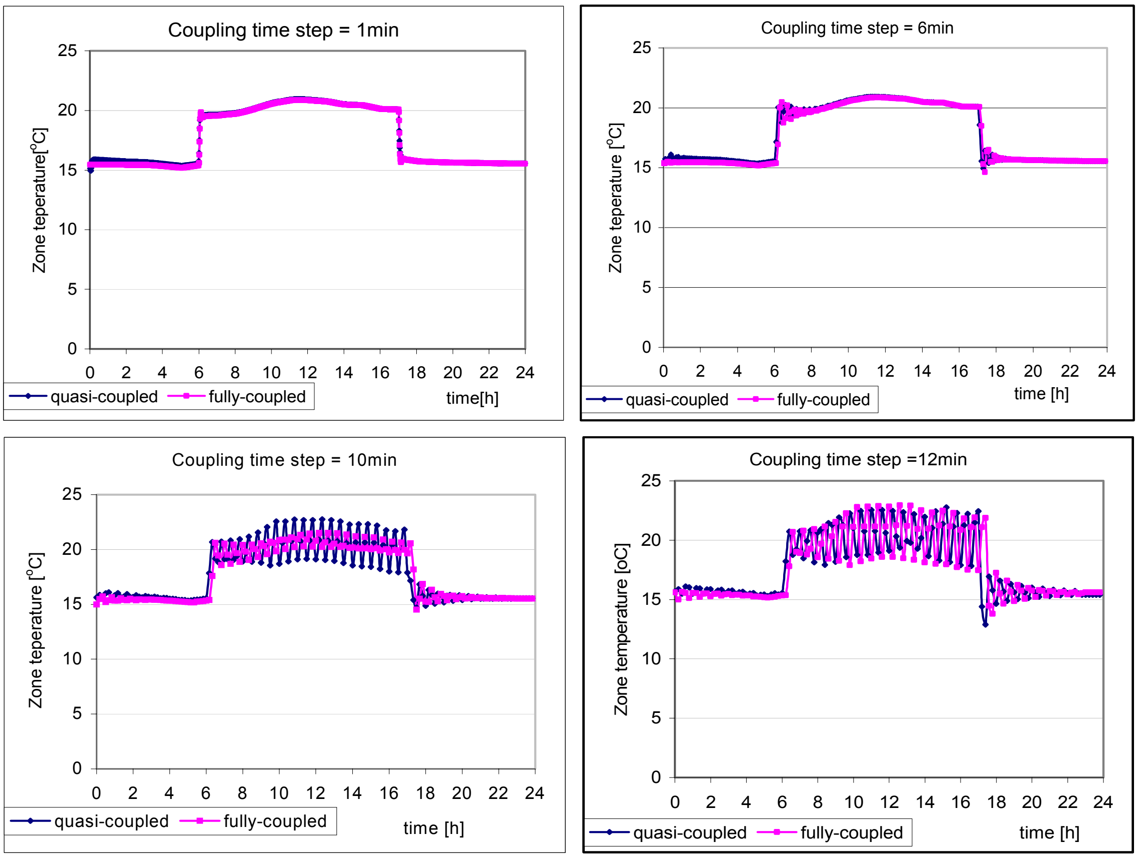

Figure4 Influence of coupling strategy on zone temperature calculation with different coupling time steps

9. CONCLUSIONS

With its roots in domains of software engineering and military training simulation, the benefits of distributed simulation environments are also being recognized in some parts of civil industry. With distributed approach each program can represent only a part of a system that is able to model. It may happen that a simulation model potentially residing on a distant computer already provides the particular functionality. The distributed simulation is in this case an alternative to additional effort for rewriting the software locally. Additionally, a varied level of detail of a simulation models can introduce better correlation: fidelity in obtained results vs. simulation goals as well as the improved behavior of the simulation models that can have varied time management schemes. The distributed simulation brakes boundaries between different simulations and by that introduces the potential to “pool recourses”. We recognized the potential of its use in the building performance simulation and explored its benefits and pitfalls.

The time management issue has been addressed in particular. Different approaches have been discussed in relation to the specific types of simulation packages and solution techniques used in the building performance simulation.

To finish, the example that investigated the influence of employed coupling strategy to the simulation results has been presented. The results from the study justified the choice of quasi-dynamic coupling strategy for the developed prototypes.

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LINKING DESIGN MANAGEMENT TO VALUE PERCEPTION IN ARCHITECTURAL BUILDING DESIGN

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ABSTRACT: The field of architectural design management can be characterized by a mixture of belief and science, joined in several models and theories. Scientifically we do not know if and which of these models actually attribute to value creation of the built object, we only have strong feelings they do matter. Few studies have been done in the field of architectural design management which correlate the management efforts to design output applying methods that can be generalized scientifically. In product design there are some examples of how to track this relationship. This starting PhD research tries to establish an empirical relationship between the use of management techniques in the designing phase and the quality of the design in the built environment. Because of the complex character of the topic several short explorative studies will be designed to provide input for the final method. In some studies a research method has to be found to capture management techniques used in practice. Other studies focus on measuring the different sub qualities of quality and design value as a whole. Finally the best measuring methods identified for steering and value will be brought together in a measurement method and tested empirically. The paper reflects the introductory literature review and the research design.

Keywords - correlation, design, management, value, measurement methods

1. INTRODUCTION

Every building project is unique in its complexity, stakeholders, design and process. Therefore you could conclude that it requires a customized management method. Scientists try to find similarities in these methods to define an overall model. Beneath these models often lies the assumption that the product is influenced by the process in which the product is made. Because of the iterative and cyclic character of a design process and the uniqueness of each product, it is hard to prove the existence of this relationship. Compared to building construction projects it is relatively easy to experiment in product design because of the relatively short process periods and fewer variations in the product. Examples of these experiments can be found in the literature (Ahire and Dreyfus, 2000; Swink, 2003).

Design theory states it is the designer's task to integrate and co-ordinate design constraints and to find a way to convert constraints into positive elements (Bártolo, 2001), as designers need to balance qualitative and quantitative criteria in their decision-making processes. This applies to the object of design. From the other, more engineering perspective, design is a process that transforms client requirements (input) into design objects (output). It is a process where values for the customers are created through the fulfilment of their requirements. It is also a flow of information, that has to be controlled and distributed effectively in time and space in order to eliminate waste or inefficiencies (Ballard and Koskela, 1998; Sebastian, 2004). These processes have to do with the design team and interaction between the parties. Experience and common sense tell us that all kinds of design processes have to be managed to get them done the right way. In design, object and process often overlap and it is difficult to draw a sharp line demarcating where the 'hard' object ends and the 'soft' social process begins. Traditional management could be counterproductive, particularly in contemporary large, complex and fast projects; it creates self-created problems that seriously undermine productivity. But making design subject to management is still assumed, at least by the designers involved, to result in the death of creativity. And professional managers tend to shy away from architectural design, which is seen as a black box not to be opened (Prins, 2004). Management in design processes therefore includes the 'traditional management activities' as planning, controlling, coordinating, decision making as well as the more 'modern' activities like stimulating creativity, collaborating, learning, inspiring, creating a vision and assuring quality, values and ambitions to come true. Management carries the responsibility of involving all stakeholders in the process in a sophisticated matter and to manage their expectations. Expectations that have to be fulfilled to create value.

This PhD research aims at the relation between process performance and product performance to establish a measurable connection between the management of the design process and the value of the resulting building product in terms of architectural value. Research goal is therefore to establish an empirical relationship between steering activities in the design process and the value creation of the design object.

2. THE FIELD OF DESIGN MANAGEMENT

Design management covers a wide range of functions, starting with the self-management of individual designers and ending as part of the management of the total project through integrated building design management. Based on Sebastian (2004) several views on design management can be distinguished:

1. Organizational approach: management of a design office and the coordination of inter-organizational decision-making. The mission and strategy of the design firm will play a part in finding a suitable management technique (e.g. Allinson, 1997).
2. Project approach: Design management should not interfere with the designers prerogatives regarding the quality of design products but rather take a supportive role by making the design process effective, efficient and lean through the coordination of tasks and information. They manage by analyzing, identifying, mapping, and arranging various design tasks in sequential or concurrent orders (e.g. Gray and Hughes, 2001).
3. Process approach: socio-psychological approach to manage socially complex design collaboration; creative and reflective collaboration, progressive learning-in-action, and high-performance teamwork (e.g. Sebastian, 2005).
4. Product approach: to produce the physical object that meet the aesthetic and functional expectations in use, as well as the economical and technical requirements in production. DM is responsible for defining the values to be met, translating them into a design brief en guiding the designers in their understanding of the requirements (e.g. Kestle and London, 2002).

Organizational approach: The majority of the architects find it hard to see the architectural firm as a business – they see the management of their firm as a necessary and obliged part of conducting their passion for designing. Most successful architectural firms in the Netherlands work jointly with a bureau manager or organizational business partner to strengthen their business position. Only a few authors are, just like Allinson (1997) trying to encourage architects to focus on planning, monitoring, analysis and control as well as on team management and human resource management to create added value and distinguish the firm from others. Because of the fact that in the field of architectural design artistic and utilization goals intertwine, it is hard to apply traditional management techniques. Management of the design must therefore also include ambition, satisfaction, culture, learning, understanding, values and fun to connect to the iterative, cyclic and creative process of designing.

Project approach: Architectural firms always work together in a construction project. An essential part of designing therefore concerns interactions between stakeholders. Information, interests, goals and requirements of all stakeholders must be integrated in the design. All stakeholders withhold their own view of the final product. According to Best & De Valence (1999), the success or otherwise of a building will be decided according to a complex mix of judgements offered by a range of interested parties. Gray and Hughes (2001) identify two levels of responsibility for the design and its production in design management: the associated authority for decision-making, and responsibility for the interface with other organizations. The task of the design manager is to ensure that the organization of the design process is structured appropriately and that there are sufficient integrative and coordinating mechanisms for the work to progress meaningfully. A framework therefore has to be established to keep the focus on the tasks and objectives so as to achieve the value criteria laid down in the initial stages.

Process approach: In interacting with different parties often conflicts appear. Management theories based on decision making and information transfer give little attention to this complex social phenomenon. The literature on interactive or collaborative management focuses on the guidance of uncertain processes with equal professional network parties. Because of the lack of clear common goals, theories in this field are based on cooperation, trust and influencing to take the project one step further (Bruijn et al., 2002; Teisman, 2001). Bekkering et al (2001) address the power, strength, feasibility and support of the idea and its owner as the main aspect of management. Success of the idea depends on the quality of the idea but also on the fit in its context. The research of Sebastian (2004) focuses on the complexity of interacting in a multi-designer environment. His framework should promote human creativity by using the social psychological approach. In his paradigm Design Management deals with the working frames of the designers in collaborative design conception. These working frames are: cognitive frame, social frame, and project frame, which comprise the idea generation, social interaction, and project content and context. Since these frames do not pre-exist and cannot be standardized, design management is expected to design these frames in different projects and with different project participants.

Product approach: The product approach is most closely linked to the design process and the designer. Design theory states it is the designer's task to integrate and co-ordinate design constraints and to find a way to convert constraints into positive elements (Bártolo, 2001), as designers need to balance qualitative and quantitative criteria in their decision-making processes. Poor integration of specialist user and producer stakeholder knowledge can have far-reaching consequences, such as inappropriate synthesis of the needs analysis, resulting in low value generation for the client and users. In many cases identifying value is a socially constructed process among the stakeholders, who incidentally are not just design and construction teams but are those actors who can contribute to improved design and construction building performance (Kestle and London, 2002). The Design Quality Indicator has been developed by the UK Construction Industry Council to measure quality in the brief phase as well as in use. Using the tool will confront all stakeholders with differences in expectations and constraints.

A high quality process does not necessarily result in a high quality product and vice versa. In management as well in design the process between the input and output is still seen as a black box (Figure 1). We try to understand what happens in the throughput but because of the complexity, situational and personal influences of the process we can only get a grip of a small parts.

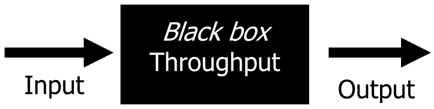

Figure 1 Input related to output

Typical of all views distinguished on Design Management is the lack of (empirical) evidence that these views rest on. A gap seems to appear between science and belief. Majority of professionals are convinced that management adds value to the product and process but have difficulty proving it. In product design external and internal quality can be distinguished by using scrap rates and market share. Processes can be varied and compared to each other because of the short project periods. In architectural buildings these methods can be applied only partially. Due to the complexity and uniqueness of the building it is hard to analyze differences. A literature review on management performances (Volker and Prins, 2005) uncovered one study in which the performances of architects in Nigeria are compared by using a survey (Oyedele and Tham, 2005) and several masters thesis's which captured steering and management techniques using observational and experimental methods (Oranje, 2004; Kruijne, 2003; Fraats, 2003). Kruijne (2003) describes an holistic but effective way of linking the level of integration that is being reached between the building design and the climate installation to the process design considering information transfer and communication. Most important empirical result of the review is the publication of Ahire & Dreyfus (2000) from the field of product design. In their study quantitative data such as scrap and rework rates, defect rates and reliability are used to define internal quality, while market share, customer complaints, warranty and litigation are used to measure external quality. Ahire & Dreyfus (2000) distributed 418 surveys to find out if Design Management and Process management affect the external and internal quality of products. The use of the management methods is measured by statements on the involvement of users and use of management tools on a Likert scale. They found that both design and process management have an equal impact on internal and external product quality. These studies provide a weak but promising knowledge base for this PhD research project.

3. THE FIELD OF VALUES

According to the Dutch Van Dale dictionary the term value has three relevant meanings. The first meaning refers to the value as possession or trade property. The second meaning concerns the ethical, personal or moral aspect. The third meaning is a number, an amount that is pointed out by a meter. The first meaning of possession is often combined with the third meaning when we express value in monetary or quantifiable value. The second meaning is harder to express, some people talk about intangible or soft values (Macmillan, 2004, 2005). Things that are difficult to describe are generally also hard to measure. However, in measuring the effect of management on value creation both kind of values are equally valuable. Quality and value are related concepts. Quality almost always refers to conformance to requirements or the fitness for use. This implies that the value can only be seen by the party which articulates the requirement or judges the potential use - quality in the eye of the beholder. Most literature is can be found on quality. Presumably this is caused by the intangible, multi-dimensional and abstract character of the term value.

In line with Einstein one could say that 'facts are just facts, it's the perception that really matters'. The experience of quality originates in the confrontation between the individual and the object, building or place and this concerns the characteristics of the individual, the object and the situation. Based on Pirsig's (1991) appreciation of quality, value judgments are always part of the relation between observer and object. This would imply an individual judgment that cannot be compared to any other. However, similarities in perception can be found from several ways. Environmental psychologists like Kaplan & Kaplan (1989), Berlyne (in Bell et al., 1996) and Prak (1979) found by using the semantic differential that mystery, complexity, coherence and legibility are important issues in the preferences of the environment because to understand and to explore are basic needs of people in environments. Although meanings about architecture vary greatly, the components of architectural quality found by Rossum (in Voordt and Wegen, 2005), Usmani & Winch (1993), Bártolo (2001) and Dijkstra (2001) by examining experts in architectural design (coherence, context, legibility, impact, expression, composition) correspond to a large extent to the factors found by the environmental psychologists. Differences between the perceptions of architects and non-architect in assessing the built environment can be found (Gifford et al., 2002). The Dutch architect Carel Weeber (in Voordt and Wegen, 2005) has his own meaning about architectural quality. He claims that a building's architectural quality is not determined by the professionalism with which it was built, but by the part it plays in architectural debate. His view assumes that only professionals can determine design quality. This assumption is also made in a design competition. The design constraints are described in the specifications and designers can complete their solution to the problem by sending in their contribution. Winners are selected by a professional jury. This method is open for discussion. Apart from the fact that judgement criteria remain vague, the jury is influenced by discussing the contributions with each other. Moreover the report of the winning design only reflects part of the reason why the design was chosen to carry the best solution. The rest of the reasons remain unsaid and are taken home by the panel members. Maybe the International Songfestival method (expert pronounce their judgement autonomously and independently) would lead to a better input of expertise.

From the background of Value Management, value depends on balancing the three factors of time, cost and quality against the client's requirements, while retaining the basic ideal. At the same time, there will also be a willingness to satisfy the client's needs, including those related to function, aesthetics, business goals and image. It always involves a relative and balanced consideration of tangible and intangible costs and benefits and a willingness to give up in order to gain (Best and Valence, 1999). This view is confirmed by Dreschler et al. (2005). Based on the Welfare-principle he defines the value of a Building Construction project as is the amount in which all persons involved are influenced in their well-being as a consequence of the project. In his model, the value judgments of the people or groups that are affected in their well-being by a project proposal (the stakeholders) are added up to determine the total value of a project. Another way of looking at value in used in environmental sciences by using hedonic pricing or travelling costs (Dammers et al., 2005). Even though the experts agree on the facts that the value measured using these methods cannot be used in expressing the 'true' value, these economically based methods can be used in cost-benefits analysis.

Vitruvius (utilitas, firmitas and venustas) is still an important source of inspiration when defining architectural quality. A variety of arrangements can be distinguished (e.g. Voordt and Wegen, 2005; CABE, 2003; Macmillan, 2004). Prasad (in Macmillan, 2004) describes quality as the achievement of a totality that is more than the sum of the parts. She argues that design quality can only be achieved when the three quality fields of functionality (use, access and space), built quality (performance, engineering systems and construction) and impact (form and materials, internal environment, urban & social integration and character & innovation) all work together as circles. Non-overlapping areas of the circles represent very basic things to get right, regions with some but not total overlap represent the added value, while in the middle all three quality fields overlap and one obtains true excellence. Without the basics there can be no true excellence. Post Occupancy Evaluations can be used to measure the experiences qualities distinguished by Vitruvius. The Design Quality Indicator has been developed on the principles of Prasad and described by Gann and White (Gann et al., 2003; Whyte and Gann, 2003). Also Vischer & Preiser (2004) and Volker & Voordt (2005) developed instruments to measure the performance of a building by using POE-techniques. By using a 5-point scale various aspects of the built environment are measured and compared to other buildings. By dividing the built environment up into aspects, these methods have difficulty capturing the whole. The critiques of these kinds of instruments cover the full range of difficulties of measuring the quality of design that is being pursued in the Journal of Building Research and Information. The existing quantitative and 'positivistic' studies have great value for science and practice but fail to address the more 'soft' and intangible aspects of quality, which only together define the excellence and 'delight' of design. The divergence in quality perception between different stakeholders is conversely well-established. It needs to be borne in mind that, in decision-making, not all stakeholders are willing or able to define their interests and goals at an early phase in the design process. Evaluation tools used in the 'old' situation often give the stakeholders the ability to think and discuss design quality instead of costs in the 'new' situation and to provide support for the continuous process of helping clients and users find an optimal spatial solution. It is, however, open to question whether the full range of quality issues can be scientifically measured in subjective terms instead of by the collection of facts and figures (Dewulf and Meel, 2004).

Looking at the value of design can best be summarized by Gann & White (2003). They identify three approaches for looking at value and design quality. The 'judgement-based approach' is adaptive, focusing on the experts' abilities to evaluate the design product. The 'manage and measure' approach is based on a belief that designers can make rational responses to social, economic and environmental needs, and research has been focused on achieving better design by measuring, management and integration of the process. In the middle lies the 'rational-adaptive approach', which accepts that quality is a difficult and uncertain aspect to measure but that the development of tools to think about the impact of the design could be beneficial. In the same article Gann & Whyte remark that we have in large part moved away from efforts to measure, analyze and control every facet of the design process. As a consequence some practitioners only rely on their own expertise while shutting other stakeholders out, while others try to develop new methods to assess risks, options and choices in multi-criteria environments. This opens up a discussion on how to value design products.

4. DEFINITIONS AND RESEARCH QUESTIONS

The research goal of this PhD research is to establish an empirical relationship between steering activities during the design process and value creation of the design object. This leads to the following main research question: *'To what extent does the use of management techniques add value to the architectural building design?'*.

To answer this question several partial questions have to be solved:

1. *Which steering methods are applied (successfully) in managing architectural design and how can these be captured?*
2. *Which values are created through the product and how can these be measured?*
3. *How to design a reliable and valid method to determine the relationship between steering techniques and value through design?*

Expectations are concerning the function of management in design. In the most beneficial way design management should work as a catalyst – accelerating and intensifying the design process without changing the potential quality of the ingredients and keeping the natural environment intact. Otherwise it could have a contra productive effect on the design and the ultimate product of the design process in the shape of a building.

Based on theories and models mentioned in the paragraph on management this PhD research holds on to the following definition of Design Management: 'Design Management is a combination of instrumental and human steering activities to realize an architectural building design which fulfils all expectations of the stakeholder. Instrumental steering implies distributing design information by using management techniques, tools and models. Human steering means influencing behaviour of the designing parties in the right direction through facilitation, stimulation and motivation.' The human steering has a lot in common with leadership- and interpersonal skills while instrumental steering has to do with the use of ISO 9000, PMI or PRINCE.

Because value does imply an opinion or judgment in of a quality in itself, this PhD-research project uses the term 'value' in stead of 'quality'. This research recognizes two kinds of looking at value in architectural design. At first value can be seen as complementary parts based on Vitruvius. Next to this value can be seen as a whole, valued as true excellence holistically. To measure both kinds of value the three approaches mentioned by Gann & Whyte (2003) can be used. It has to be examined which approach fits best which kind of value. Basic question in this part of the research is *'Does the sum of the parts equal the richness of the whole?*'. Because value can only be evaluated by persons which have some kind of interest in the object to be built, stakeholders play an important role in valuing design (figure 2). Value can be defined as: the total of a (time and place dependent) profile of tangible and intangible meanings caused by the confrontation of the stakeholders with the building or the building design' seen by the stakeholders.

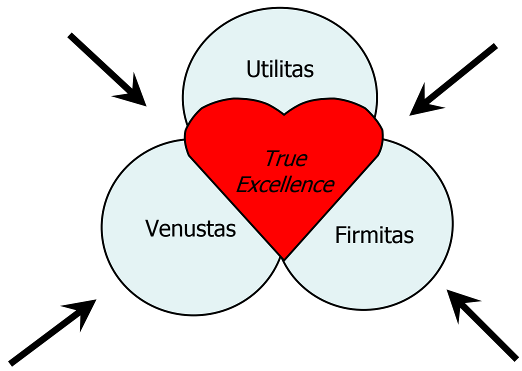

Figure 2 Image of valuing design by different stakeholders on different ways

5. RESEARCH DESIGN & METHOD

This research project distinguishes two parts of design management (instrumental steering techniques and human steering activities) and two kinds of looking at value (as a whole or as complementary parts). The research design (2x2) derives from these distinctions (Table 1). The research design creates possibilities to explore several measurement methods for the variables of management and value. Final intention is to connect the different variables and develop a measurement techniques which connects management to value in design.

Table 1 Research design

Step 2 Empirical connection	*Management measured by*	**Complementary parts of value**	**Value as a whole**
Value measured by	**Step 1** Exploring combinations	Surveys or value models	Semantic differential or expert method
Instrumental steering (methods, techniques, tools)	Document analysis or (written) interviews		
Human steering (facilitation, stimulation and motivation)	Observation or written interviews		

Methods mentioned in step 1 (see Table 1) are based on the properties of the definitions of steering and value set for this research project. To measure behavioural issues observation or interview techniques have to be used. The use of instrumental techniques can be measured by document analysis or (written) interviews. Values can be captures by using several ways to measure perception.

In the field of product design and design theory several experiments have been carried out that can be used as a example (Goldschmidt and Tatsa, 2005; Oranje, 2004) to measure aspects of the human design process. Case studies done on performances of management (Ahire and Dreyfus, 2000; Fraats, 2003) and the critical success and fail factors in building construction (Chan et al., 2004) provide us with ideas on how to measure instrumental steering. POE-instruments (Volker and Voordt, 2005) and economical models (Dammers et al., 2005) can set an example for measuring complementary parts of value. Cognitive psychological studies (Gifford et al., 2002; Stamps, 2004) and expert judgements (Dijkstra, 2001; Kruijne, 2003) open up possibilities for measuring the wholeness of value. Combining these ideas will lead to several experiments. Because of the limited time of the PhD research some experiment will be combined with other PhD-projects and MSc-theses.

The research method can be compared to solving puzzles: you know what image to achieve, you start finding a piece which addresses a point of reference, from there you start to find an adjacent piece. The adjacent pieces form a fragment and finally the joint fragments form the final image (see Figure 3). Based on this principle the first step in finding the connection between management and value in building design would be to form a fragment by combining different research methods with different parts of steering and value. To do so several combinations of measurement methods have to be explored in experimental settings (step 1). The second part of the research project will focus on establishing an empirical connection between design management and value creation by combining the best ‘method-variable combinations’ (Step 2).

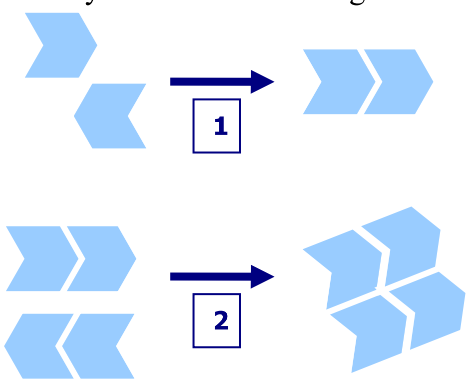

Figure 3 The research method compared to doing puzzles in two

6. PERCEIVED BOTTLENECKS

It is hard to image that in this world where everything is possible we cannot get a grip on the value creating effect of management activities in a design process. Uncertainty plays a big role in human activities, fortunately I would say. It also contributes to fun in life. The processes that occur in the mind of people still surprise scientists. But in business performance it would be nice to have a little control. Unfortunately, in the buildings construction sector a high quality process does not necessarily result in a high quality product and vice versa. We try to understand what happens in the throughput (the black box) but because of the complexity, situational and personal influences of the process we can only get a grip on small parts. Therefore we assume that the process does matter in creating value. This research tries to contribute to these small parts by experimenting with different research methods. Experiments carry a great risk of failing but failure also contribute to knowledge development.

Steering activities are hard to distinguish from normal interaction activities. In this research project we assume that the activities of the steering party are all focussed on accomplishing the mission and reaching the intended goal. These activities can seem productive in advance but could turn out to be contra productive in the end. The exact effect of steering activities cannot be predicted. Defining design management as a combination of steering activities but pursuing the measurement separately and in an experimental way could be a promising strategy. Results could indicate that it isn't possible to make this distinction.

Quality is mostly defined as meeting agreed requirements or conformance to requirements. In this research project architectural value has been defined as a profile pf meanings for the stakeholders. This definition is about subjective quality. It implies that quality can only be seen in the eye of the beholder. As long as they are satisfied, the quality is high. Theoretically it should be able to reach the final goal as set in the beginning that integrates all views, but in practice it is impossible to fulfil the needs of all stakeholders in the same product. The perception of the beholder is influenced by personal and situational factors and changes over time. The process and the way the beholder is involved in the process also influences the perception of quality. By using quantitative research methods these differences could be levelled.

An way at looking at quality could be by using Key Performance Indicators. For 'hard' physical building elements KPI's can be quite easily set (e.g. the amount of day light, the average temperature). But what about the atmosphere and architecture of the building? How can these intangible or soft indicators be set? Do we actually have to quantify these performances or can they be measured in a qualitative manner like is done in POE's and satisfaction research? These different perspectives have to be compared somehow to answer these questions.

Tombesi (2005) measured the effect on company results and continuation of existing among organizations that contributed to the Sydney Opera house. Preliminary results show a great return on investments in terms of innovation power. The amount of tourists visiting Sydney especially because of the Opera house can hardly be distinguished from the ordinary visitors stream but the design seems to attract extra people. Another example is the Guggenheim museum in Bilbao. These kind of values can only be measured over at least 10 years time. The same applies for monuments that carry cultural value: one cannot design every building as a monument, time will tell which building will develop as such. By the use of experts, this research will hopefully include the future effect of the building as much as possible.

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ECONOMIC MANAGEMENT IN SELECTED OIL EXPORTING COUNTRIES

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ABSTRACT: Oil revenue plays an important role in oil exporting countries acting as a catalyst for economic development and creating employment. These countries are heavily dependent on oil revenue, which constitutes more than 80 % per cent of the balance of payments and between 30%-60% of GDP. However, this heavy reliance on oil exports makes these economies vulnerable to the volatility of oil prices, which are difficult to predict. The structural change, which occurs in oil markets through price shocks and the subsequent direct effect on these economies, may cause cuts in development programmes, employment shrinkage and short-term damage.

This paper examines the performance of various oil exporting countries over the last few decades, through concentration on the strategies and policies, which are pursued by these countries in terms of fiscal, employment policy and economic reforms, which are undertake by each country. The paper also highlights the difficult fiscal and macroeconomic challenges that reliance on oil revenue poses for policy makers

Keywords: economic development, diversification, oil, structural changes, volatility,

1. INTRODUCTION

Oil-producing countries face special challenges in managing their economies. Oil and gas, like other minerals, are non-renewable. Oil prices and revenues are highly volatile and hard to predict. Also, the reserves in a particular country or region may become depleted over the lifetime of a generation or two, even if reserves may be discovered elsewhere, so that the global reserves can be maintained. The exhaustibility of oil reserves and the high concentration of revenues flowing from the oil sector may produce rent-seeking behaviour and may lead to a problem with long-term fiscal policy. The fact that oil is a non-renewable source of energy raises complex issues of sustainability and intergenerational resource allocation. A country that has depleted its reserves over the time span of a generation or so faces the choices of letting that generation use up the oil wealth for its own benefit or giving future generations a share in these resources.

Clearly, this is possible only by transformation of the non-renewable resource into a renewable one. It is clear that many countries have had difficulties in addressing the challenges posed by oil-dependence. Notably, the growth performance of many oil producers has been disappointing, despite their huge natural resources.

This paper focuses on the policies that have been implemented by the oil-producing countries. In addition to a survey of countries' strategies and experiences in managing their oil dependency, the main objectives are :(i) to give an overview of the general policy in oil producing countries;(ii) to describe actual practice in the countries. Obviously, oil-producing countries are not all the same. There are considerable differences not just in the relative importance of oil to the economy but also in the size of oil reserves, maturity of the oil industry, ownership and taxation structure in the oil sector, stage of development of the non-oil economy and the government's financial position.

2. LONG TERM-CHALLENGES

The biggest challenge, which faces these countries, is how to use and manage their wealth wisely and prudently without squandering and wasting the proceeds. Oil is exhaustible and it is, therefore, inevitable that oil earning will, at some point, dry up. Therefore, focusing first on the long run, a key challenge for fiscal policy is deciding how to allocate government wealth (including oil wealth) across the generations. This challenge reflects a concern for intergenerational equity and financial prudence. The preservation of wealth requires that consumption in each period be limited to stable income or, in this case, the implicit return on government wealth.

The government of an oil-dependent country, however, is confronted with significant uncertainty relating to its oil wealth. The volatility of oil revenue, because of swings in oil prices, is problematic, especially for short-run macro-fiscal management. However, it is the uncertainty about wealth itself, which stems from uncertainties about such issues as the future path of oil prices, the size of the oil reserves, and the cost of extracting them, that is most important for long-term considerations. Moreover, domestic debt would be put on a sustained downward trend, thus providing greater fiscal space for productive spending. Given the close interdependence of the public sector and the budget, speedy structural reform and privatisation of state enterprises would help reduce subsidies and enforce market competition.

Askari and Jaber (1999) conclude that, the biggest challenge to face oil-exporting countries is how to preserve a high level of saving during the pre-depletion period and invest these in high-yielding, diversified assets. The crucial challenges are to use oil revenues to achieve optimum growth and diversification without undue inflationary pressures and to spread the benefit of oil income over the largest segment of the population. Furthermore, the government requires a decrease in the share of oil in total revenue.

According to Stiglitz (2003), to overcome these challenge, the government should improve budget transparency by requiring that the Ministry of Finance provide information to Parliament and the public about the basis for the draft budget's revenue and expenditure estimates, as well as greater line-item detail about proposed expenditure. To take one example, the central challenge, which faced the Oman economy recently, was to forge a path of development that ensured steady growth in real income per capita along with sustainable fiscal and external sector adjustment (MArtey, 2003). The Oman high oil-dependency profile is resulting in greater vulnerability to changed oil prices. Treichel (2003) believes that fiscal policy has a crucial role through economic policies, which can directly influence the growth rate of a country. The role of fiscal policy has been assessed as an important factor contributing to growth. The impact of fiscal policy on the long-term growth rate of a country can be analysed by considering separately the influences of tax policy and expenditure policy.

Amuzher (1983) noted that the economic problem encountered by the oil-producing countries is how best to transform a dormant pool of valuable but depletable oil reserves into a flow of present and future income needed to raise their standard of living. The most public debate, which faces oil-producing countries, is management of their petroleum wealth in a long-term perspective. While it is true that issues such as “what shall we do when the oil runs out?” pop up from time to time, the perspective is one of preserving an industry, or perhaps even an industrial relic, rather than of investing oil revenues and making oil wealth permanent. (Rognvaldur, 2001).

3. OIL PRICE VOLATILITY

Oil prices fluctuate from month-to-month (in some cases from day-to-day) due to temporary changes in global economic and political conditions that affect the supply and demand for oil. Besides, there are some factors, which may affect the prices, such as extracting and transport costs. Several factors were behind the recent spike in prices including unexpectedly large growth, and a number of supply constraints. This has translated into substantial windfalls for oil producers the world over. See Fig 1. The volatility of oil prices in recent years has brought these major challenges into sharper focus. See Fig 2

Davis et al (2003) state that this volatility can translate into significant fluctuations in fiscal revenue Based on sustainability considerations; government spending should not be dependent on changes in oil prices. However, this needs to be interpreted carefully, because wealth itself is not known with certainty (Barnett and Ossoski, 2002).

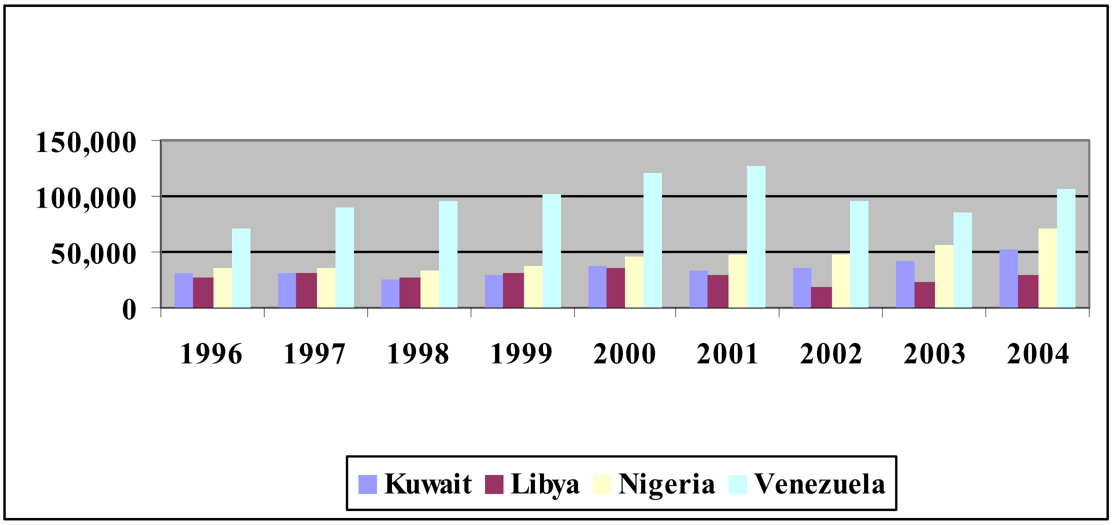

Figure 1: Selected OPEC members' GDP at current market prices, 1996-2004 (m $)

Source: BP Statistics of World Energy June 2005, OPEC Annual Statistical Bulletin, 2004

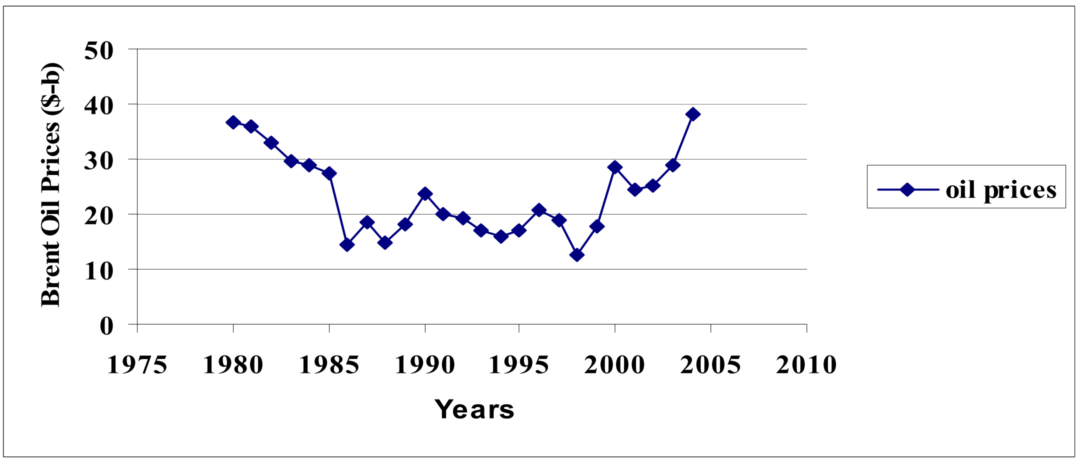

Figure 2: Spot Oil Prices (Brent) 1980-2004 ($-b)

Source: BP Statistics of World Energy June 2005, OPEC Annual Statistical Bulletin, 2004

4. BASIC DIFFERENCES

The oil-producing countries are not all the same see fig 2. There are considerable differences not just in the relative importance of oil to the economy but also in the size of oil reserves, maturity of the oil industry ownership and taxation structure. Additionally, the oil sector, stage of development of non-oil economy, and the government's financial position are also sources of divergence.

Besides, oil-exporting countries clearly differ from other developing countries that are dependent on single raw material exports. The two essential characteristics are economic dependence on depleting resources and the public possession of that resource. The secondary features are the unique properties of petroleum as a raw material and the characteristics of the world oil market. The oil exporting developing countries differ from many other developing countries in their heavy dependence on single commodity export, which serves as the principal source of government revenues and foreign exchange receipts.

An increasing number of developing countries are (particularly those in the more advanced category), while traditionally dependent on agricultural exports, and have now significantly diversified their economies. By all these criteria, the oil-exporting developing countries show greater dependence on a single resource (see Fig 3)

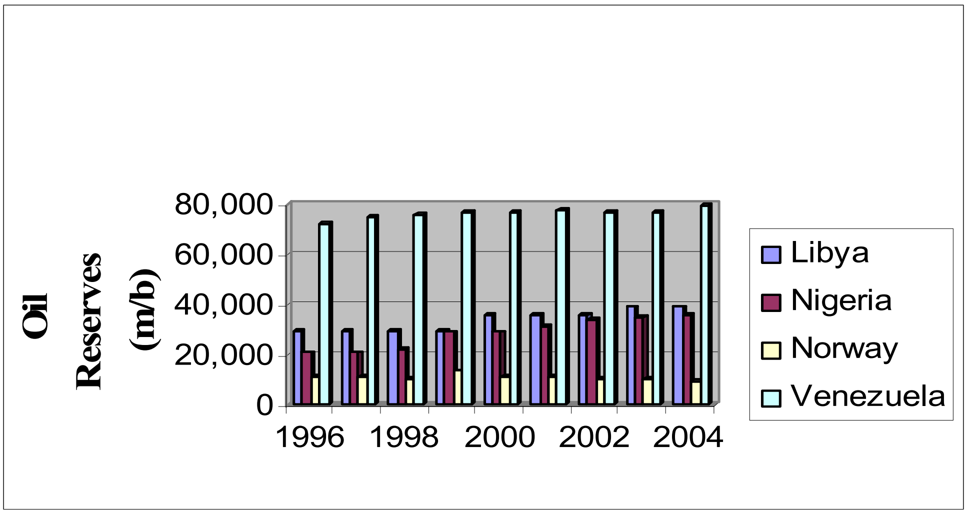

Figure3: Selected Oil Exporting Countries, Values of Export and Oil Export, 2004 (billion $)

Source**:** Annual Statistical Bulletin OPEC 2004, BP statistical Review of World Energy June 2005

5. POLICY OPTION STRATEGIES

The ability to absorb unanticipated cash flow shocks depends on the robustness of the government's financial position. Strong fiscal and financial positions provide the government of an oil-producing country with room to manoeuvre during oil price downturns. In particular, the government can accommodate cash-flow fluctuation through a mix of adjustment and financing. By doing so, the government can afford to pursue short-run fiscal strategies that avoid fiscal instability and help insulate the domestic economy from oil revenue volatility. Moreover, when the government can smooth expenditure and the non-oil balance in the face of cash-flow volatility, the use of oil revenue can be successfully decoupled from current earnings, enhancing the stabilisation role of fiscal policy.

In countries that are unable to accommodate oil revenue fluctuations because of financial constraints related to sustainability and other policy concerns, a key policy objective should be to pursue fiscal strategies aimed at breaking the procyclical response of expenditure to volatile oil prices, including the use of hedging instruments to help reduce oil revenue uncertainty and volatility.

A regular feature of fiscal policy in many oil-producing countries has been the inability to rein in public expenditure at times of rising oil prices. Expenditure has subsequently proven difficult to reduce during oil price downturns. There may also have been the belief that the oil price decline would be short-lived, prompting the temptation to ride out the downturn. Thus, when governments are unable to generate fiscal surpluses during periods of rising oil prices that would permit the budget to withstand adverse oil shocks without falling into deficits that lead to sustainability concerns, fiscal policy tends to transmit oil volatility to the rest of the economy.

Lack of financing during the price downturns, in turn, eventually forces governments to undertake sharp and disruptive fiscal contractions, at a time when the economy can least afford them. Countries where external financing is limited, and available domestic financing fluctuates with shifts in sentiment toward the domestic currency, are particularly vulnerable.

Therefore, to protect the oil proceeds and subsequently the budget deficit, many countries have established a saving or stabilisation fund as a part of solution of the problem oil revenue fluctuation.

6. DIVERSIFICATION DILEMMA

Economic diversification implies that a country will gain more from diversification if output in the emerging sectors correlated with output in the rest of the economy. This implies that production diversification is not just about moving the economy into new sectors. Rather, it is about moving the economy toward sectors whose fortunes are not directly tied to the rest of the economy. When a country suffers from high unemployment and excess capacity, diversification can increase national income without drawing away resources from existing sectors. Resources that were previously idle become employed in the new sector. Thus, diversification, if correctly undertaken, can lead to not only a larger share of the pie, but a larger pie itself. This qualification, however, reinforces the concept that there are diminishing returns to diversification.

The crucial question is how the oil producing countries respond to the challenges of managing and conducting their petroleum wealth. Have they built up investment funds and are they embarking on economic diversification or have they used up all the rent immediately for the benefit of future generations? The advantages of this diversification strategy would be twofold. Firstly, it would make the country better able to enter more high-value-added industries thus boosting income from the extraction of its non-renewable resources. Secondly, the economy is no larger as vulnerable to change in hydrocarbon prices as it was in the past. Most policymakers in oil exporter countries have illusions and believe that oil prices will never change. Countries should diversify their economy, wherever they have the comparative advantage particular.

7. FROM DEPENDENCE TO DIVERSIFICATION

7.1 Diversification of industry policy

In their efforts to achieve a sustainable future level of consumption and improve standards of living, oil-producing developing countries have a very strong incentive to diversify their economy away from oil. It is perhaps this incentive, more than any other, which provides these countries with the motivation to develop healthy non-oil sectors. However, a number of other important justifications do exist for the adoption of this objective. The dependence on oil exposes these countries to the risk of fluctuating hydrocarbon prices see Fig 4. Volatility in oil prices lead to considerable variation in the terms of trade of oil exporting countries.

Besides reducing the economy's vulnerability to oil prices changes, diversification allows the country to mitigate the effects of a capital-intensive oil sector on employment. A number of oil exporting developing countries, especially high absorbing ones possess a large, relatively low-skilled labour force.

Accepting the need for diversification, nevertheless, an essential question remains. What types of industry should be promoted in order to achieve successful diversification? From an economic perspective, one could argue that oil-exporting countries should invest in industries that are compatible with their respective factor endowments and comparative advantages. Moreover, investing in education and encouraging the inflow of technology, these countries can create a dynamic comparative advantage that would allow them to break away from their natural constraints.

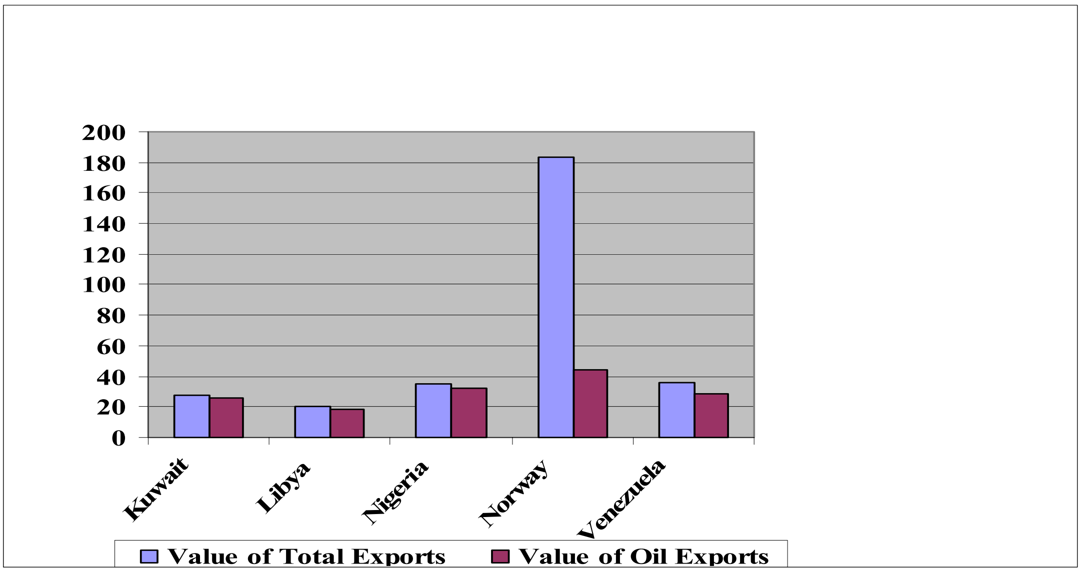

Figure 4: Selected oil exporting countries: Values of Total Export and Oil Export 2004 (000' billion $)

Source**:** Annual Statistical, bulletin OPEC, 2004

7.2 Consumption variability

One of the chief benefits of production diversification is that it reduces consumption variability. Governments could smooth consumption perfectly over time by borrowing and saving, depleting or accumulating financial and non-financial assets, adjusting the labour supply and by borrowing. For the economy as a whole, consumption smoothing would imply running a current account deficit, when national income is temporarily high. Thus, in an ideal world, production and consumption decisions are separate-production decisions are made to maximise expected profits, without any concern for risk.

Thus, efforts to diversify economic base production should be seen as part of a larger problem-the inability of governments and countries to increase and smooth production. Production diversification is more useful when governments and authorities cannot fully insure themselves against income shocks. Hence, decreasing volatility should be regarded as an important goal of diversification.

8. COUNTRIES' EXPERIENCE

8.1 Libya

Libya has depended heavily on oil revenue. Over the past three decades, it has gone through a far-reaching social and economic despite the huge amounts of money, which have been spent, on the development process. Aiming to diversify and aim for self-sufficiency. New development challenges over coming decades will test their ability to reconcile traditional institutions with the requirements of a modern economy in an increasingly competitive global environment.

The Libyan government embarked on massive investment programmes, with priority given to basic infrastructure, aiming to transfer part of the windfall to the population at large, as well as to future generations. Libya initiated programmes to build up domestic industrial capacity, boosted by very generous subsidies (Auty, 2001).

However, the state generally has not been able to translate the huge investments in infrastructure and human resource development into vigorous, self-sustained private sector growth. Instead, the efficiency of investment has been steadily declining, reflecting poor screening of the economy viability of projects

8.2 Norway

If the increase in the cash flow is taken into the economy through expenditure or reduced taxes in the central government budget, aggregate domestic demand will be affected. Higher expenditure requires that an increase in the oil price should accrue to the fund and be invested abroad.

Thus, rather than affecting the domestic economy, the increase in the cash flow would be invested abroad through a Petroleum Fund. Similarly, a fall in the oil price would not affect the domestic economy, but would result in lower accumulation of foreign assets. Building the fund ensures that several generations will enjoy the benefits of Norway petroleum wealth.

The Petroleum Fund can be invested into two main types of instruments-bonds and equities. Government bonds are a relatively safe investment, but the return is low.

The government invests revenue from oil in foreign securities in order to share the oil receipts fairly between the present generation and the future generation, as well to shield the domestic economy from the windfalls.

Economic policies are generally sound. Norway has a solid financial position for the government which reflects to a large extent the more fundamental long-run policy objectives of spreading, high government saving rates and the build-up of foreign assets, resisting potential damage to the non-oil tradable sector.

8.3 Venezuela

Oil revenue has shaped Venezuela politics for decades, creating a rentier state legitimised by patronage and entrenched constituencies, whose continued loyalty is attached directly to state expenditures funded by oil rents. Economic performances have been influenced by oil revenue volatility. Transitory oil price increases have led to increased spending,

Following the sudden large oil windfalls after 1973, Venezuela embarked on a policy of extensive expansion of the state's involvement in the economy. The oil industry and large-scale state investments in capital-intensive projects in steel, aluminium, iron ore, and energy were made as part of the drive to diversify the economy and reduce import dependency.

Despite massive overspending, the government and state enterprises were able to obtain foreign credits without difficulty. Despite modest reforms, the country's fiscal position became increasingly fragile and, faced with the oil price downturn of 1982-83 the government was unable to meet its debt obligations (Mommer, 1998).

Pressures to take on board even more government workers, to create jobs for the unemployed have strengthened as foreign investors have increasingly fled Venezuela. The overall budget balance has continued to fluctuate widely alongside the price of oil (Nissen and Welsh, 1994).

8.4 Nigeria

Oil is the main source of revenue in Nigeria. Oil accounted for more than 90 % of its exports, 25 % of its gross domestic Product (GDP), and 80% of its public revenues in 2000. After so-called first charges are withheld, gross oil revenue is divided between the central government and subnational government. Thus, a small oil price increase can have a large impact. Nigerian reliance on oil production for income generation clearly has serious implications for its economic development management.

Nigeria has been ruled by military dictatorship for the past three decades. While proceeds were flowing, considerable sums were poured into social expenditure but huge amounts also went into largely and wasteful industry projects, from which billions of dollars appear to have been, embezzled (Isham et al, 2002).

Nigeria is unable to accommodate oil revenue fluctuations due to financial constraints related to sustainability and others concern. A key policy objective should be to pursue fiscal strategies aimed to breaking the procyclical response of expenditure to volatile oil prices. This would imply eliminating expansionary fiscal policy bias during an oil boom, and critically, targeting prudent non-oil fiscal balances and reducing the non-oil fiscal deficit over time. This would place the government in a better position to deal with oil market volatility, and increase the likelihood that it can weather temporary oil shocks without drastic short-run fiscal adjustment. A strong financial position is also essential to allow for an orderly adjustment to catastrophic oil shocks, that turn out to be long lasting, such as the oil market collapse in 1986.

8.5 Justification of the research

The authors have chosen these countries due to these countries experiences in the context of oil wealth macroeconomic management. Some of them have performanced well whereas others such Nigeria and Venezuela have failed to utilize their oil wealth efficiently.
The authors mention these specific countries because they believe that countries can be used as example due to their experiences.

The author is a Ph D student and he is investigating the role of oil in the Libyan economy and comprising it with other countries' experiences, in the context of economic diversification and development. In addition, he is investigating and studying other countries' experiences, such as Norway and Nigeria. The search may be useful and benefit for the policy makers in their decisions to solve the problems associated therewith oil wealth has become both a blessing and curse.

9. CONCLUSION

This paper has focused on fiscal policy, economic management and performance in a number of oil exporters, emphasizing the issues of long term saving, short to medium–term stabilization and the effective use of rent income. While these are different objectives, they are all part of good economic and fiscal management, and countries that have been able to do well in one area have typically been able to do well in others. The consequences are mixed.

However, oil exporters' economic performance has, with few exceptions, been poor. Since the first oil booms, evidence has accumulated on better technical approaches toward managing resource rents, especially rents from geographically concentrated oil and hard-mineral resources, as well as on the high cost, and failure to use rents well to support a broader process of development. Surpluses should be invested abroad, to reduce the risk of politicisation. Integration of oil funds with the regular budget avoids the risk of competing decisions on spending and facilitates accountability and oversight.

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MULTI CRITERIA DECISION MAKING AND THE PRINCIPLE OF REFLECTION

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ABSTRACT: Apart from the methodology constructed by Barzilai (2005), the methodologies underlying multi criteria decision making tools lack the foundation to allow for the application of the mathematical operations of addition and multiplication. Consequently, numerical output derived using these methodologies has no meaning. In this paper I will demonstrate this problem using two examples. It will be shown that the methodologies that underlie the decision process in these examples lack the required foundation for the application of mathematical operations. Reference will also be made to a methodology that does have a foundation and that enables the mathematical operations of addition and multiplication. The result of this paper can be of use for future projects involving multi criteria decision making.

Keywords – Multi criteria decision making, operations research.

1. INTRODUCTION

In this paper I will show that the methodologies underlying two cases of Multi Criteria Decision Analysis (MCDA) of projects lack a foundation required for the construction of a mathematical system which is a reflection of the empirical system, namely, the preferences stakeholders have for different (design) alternatives. I will also give reference to a methodology that does have a foundation and does allow for the mathematical operations of addition and multiplication.

2. MULTI CRITERIA DECISION ANALYSIS AND MEASUREMENT

Although I assume that the reader is somewhat familiar with MCDA, I will start with a brief description of MCDA. MCDA is aimed at supporting a decision maker or a group of decision makers in choosing, from a number of decision alternatives, the most preferred alternative. Usually different properties (decision criteria) of the decision alternatives are taken into account. MCDA involves measuring the decision maker's preferences per alternative per criteria. This paper focuses on this measuring procedure.

Determining the decision maker's preference per alternative per criteria is a measuring process involving the use of scales. Because there are requirements with regards to the scale type used for measuring the preference per criteria in order to allow for mathematical operations, the next section will focus on the following two issues concerning MCDA:

- The application of mathematical operations;
- The types of scales used in measuring.

3. STEVENS' SCALE TYPES

As stated before, determining the decision maker's preference per alternative per criteria is a measurement process involving the construction of scales. The purpose of measurement is to enable the application of mathematical operations to the objects under measurement. Measurement scales can be classified by the mathematical operations that are enabled on the resultant scales and scale values. Although several scale types have been identified in the literature of classical measurement theory, it will suffice for the purpose of this paper to focus on the following four types of measurement as proposed by Stevens (1946):

1. Nominal measurement;
2. Ordinal measurement;
3. Interval measurement;
4. Ratio measurement.

Nominal measurement involves assigning numerals to objects as labels or names. This measurement procedure only allows comparisons between objects on equality or inequality.

Ordinal measurement involves assigning numbers to objects to represent the rank order (1st, 2nd, 3rd, etc.) of the objects measured. This measurement procedure allows 'less than' or 'greater than' comparisons.

Interval measurement assigns numbers to objects that have all the features of ordinal measurement but also, equal differences between measurements represent equivalent intervals. Measuring the temperature of objects using the Celsius or Fahrenheit scale are examples of interval measurement. The zero point on interval scales is arbitrary.

Ratio measurement assigns numbers to objects in a similar way as interval measurement but the zero value is non-arbitrary. Physical measurements such as mass, or length are measured using ratio scales.

The operations of addition and multiplication are not applicable to measurement scales as described by Stevens, including to ratio and interval scales. In fact, these operations are not applicable to any measurement scales that are based on the models of classical measurement theory. For a construction of scales that permit these operations see Barzilai (2005).

In MCDA projects ordinal scales nearly always play a role. There is, however, a problem with ordinal scales when used in MCDA. They lack a foundation that makes further mathematical operations possible. Such operations would result in modelling errors.

I would like to illustrate this problem using the following two cases.

4. FIRST CASE: THE 'RIJNLANDROUTE'

Consider the 'Rijnlandroute', a project aimed at linking two Dutch motorways. There are several possibilities where these two motorways could be linked. Figure 1 shows one such possibility. The project's design team considered six alternative ways to link the motorways. In order to make a choice between the different alternatives the project team took into account different criteria like investment costs, travel time gain, emissions, etc. The results of the study are summarised in Table 1. The table shows that the measurement makes use of different scale types and units. Some measurements make use of a ratio scale and are expressed in monetary units, and some make use of an ordinal five-point scale.

In order to make a choice based on the different alternatives, the design team must arrange the alternatives in order of preference, thus allowing it to select the one that is most preferable.

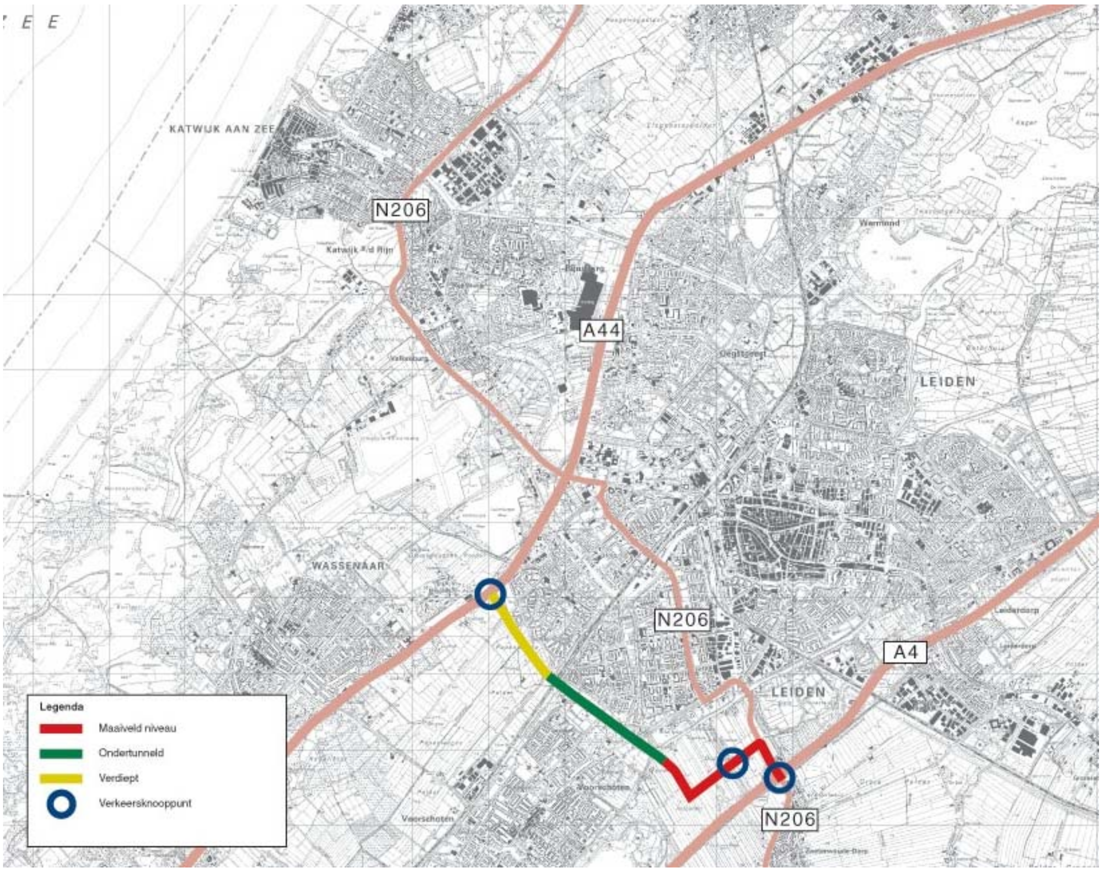

Figure 1. Map showing one of the alternatives to link the two motorways

Table 1. The different alternatives to link the two motorways and the criteria considered

	Alternatives					
Criteria	1	2	3	4	5	6
Investment costs [M€]	520	464	779	377	293	261
Maintenance costs [M€]	166	148	249	120	94	83
Exit value [M€]	57	51	85	41	32	29
Traveltime gain	538	661	815	1347	1165	1731
Shipping reliability gain	11	14	17	28	24	36
Spatial development	++	++	++	++	++	++
Internal safety	0	0	0	0	0	0
External safety	0	0	0	+	+	+
Emissions	-	0	0	-	0	-
Noise	--	--	0	-	-	-
Nature and landscape	-	0	0	-	-	-

The measurements regarding the criteria ‘spatial development’, ‘internal safety’, ‘external safety’, ‘emissions’, ‘noise’ and ‘nature and landscape’ are made, using a five-point scale (--

/-/0/+/++). So, in essence, these measurements are using a symbolical representation that is only *order* preserving, so-called ordinal scales, and cannot be used in further mathematical operations. This could mean two things:

- The empirical system is ordinal and therefore, if the mathematical system is a reflection of it, then the mathematical system should be ordinal too;
- The empirical system is not ordinal and therefore the mathematical system should not be ordinal either.

Some of the measurements, for instance the measurements regarding the emissions, were originally expressed using a ratio scale (NO_x concentrations measured in $\mu g/m^3$). In the final table of the study, however, these measurements were made using an ordinal scale thereby reducing the information that can be gathered from them and the possible mathematical operations that can be carried out upon them. Therefore it is very likely that the empirical system is not ordinal and that the mathematical system should not be ordinal either. It can therefore be concluded that the methodology used in this project cannot be used as a proper base for multi criteria decision making because it does not fulfil the basic requirements that make the construction of a mathematical system possible that is a *reflection* of the empirical system (the Principle of Reflection).

5. ANOTHER EXAMPLE: THE DYNAMIC ACTOR NETWORK ANALYSIS TOOL

The Dynamic Actor Network Analysis (DANA) is a software package aimed at supporting policy analysts in some policy situation:

> "The aim of the DANA project is to construct a workbench to support policy analysts in their representation and analysis of information on actors (organizations, stakeholder groups, or individuals) that play a role in some policy situation.
>
> The design of the workbench is largely determined by the underlying method of actor network analysis. This method (dynamic actor network analysis = DANA) leads the analyst to think in terms of actors who all have their own problem perception. By making these perceptions explicit in a qualitative, conceptual language and then perform different types of comparative analysis, the analyst sharpens her insight not only in the policy situation at hand, but also in her own reasoning (analyst as reflective practitioner). The representations of actor perceptions may also serve as (organizational) memory and as a basis for discussion amongst analysts and/or actors." (www.dana.tudelft.nl)

The use of the words 'qualitative' and 'comparative' points to the use of ordinal scales for measurement. If this is the case then the mathematical operations that are enabled on the resultant scales and scale values are limited.

In its measurement procedure the method makes use of a seven-point scale. The use of this seven-point scale is only order preserving, because it only makes use of a similarity of that property and symbols, not numbers. As mentioned before, these ordinal scales limit the mathematical operations that can be carried out upon them.

The maker of DANA acknowledges this and uses the term 'semi-quantification' which is very confusing. Quantification is a variable binding operation and one cannot 'semi-bind' a variable. Although there is no foundation for carrying out extraneous operations on ordinal scales and scale values, DANA does internally convert ordinal measurements into numerical values and uses these values to compute the required analysis results. Table 2 shows how the ordinal scale is translated into numeric values. Because this conversion is based upon ordinal scale values it is in fact a modelling error and does not permit the mathematical operations of addition and subtraction. The resulting numerical output is therefore meaningless.

One of our master students used DANA and concluded that DANA was very useful in identifying the different stakeholders and the way they are linked. The numerical output, however, suffers from inconsistencies and was not useful.

Table 2. The ordinal scale used in DANA and the corresponding numeric values

	Changes	Multipliers	Utilities
---	-4	-2	-4
--	-2	-1	-2
-	-1	-½	-1
0	0	0	0
+	1	½	1
++	2	1	2
+++	4	2	4

6. CONCLUSIONS

In this paper I showed that two current multi decision making methodologies lack a foundation that enables the construction of a mathematical system that is a reflection of the empirical system. The use of ordinal scales in both examples prohibits further mathematical operations and therefore prohibits the construction of a mathematical system.

However, this does not mean that it is not possible to construct a mathematical system that is a reflection of the empirical system. Barzilai (2005) constructed a strong model to which the operations of addition and multiplication are applicable.

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FINANCIAL SECTOR DEVELOPMENT AND ECONOMIC GROWTH IN LIBYA 1970-2000

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ABSTRACT: The aim of this paper is to analyse the relationship between financial sector development and economic growth in Libya. This is due to the significant role played by the financial sector in various investment channels; therefore this paper focuses on the literature related to the relationship between financial sector development and economic growth.
However, in Libya, there is an absence of diversification among financial institutions and the banking sector is the only financial organisation that can provide funding to the other sectors, thus this paper also seeks to identify economic factors that affect the efficiency of the financial sector into development and economic growth in Libyan economy by employing econometric technique.

Keywords: Banking sector, Economic growth, Financial development and Libyan economy.
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1. INTRODUCTION

The financial sector is regarded as a necessary support for developing and increasing productivity in different economic activity, because it connects savings and investments and therefore increasing economic growth. Achieving a high rate of economic growth is a major aim of economic development in developing countries.

A large and expanding of the literature tries to shed lights on the variables in the determination of economic growth but most of this literature mainly focuses on the relationship between financial sector development and economic growth or macroeconomic performance. The role of the financial sector in the growth process has recently received much attention and this financial development is considered by many economists to be exceptionally significant.

However, in Libya the banking system is the only real financial institution that represents the financial sector and provides credit and funding to all economic activities in Libya in terms of finance, this has made the banking sector essential to the Libyan economy. The Libyan state has decided to improve and diversify its resources of income and privatize the economy instead of relying on oil exports as the main source of income. This paper is organized as follows, Section 2 provides background from the literature on the relationship between financial sector development and economic growth, Section 3 explores the Libyan economy, including economic growth, and Financial Sector in Libya , Section 4 focuses on the financial sector in Libya, Section 5 analyses the impact of the financial sector upon economic growth (GDP) and Section 6 forms the conclusion.

2. LITERATURE BACKGROUND

2.1 What do we mean by financial sector development?

The financial sector development is all the wholesale, retail, formal and informal institutions in an economy offering financial service to consumer, business and other financial institutions. In its broadest definition, it includes everything from banks, stock market and insurance, to credit unions, microfinance institutions and money lenders.
There are many different ways in which the financial sector can be said to develop, for example:

- the efficiency and competitiveness of the sector may improve
- the range of financial services that are available may increase
- diversification of the institutions which operate in the financial sector may increase
- the amount of money intermediated through the financial sector may increase
- the regulation and stability of the financial sector may improve
- particularly important from a poverty reduction perspective , more of the population may gain access to financial services

Hence there is no single definition of Financial sector development (FSD).

2.2 Financial sector development and economic growth

The relationship between the financial sector development and economic growth has been extensively studied by researchers. The financial sector development in mobilising savings affects investment and growth. The functions performed by the financial system affect steady growth by influencing the rate of capital formation. The financial sector affects capital accumulation either by altering the savings rate or by reallocating savings among different capital producing technologies. Gallagher (1991) and Odedokun (1992) found financial variables had an important impact on economic variables and economic efficiency. Levine and Renelt (1992) find a positive and strong correlation between average growth rates and the average share of investment in GDP.

King and Levine (1993) study the contemporaneous issues between financial development, growth and sources of growth and found that the predetermined component of financial development is a good predictor of long-term growth. Higher levels of financial development are associated with future rates of capital accumulation and future improvements in the efficiency with which economies employ capital.

However, this issue is far from settled. Levine (1997) explains the debate in the literature over the importance of the financial sector on economic growth and summarizes the analytical problems with linking the financial structure to economic performance into the following points (i) exciting research on financial structure does not quantify the structure of financial system or how well financial systems function overall, (ii) the current debate focuses on bank-based systems versus market-based systems while there are significant interactions between stock market and banks during economic development and (iii) the understanding between financial sector development and growth has been limited by results from industrialized countries.

Until now the financial system in many developing countries are not advanced and it is in their priority while in developing countries, reforming and updating the financial system is the great significant to their countries. In developed countries the financial sector is considered to be the heart of their economy and all economic activity to ensure the efficient allocation of resources.

3. THE STRUCTURE OF THE LIBYAN ECONOMY

The structure of the economy is described by using the contribution of both productive and service economic sectors in gross domestic production (GDP) in Libya during the period of 1970 to 2000, because this is the most important time the Libyan economy has gone through. The productive sectors in Libya include: agriculture, oil and natural gas, manufacturing, mining and quarrying and construction. Trade, restaurants, and hotels, transportation and storage, electricity and water, education and health are in community services. Table 3.1 shows the contribution of these sectors into the GDP and the annual growth rates based on 1970 prices below.

Table 3.1: Percentage distribution of GDP by major economic sectors and Annual growth rates at constant 1970 price

Economic Activities	**1970**	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**
Agriculture	2.2	2.3	2.2	4.4	5.1	9.5	10
Oil and gas	63.1	53.4	61.8	44.6	35.4	24.5	25
Manufacturing	1.7	1.8	2.0	5.4	7.1	8.0	9.2
Mining and quarrying	0.1	0.5	0.5	0.6	1.4	1.4	1.5
Construction	6.8	11.8	10.4	8.6	5.9	4.9	5.1
Trade, restaurants & hotels	3.7	6.1	4.9	7.3	10.2	12.9	13
Transportation & storage	3.4	4.8	4.0	6.0	8.3	9.2	8.9
Electricity & water	0.6	0.5	0.5	1.4	2.0	2.2	2.7
Education service	3.1	3.1	2.2	5.5	7.0	6.4	6
Health services	1.2	1.4	1.1	2.4	5.5	2.5	3
GDP(million L.D)	1288.3	3674.3	1o553.8	7852.1	7933.4	9794.1	14135.7
Oil & natural gas	63.1	53.4	61.8	44.6	35.4	24.5	25
Non oil economic activities	36.9	46.6	38.2	55.4	64.6	75.5	75
Annual GDP Growth Rate	23.1	-3.2	38.8	0.6	9.2	9.3	9.8
Per capita (LD)	656	1,369	3,252	2,140	1,600	3238.3	3426.7

Source: Annual reports of the Central Bank of Libya from 1970 to 2000.

Table 3.1 shows that the oil industry is the most important sector of the productive economy towards GDP, accounting for over 24.5 percent of GDP. Therefore, Libya depends on oil as a major source of income. The following review of some key economic variables shows that the Libyan economy has not obtained a level of substantial development. The current estimate of DGP is close to US$10 billion with a per capita income of US$3000 As already noted, the economy is largely based on the oil sector. As shown in table 3.1 the share of non oil sectors (especially manufacturing, agriculture, construction and trade service) has been increased but still not in demand at the desired level, while the opposite has been happening to the oil sector share. The average GDP growth rate over the past decade was 9.0 percent, with a maximum of 38.8 in 1980. This was because of the increase in oil price in that time. There has been a decline in the contribution of some sectors, in particular the service industries such as health service, electricity and water and transportation (infrastructure).

3.1 Libyan Exports and Imports

The importance of foreign trade in the process of economic development stems from the role it plays in expanding the production capacity and marketing potential of domestic products. It provides chances to domestic economies through opening channels of exchange and increasing the overall economic welfare by expanding the array of choice in consumption, investment and resource allocation.

However, Libya is regarded as a one sided economy that depends heavily on oil products which make up most of its exports. Table 3.2 shows that the main role in the export sector is played by the oil industry, especially in the period 1970-1985 when the percentage of the oil industry export ranged between 95 per cent to 99.9 per cent.

The non-oil Libyan exports accounted for only 0.1 per cent of the total exports in 1970. This percentage increased in the following years to reach its highest level in 2000 at 5.2 per cent. This increase in non-oil exports was due to many reasons, including the Libyan state policy to diversify production activities, the decline in oil prices in late 1980s and OPEC decisions to reduce oil supply. Therefore, the Libyan non-oil exports are described as negligible in value and quantity and characterised by both discontinuity and high costs of production.

Table 3.2: Libyan exports in the period 1970-2000(%)

Year	**Oil exports**	**Other exports**
1970	99.9	0.1
1975	99.9	0.1
1980	99.9	0.1
1985	96.7	3.3
1990	95.5	4.5
1995	95.2	4.8
2000	94.8	5.2

Source: Annual reports of the Central Bank of Libya from 1970 to2000.

The difference between Libyan imported and exported products is uneven, with mainly crude oil, refined petroleum products and natural gas exported to Europe, and a dominance of technology product imports into Libya. European countries, mainly Italy, Germany, Spain, France, UK, Turkey, Greece and Eastern Europe are the main partners from which the country imports and to which it exports. Egypt, Morocco and Tunisia are the main Arabic markets.

4. THE FINANCIAL SECTOR IN LIBYA

The financial sector in Libya, like other developing countries, comprises of financial institutions, financial intermediaries and capital markets. Noticeably, the banking sector dominates the financial sector at the expense of other types of financial institutions.

4.1 The banking sector in Libya

The banking sector in Libya is no different from banking sectors in other developing countries such as Tunisia and Egypt. However, in Libya the banking sector is more crucial to the economy because it is only source of finance, unlike some developing countries, where the stock market contributes towards finance. The banking sector consists of the central bank, which is the highest monetary authority in Libya, commercial banks and specialist banks. The banking sector witnessed some important developments after the decree that the banks were nationalized shares. This led to far-reaching effects in the transformation of the banking system and the development of its services in such a way as to provide the best atmosphere for business and enable contribution towards the implementation of economic and social plans. In the wake of this development, a law was issued concerning the amendment of the rules of the banking law for the year 1971. In harmony with the new state of affairs it gave the central bank of Libya further responsibilities for the supervision and control of commercial banks and the follow-up of their activities, coordination among them and directing the monetary policy towards achieving the general targets of the state. Consequently, the commercial banks began to spread their services and expand the range of their work to many areas, where they contributed by providing housing loans for people with limited income. They also contributed by providing real estate loans in collaboration with the industrial and real estate bank, in a joint effort to solve the housing problem. The commercial banks, in collaboration with the central bank of Libya and the insurance companies, established the National Investment Company for foreign Investment with a contribution percentage of 30% ,This is now called the Libyan Arab Company for Foreign Investment.

The banking sector's credit has an indirect impact on the Gross Domestic Product (GDP) in Libya through various sectors. In the period from 1970 to 2000 there was a noticeable increase in the commercial banks' credit towards GDP that has made an indirect positive impact on GDP. Table 4.1 depicts the relationship between credit and GDP.

Table 4.1: GDP and Commercial banks' credit in Libya (Million Dinars)

YEAR	1970	1975	1980	1985	1990	1995	2000
GDP	1288.0	3674.3	10,553.8	7852.1	7933.4	9794.1	14,135.7
Credit	96.2	641.9	1321.2	2033.0	3053.3	4281.5	5584.0

Source: Economic and Social Development Achievement in 30 Years, Libyan planning Ministry.

5. FINANCIAL SECTOR DEVELOPMENT IN LIBYA

Finding suitable data is one of the important issues that applied economists face. This issue becomes more problematic, especially in developing countries, which lack the well-structured statistical organizations and sufficient technology that enables countries to provide accurate statistical data. Compared with the issue of measuring macroeconomic variables such as inflation rate, GDP, and unemployment the issue of measuring financial development and savings is problematic. This is because of the calculations of savings as the difference between income and consumption on one hand, and the difficulty of finding appropriate definition of financial development on the other hand.

There is no agreement about what is the most appropriate indicator of financial sector development. The difficulty of finding a suitable proxy of financial sector developments comes from the lack of clear-cut definition of financial development. The notion of financial development includes a wide range of reforms and changes in different aspects of the financial sector. It consists of changes and reforms in financial institutions, including banks, non banking institutions, capital markets and contractual savings institutions, such as pension funds, life insurance and investment trust. Therefore, it is not easy to find the most appropriate indicator to include in econometric regressions as a proxy of financial sector development. It has been common practice to employ the monetary variables such as M1and M2 as proxies of financial sector development in empirical studies (King and Levine 1997). M1 is the narrow money variable and refers to the sum of currency outside and demand deposits. M2 comprises M1 and time savings. M2 is broader than M1, and is usually referred to as the broad money.

Table 5.1: Composition of narrow money and broad money from 1970 to 2000 (Million Dinars)

Years	**Currency Outside**	**Demand Deposit**	**M1(Narrow Money)**	**Time Savings**	**M2(Broad Money)**
1970	112.3	128.3	240.6	79.7	320.3
1975	346.0	489.5	835.5	492.9	1328.4
1980	682.3	1174.6	1856.9	1205.7	3062.6
1985	985.0	2507.2	3492.2	1561.4	5053.6
1990	1454.1	3184.3	4638.4	1509.9	6148.3
1995	2035.4	4337.0	6372.4	2570.3	8942.7
2000	2699.2	4843.9	7543.1	2943.6	10486.7

Source**:** Annual reports of the Central Bank of Libya from1970 to 2000.

Table 5.1 shows that there has been an increase in the monetary variables that compose M1 and M2. M1 has witnessed significant increase since 1970, M2 also increased from 320.3 million in 1970 to 10486.7 in 2000. With respect to the importance of M2, The demand money constitutes the big share.

Table 5.2: Financial development variables for 1970- 2000

Indicator	1970	1975	1980	1985	1990	1995	2000
M2/GDP (%)	24.9	36.2	29.0	64.4	77	91	74
Currency/M2 (%)	35.1	26.0	22.3	19.5	23.7	22.8	25.7
Bank Deposit/GDP	9	13.3	11.1	31	40	44	34.2

Source**:** Annual reports of the Central Bank of the Libya from 1970 to 2000.

A vast number of theoretical and empirical studies have been carried out to investigate the effects of financial development as a driving force behind an economy's investment and economic growth. The volume of intermediation is measured by the ratio of M2/GDP, and it should exhibit a positive relationship with savings.

Table 5.2 shows leading indicators of financial depth between 1970 and 2000. There is an evident lack of financial system is shown by a high currency/money supply ratio of 25.7 percent in 2000. This represented a decline in the size of the monetary economy and the level of financial intermediation. In addition, the use of financial instruments such as cheques declined tremendously. There has been an increase in the proportion of the M2 to GDP and this is due to inflation that the Libyan economy has gone through and the expansion of using monetary policy to deal with government debt by Central Bank of Libya.

5.1 Estimating the relationship between GDP and Financial development.

In this section econometric technique is employed to estimate the relationship between GDP and financial development (monetary basis). Recent empirical studies on financial development and growth are based on regression analysis for the time series data, following the important work of Gergorio (1996). The basic linear regression equation is:

$$Yi = \beta 0 + \beta 1 Xi + \varepsilon \qquad (5.1)$$

Where *Yi* is GDP(Gross Domestic Product) of Libyan economy, *Xi* is the monetary basis, which consists banking reserves, currency outside the banking sector and public deposits, other variables that can impact on the economic growth that usually contains the initial level of GDP to control for conditional convergence, indices of political stability, government expenditure and indices of the level of education, etc. Several financial developments have been mentioned, different indicators will proxy different aspects of the relationship between the financial variables and economic growth. B0 and β1 are the parameters of the regression equation. β0 is the constant in the equation and it does not depend on the Xi, β1 is the main parameter in the regression equation, which represents the slope and the kind of the association between the independent variable (Xi) and the dependant variable(Yi). ε represents the disturbance term in the equation, which reflects the impact of the other variables on the dependent variable.

The E views package is used in this section to estimate the regression equation between the GDP and financial development in Libya, by the common method of estimating the parameters in econometrics. This method is the Ordinary Least Square (OLS).

$$Y_i = 2888.08 + 1.844X_i \qquad (5.2)$$

Equation 5.2 shows a positive relationship between financial development and economic growth in Libya during the period 1970 to 2000 (see appendix 1 and 2).
The determinants coefficient (R) indicates that 84% of the variation in GDP can be attributed to the variation in the financial development. The reason of the high value of the constant is due to the absence of other variables that can impact the economic growth in equation 5.2 in the Libyan economy. The value of t-statistic is high as in appendix 1, which leads to the important result that the parameters are significant ($\beta 0$, $\beta 1$) and parameters in 5.2 can be relied in terms of evaluation.

6. CONCLUSION

This paper reviewed financial sector development and the relationship between financial development and economic growth. The paper also described the condition of the Libyan economy, emphasizing the importance of the banking system towards the financial sector. A set of financial development indicators have been given and the econometric technique carried out to estimate the impact of financial development indicators on the economic growth of the Libyan economy in the period of 1970-2000. The following observations can be concluded from the analysis:

- The financial sector in Libya still has a mostly banking-based structure, and there is no efficiency of other parts into economic activities in the Libyan economy.

- Bank-based financial development indicators have a positive impact on economic growth, and there is strong reliance on the banking sector as the main source of credit and funding.

- The financial systems in many developing countries are not advanced and it is in their priority while in developing countries, reforming and updating the financial system is the great significant to their countries.

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Appendix 1

Dependent Variable: Y
Method: Least Squares
Sample: 1970 2000
Included observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2888.080	461.2217	6.261805	0.0000
X	1.844065	0.146796	12.56206	0.0000

R-squared	0.844758	Mean dependent var	7678.603
Adjusted R-squared	0.839405	S.D. dependent var	3604.278
S.E. of regression	1444.389	Akaike info criterion	17.45110
Sum squared resid	60501551	Schwarz criterion	17.54362
Log likelihood	-268.4921	F-statistic	157.8053
Durbin-Watson stat	0.475473	Prob(F-statistic)	0.000000

Appendix 2

Y is GDP of LIBYA economy

X is the monetary basis (currency outside banks + banking reserves + public reserves)

obs	Y	X
1970	1288.000	199.4000
1971	1586.000	314.6000
1972	1753.000	388.0000
1973	2182.500	425.1000
1974	3795.700	601.3000
1975	3674.300	696.5000
1976	4768.100	829.6000
1977	5612.700	1051.500
1978	5496.100	1355.800
1979	7603.000	1796.000
1980	10553.80	2307.200
1981	8798.800	2166.900
1982	8932.400	2261.100
1983	8511.700	1798.900
1984	7804.700	1717.900
1985	7852.100	2221.600
1986	6960.700	2113.100
1987	6011.600	2250.700
1988	6186.600	1912.900
1989	7191.000	2371.100
1990	7933.400	3186.000
1991	8757.300	3185.400
1992	9231.900	4092.300
1993	9137.300	3992.600
1994	9670.800	4627.200
1995	9794.100	4885.800
1996	12327.30	5435.100
1997	13800.50	5592.800
1998	12610.60	5833.800
1999	14075.00	5553.300
2000	14135.70	5368.500

Source: the Central Bank of Libya

INFRASTRUCTURE DELAYS AND COST ESCALATION: CAUSES AND EFFECTS IN NIGERIA.

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ABSTRACT: One of the major outcomes of the present ailing social and economic conditions in sub-Saharan Africa is the enormous waste of resources due to project delay and cost escalation in the region. This paper critically analyses the causes and effects of project delay and cost escalation in sub-Saharan Africa taking Nigeria as a case study. The major causes of project delay and cost escalation in Nigeria from experimental survey were acknowledged and ranked. The ranking was carried out using the relative net difference between the mean severity index percentage and the standard error of mean percentage in order to achieve unambiguously the ranking for each variable factor. Empirical analysis revealed the consequences of project delays and cost escalation for some completed projects in Nigeria with these subsequent findings: the minimum average percentage escalation cost of projects in Nigeria was 14%; the minimum average percentage escalation period of projects in Nigeria was found to be 188% with an average percentage completion work of just 96%. To enhance the ability to study this disturbing trend in the future, some mathematical relationships to forecast future project delays and cost escalation effects in Nigeria was developed. It was recommended that efficient man-power and material systems, alternative financial strategies and increased contingency allowance pattern in pre-contract estimates be developed.

Keywords: Infrastructure-delays, Causes, Effects, Cost-Escalation, Nigeria, sub-Saharan Africa.

1. INTRODUCTION

This paper addresses the problems resulting from infrastructure delays and cost escalation in Nigeria through a detailed empirical analysis of its causes and effects. Secondary data was collected from the Nigerian Federal Ministry of Works and Housing and questionnaire survey results from Mansfield *et al*. (1994). This literature and data addresses the causes of delays and cost overruns in Nigerian construction projects. Firstly, however, it would be appropriate to develop an overview of infrastructure projects in sub-Saharan Africa, and Nigeria in particular.

Developing countries invest about US$200 billion a year on new infrastructure, and this constitutes 4% of their national output and a fifth of their total investment (World Bank 1994). The result has been a striking increase in infrastructure services for transport, power, water, sanitation, telecommunications and irrigation. However, one billion people in the developing world still lack access to clean water and nearly two billion lack sufficient sanitation (World Bank 1994). Meanwhile, in rural areas, women and children frequently spend long hours fetching water just to meet daily needs. At the same time, transport systems are deteriorating rapidly, while electric power is yet to reach two billion people in many developing countries, all of which has implications for employment and education (World Bank 1994). This demand for infrastructure to modernize production and enhance both domestic and international competitiveness is overwhelming and exceeds existing capacity. Despite these inadequacies, population growth and urbanization are exacting more pressure on the few available infrastructures in these countries (World Bank, 1994).

In bridging the huge infrastructure gaps, there is an urgent need for a thorough appraisal of the process of infrastructure delivery in the developing countries. One of most pressing concerns is the alarming rate of project delay and cost escalations in the construction industry for most developing countries. Such trends have adversely affected infrastructure provision in sub-Saharan African countries with specific reference to Nigeria.

The relevance of the construction industry to the task of bridging this huge infrastructural gap is obvious because the social and economic stability and relevance to the world economy of any developing country hinges to a considerable extent on the effectiveness of that industry (Ofori *et al*. 1996). The relatively large investments committed to construction, makes the industry an important source of demand generation (Ofori *et al*. 1996). The multiplier effect of this demand (i.e. the great capacity to generate employment, income and expenditure in other sectors of the economy) contributes distinctively to the general economy (Mansfield *et al*. 1994; Ofori *et al*. 1996).

However, various projects of high economic and social relevance in Nigeria, worth billions of naira, are in complete state of disrepair. Amongst them are abandoned hospitals, clinics, markets, dams, airports, office blocks, housing projects, school buildings, factories, industries, libraries, theatre complexes, hotels, hi tech installation-to mention just a few. Nonetheless, the pivotal role of the Nigerian construction industry in the mainstream economy gives weight to the need for effective planning and management of this sub sector. Construction investment accounts for over 60% of the gross fixed capital formation (GFCF) (i.e. the total national investments in Nigeria) and only 20% of the GFCF in most other sub-Saharan countries (Dlakwa and Culpin 1990). By implication, the construction industry in Nigeria has a far reaching effect in comparison to other countries as it could impede national growth and planned economic developments if it becomes ineffective, as observed by Dlakwa and Culpin (1990). The enormous debt burden of over US$31 billion as at 2005 ending makes this problem of project delay and cost escalation in practically all infrastructural projects much worse. Worse still, the limited and scarce resources divested as a result of these problems further compounds the poverty level of the nation.

3. OBSERVATION

Mansfield *et al*. (1994) survey results (the secondary data employed for this investigation) have been summarised in Tables 1, 2 and 3. In addition to Mansfield *et al*.'s investigation, the authors are of the view that price fluctuations, inaccurate estimates, delays and additional work are not necessarily cost overrun variables only as indicated in Table 2 but also of delays. Hence, it is wise to classify all the variable factors as factors responsible for project delays and cost overruns in Nigeria.

Table 1. Questionnaire distribution and response

Description	Number distributed	Number of respondents	% of number distributed	% of number of responses
Contractors	35	15	43	41
Consultants	25	13	52	35
Public clients	20	09	45	24
Total	80	37		47

Source: [Data from Mansfield *et al.* (1994)]

Table 2. Factors responsible for project delays and cost overruns from Mansfield et al. (1994)

Variables	Severity index, %		
	Contractors	**Consultants**	**Public clients**
Poor contract management	80	100	100
Financing and payment of completed works	100	92	88
Changes in site conditions	74	84	77
Shortages of materials	74	76	77
Imported materials and plant items	54	84	88
Design changes	66	68	66
Subcontractors and nominated suppliers	80	62	55
Cost overrun variables (only):			
Price fluctuations	100	100	100
Inaccurate estimates	86	76	66
Delays	73	91	88
Additional work	60	77	77

Table 3. Summary of survey results from Mansfield et al. (1994)

Variable code	Variables	Severity Index %		
		contractors	consultants	Public clients
1	Financing and payment of completed works	100	92	88
2	Poor contract management	80	100	100
3	Subcontractors and nominated suppliers	80	62	55
4	Shortages of materials	74	76	77
5	Changes in site conditions	74	84	77
6	Weather	67	62	55
7	Design changes	66	68	66
8	Mistakes and Discrepancies in contract document	60	46	55
9	Imported materials and plant items	54	84	88
10	Preparation and approval of drawings	54	46	55
11	Nonadherance to contract conditions	47	62	66
12	Mistakes during construction	40	53	22
13	Negotiations and obtaining of contracts	33	38	44
14	Labour and management relations	27	31	55
15	Inspection and testing of completed portion of work	13	15	33
16	Construction methods	13	23	11
17	Price fluctuations	100	100	100
18	Inaccurate estimate	86	76	66
19	Delays	73	91	88
20	Additional work	60	77	77
21	Fraudulent practices and kickbacks	54	60	44
22	Shortening of contract periods	40	60	55
23	Insurance	13	15	22

4. METHODOLOGY OF EMPIRICAL ANALYSIS CARRIED OUT

Firstly, the authors had sought to determine if there was an acceptable general agreement amongst respondents in terms of the relative severity index accorded all the variable factors in Table 3. The one-way analysis of variance (One-way ANOVA) test was applied to the data in Table 3. One–way ANOVA was employed because of its robustness – i.e. its property of broad applicability to procedures that depart somewhat from basic assumptions, a state of affairs common in relatively large samples of twenty or more observations (Kleinbaum *et al*., 1988). This test was carried out using ORIGINS software. Furthermore, a graph was plotted for the severity index against the overall ranking of variables based on the severity index magnitudes for contractors, consultants and public clients. This was intended to facilitate a visualisation of the level of agreement amongst respondents (See Figure 1).

Secondly, the data in Table 3 were subjected to a further descriptive statistical analysis to obtain the standard deviation of severity index, standard error of mean and the mean severity index (See Table 4). Using the mean severity index magnitude some notable variable factors were selected and ranked accordingly. At the same time, a ranking comparison of variable factors was carried out between the mean severity index on one hand and the net difference of the mean severity index and the standard error of mean on the other (See Tables 5 and 6).

The methods of regression analysis and descriptive analysis were adopted for analyzing the effects of project delay and cost escalation using some completed highway projects in Nigeria from 1988-1991. The data was collected from the Federal Ministry of Works and Housing (See Table 7 and Table 8). The regression and descriptive analysis was achieved by summarising the data collected into a more presentable format that would reflect the effects of project delay and cost escalation (see Table 9) in terms of percentage cost escalation of Project ($\boldsymbol{E_C}$), percentage project cost escalation period ($\boldsymbol{E_P}$) and percentage completion of project work ($\boldsymbol{C_P}$). The average mean percentage, standard deviation and standard error of mean of $\boldsymbol{E_C}$, $\boldsymbol{E_P}$ and $\boldsymbol{C_P}$ were estimated (See Table 10). The standardized mean of these three major effects were also estimated (see Table 11).

Furthermore, the following regression plots of the data in Table 9 were carried out in order to quantitatively capture some models that would assist future forecast of the effects of project delay and cost escalation in Nigeria:

- percentage (%) escalation cost (E_C) against percentage (%) escalation period (E_P)
- percentage (%) escalation cost(E_C) against Project duration (P_d)
- percentage (%) escalation period (E_P) against sub total expenditure (S_e)
- percentage (%) completion of project work to date (C_P) against percentage(%) escalation period (E_P)

In all, testing for the best-fitted regression plot to get the best fitted model for the data was carried out through the means of empirical parameters like standard deviation of fit, correlation coefficient, and the probability that the correlation coefficient would be zero. The test was limited to polynomial regression plot of first, second and third degree because these types of polynomial are much easier approximations that could better represent the given data.

5. DISCUSSION OF SURVEY RESULTS

The results obtained from one-way analysis of variance test revealed that the means of the three groups of respondents are not significantly different. In addition, the plot in Figure 1 reveals a similar order of progression in the mean severity index accorded variable factors by the contractors, consultants and public clients. Hence, there was a significant degree of agreement amongst respondents with respect to how they ranked the variable factors. The following 15 variable factors were selected out of the total 23 to be the major causes of project delay and cost escalation in Nigeria.

The survey results revealed ***price fluctuations*** as the most severe cause of project cost escalation in Nigeria. This is true because the mean severity index response from contractors, consultants and public clients was 100% and the mean standard error of Severity Index was 0%; (See Tables 3 and 4 and Figures 2 and 3). This could be attributed to the limitation in exchange rate which in turn affects construction materials prices and the general price level. Another factor is the unstable inflationary trend in Nigeria and sub-Saharan Africa in general. This inflationary trend is a result of demand exceeding supply, creating a scarcity of goods which in turn leads to the escalation of the cost of goods. Given such a scenario, construction cost projection is extremely difficult (Arditi *et al.*, 1985).

Financing and payment of completed works was second in the order of ranking of factors responsible for project delay and cost escalation in Nigeria. The mean severity index from respondents was 97.33%. The variation in ranking between respondents amounted to a standard mean error severity index of 2.67%. The net difference between these two values was 94.66%, a difference value which indicated the marginal nature of disagreement amongst respondents with respect to the ranking of this factor (See Tables 3 and 4 and Figure 2 and 3). The irregular financing of public projects is a major cause of liquidity problem for contractors; however, contractors can be paid in accordance with the contract agreement if clients can guarantee the availability of adequate funds before the project commences (Mansfield *et al*., 1994; Ogunlana *et al*., 1996). Regular ***financing and payment of completed works*** could remove constraints that could otherwise impedes project objectives, as observed by Oglesby *et al*. (1989) and reported by Frimpong *et al*. (2003).

Third in ranking of factors from the survey on project delay and cost escalation is ***poor contract management***. The results showed that this factor had a mean severity index of 89.3% with a standard mean error of the severity index of 5.8% due to the level of disagreement amongst respondents (see Tables 3 and 4 and Figures 2 and 3). The difference between these two values was 83.5%. ***Poor contract management*** could well be attributed to the manner in which contracts are awarded. In most cases projects are awarded to the lowest bidder (Mansfield *et al*., 1994). Some of these low bidders may lack management skills and have less regard for contract plans, cost control, overall site management and resource allocation. As we know in the case of Nigeria, contracts are usually awarded to politicians and well connected individuals irrespective of the apparent deficiencies in their relevant delivery potentials. Accordingly, Frimpong *et al*. (2003) and Ogunlana *et al*. (1996) have observed that most contractors in sub-Saharan Africa are entrepreneurs who are in the business of making money at the expense of good management. Consequently, they pay low wages, submit very low bids and have very little, if any ability to plan and co-ordinate contracts (Ogunlana *et al*., 1996).

Delay constitutes another factor that was ranked fourth with a mean severity index of 84% and standard mean error of 5.5% by respondents (See Tables 3 and 4 and Figures 2 and 3). The variation in agreement of ranking by respondents was slightly less than that of ***poor contract management***. The net difference in both values for ***delay*** was 78.5%. ***Delay*** in construction sites could be due to the absence of adequate statistics on available materials, fluctuations in the availability of construction materials, very long average waiting times and uncertainties about deliveries of ordered materials, shortages of funds to procure materials and inadequacy in terms of transportation (Mansfield *et al*., 1994).

Changes in site conditions is another factor ranking fifth from the survey with a mean severity index of 78.3%; standard mean error due to variation in ranking by respondents was 2.96% (See Tables 3 and 4 and Figures 2 and 3). The difference in values was 75.34%, an indication that the variations in ranking by respondents have not affected the position accorded this factor. This problem of ***changes in site conditions*** is attributed to inadequate feasibility studies before project authorisation (Mansfield *et al*., 1994). Moreover, political insensitivity and the exploitation of resident communities contribute immensely to ***changes in site conditions*** in Nigeria with an enormous potential to stall project developments. A practical example of this in Nigeria is the effects resulting from protests and repression of affected communities or regions plagued by neglect and environmental disasters, as in the Niger delta region. Such neglect and environmental disaster ranges from drinking water containing levels of petroleum hydrocarbons that are 350 times that allowed in European Union and an average of four oil spills per week to an estimated 1.1 billion cubic feet of natural gas flaring each day between 1976 and 1991 causing acid rain that destroys crops and causes illness in residents (Dixon, 2000).

Inaccurate estimates ranked sixth. The severity index was 76% with a standard mean error of about 5.77% (See Tables 3 and 4 and Figures 2 and 3). The net difference in values between the mean severity index and the standard mean error of severity index was 70.23%. The ranking position accorded this factor by virtue of its mean severity index percentage is questionable, as shown in the next paragraph. Nonetheless, this factor could be attributed to the unpredictable inflationary trend, specialisation, lack of adequate training and experience at the senior management level, and fraudulent practices (Mansfield *et al*., 1994).

Shortage of materials was ranked seventh. The mean severity index for it was 75% with a very small variation to the degree of disagreement by the respondents; standard mean error was 0.88% (See Tables 3 and 4 and Figures 2 and 3). The net difference between both values was 74.12% which was greater than the 70.23% calculated for ***inaccurate estimate*** in the preceding paragraph. The implication of this finding is that ***shortages of materials*** ranked seventh because of its mean severity index magnitude ought to have been ranked sixth and ***inaccurate estimate*** ranked seventh. However, the reason that could be attributed for ***shortage of materials*** is defective supply of materials occasioned by general shortages in the industry, poor communications amid sites and head office, purchasing planning and materials co ordination (Ogunlana *et al*., 1996).

Though ***imported materials and plant items*** was ranked eighth from the response made by the respondents in the survey, with a mean severity index of 75.3%, it accounted for the highest degree of disagreement amongst respondents. The standard mean error was 10.72% (See Tables 3 and 4 and Figures 2 and 3). The net difference between mean severity index and the standard mean error was 64.58%. One of the chief reasons for this drawback is the low level of manufacturing and exploitation of abundant local construction materials in Nigeria. Eyo-Ita-Eyo (2001) observed that Nigeria still imports cement when Nigeria's cement production potentials surpass any other African country except Egypt and that the 100 per cent raw materials required for cement production is readily available in Nigeria. Although energy contributes as much as 70% of the cost of cement production, Nigeria's energy needs for this sector are adequately catered for by its enormous energy resource. In another development, Makoju (2000) observed that 90% of the aggregate components for production and delivery of electricity in the country still depends on other developed countries. In other words, the inadequacies of indigenous technical capabilities have contributed to the overdependence on foreign construction firms.

The next in the order of ranking from the survey was the problem arising from ***additional work***. The mean severity index was 71.33% with a standard mean error of 5.66% resulting from the variations in levels of ranking amongst respondents (See Tables 3 and 4 and Figures 2 and 3). The net difference between mean severity index and the standard mean error was 65.67% which was slightly greater than the 64.58% for ***imported materials*** and plant items. This implied that its actual ranking position should have come first before that of ***imported materials and plant items***. Mansfield *et al*. (1994) had observed that ***additional work*** is related to design changes, which is due to lack of detailed briefing on the functional and technical requirements of the project by the clients.

Design change was ranked tenth, with a mean severity index of 66.67% and a standard mean error of about 0.67 % (See Tables 3 and 4 and Figures 2 and 3). The net difference between the two values was 66%, which was higher than the two presiding variable factors and should have been ranked eighth instead of tenth position. This problem arose from inadequate project planning and management of the design process. A quite distinctive example is the Progress of West African gas pipeline (WAGP). Asamoah (2002) reported that WAGP Project has suffered a number of setbacks, culminating in the escalation of its cost from an initial US$430 million to US$500 million. One of the problems includes the changing of the initial plans to lay the pipeline offshore to an onshore configuration (Asamoah, 2002).

Subcontractors and nominated supplier were ranked eleventh, with a mean severity index of 65.7% and a standard mean error indicating the variation in agreement of 7.45% (See Tables 3 and 4 and Figures 2 and 3). The difference or net value was 58.25%. The major reasons responsible for this factor as observed by Manavazhi and Adhikari (2002) were monopoly control of the market by some suppliers, work stoppages in factories, lack of industrialized materials, fluctuating demands forcing suppliers to wait for accumulation of orders and difficulty in importing raw materials from other countries. Other factors included governmental delays resulting in procurement delays. During procurement, delays come from foreign exchange unavailability which would have been required for importing materials and equipment.

The twelfth factor the ***Weather*** with a mean severity index of 61.33% and standard mean error of about 6.03% (See Tables 3 and 4 and Figure 2 and 3). The net difference value was 55.3%. ***Weather*** was the most uncontrollable factor amongst the other variables considered. Temperature and humidity affects productivity of workers. If the temperature and humidity are high, workers feel lethargic and lose physical coordination, as reported by Frimpong *et al*. (2003).

Non-adherence to contract conditions, ***mistakes and discrepancies in contract document*** all amount to ***fraudulent practices*** in Nigeria. ***Fraudulent practices and kickbacks*** were ranked with a mean severity index of about 52.67% and a standard mean error of 4.67% (See Tables 3 and 4 and Figure 2 and 3). The net difference value was only 48%. It is rather unfortunate that as prevalent as this factor in the sub Saharan Africa, it was ranked low by the respondents amongst the major factors responsible for project cost escalation. ***Fraudulent practices and kickbacks*** occasioned by greed are perpetuated by some major players in the Nigerian construction industry (Hussain, 1999). The severity index percentage of this factor in the survey was small because the perpetrators of this act in the industry are predominantly found within the rank and file of contractors, consultants and public clients as evident from the report published by TELL (2002). Regrettably, it was the judgement of these three stakeholders only that was used in defining the severity index percentages. Tell (2002) reported that there were verifiable cases of corruption in the execution of some of the contracts awarded by Petroleum (special) trust fund (PTF). The Interim management committee (IMC) set up by President Obasanjo found that of the total 181.8 billion naira that accrued to PTF for the three years it operated, as much as 25.6 billion naira was wrongly paid to contractors. These include inflated contracts, fraudulent overpayment of contractors by some of the agency officials and undue receipt of interest on funds placed in banks by the agency.

In all, the presentation of the causes of project delay and cost escalation in Nigeria revealed five fundamental shifts in ranking positions of notable factors when ranked by the net difference between the mean severity index and the standard error of mean as compared to the mean severity index alone (see Tables 5 and 6).

Figure 1. A plot showing severity index against overall ranking of variables

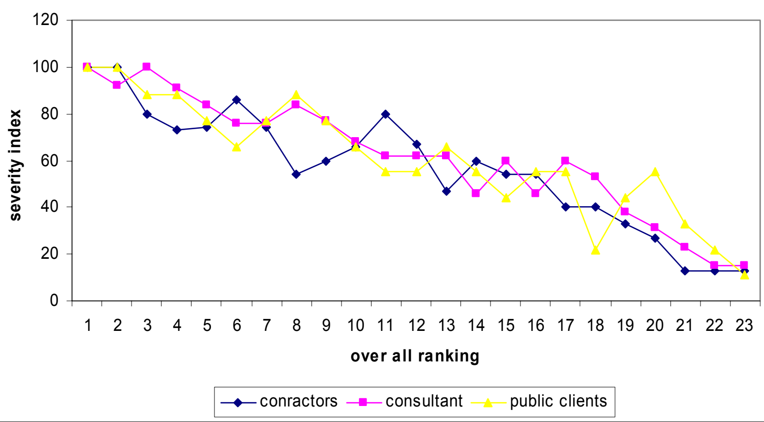

Table 4. Descriptive statistics of survey results:

Variable code	Severity Index %			Ranking			Descriptive statistics			Overall ranking
	Contractors	**Consultants**	**Public clients**	**Contractors**	**Consultants**	**Public clients**	**mean**	**Standard deviation**	**Standard Error of mean**	
1	100	92	88	1.5	3	1.5	97.3	4.6	2.66	2
2	80	100	100	4.5	1.5	3.3	89.3	10.1	5.81	3
3	80	62	55	4.5	11.3	9.2	65.7	12.9	7.44	11
4	74	76	77	6.5	8.5	5.3	75.7	1.5	0.88	7
5	74	84	77	6.5	5.5	5.3	78.3	5.1	2.96	5
6	67	62	55	9	11.3	9.2	61.3	6.0	3.48	12
7	66	68	66	10	10	7.3	66.7	1.2	0.67	10
8	60	46	55	11.5	16.5	9.2	53.7	7.1	4.10	14
9	54	84	88	13.3	5.5	3.3	75.3	18.6	10.73	8
10	54	46	55	13.3	16.5	9.2	51.7	4.9	2.85	17
11	47	62	66	15	11.3	7.2	58.3	10.0	5.78	13
12	40	53	22	16.5	15	14.5	38.3	15.6	8.99	18
13	33	38	44	18	18	11.5	38.3	5.5	3.18	19
14	27	31	55	19	19	9.2	37.7	15.1	8.74	20
15	13	15	33	20.3	20	13	23	10	5.77	21
16	13	23	11	20.3	21.5	15	13	2	1.15	23
17	100	100	100	1.5	1.5	1.5	100	0.0	0.00	1
18	86	76	66	3	8.5	7.3	76	10	5.77	6
19	73	91	88	8	4	3.3	84	9.6	5.57	4
20	60	77	77	11.5	7	5.3	71.3	9.8	5.67	9
21	54	60	44	13.3	13.5	11.5	52.7	8.1	4.67	15
22	40	60	55	16.5	13.5	9.2	51.7	10.4	6.01	16
23	13	15	22	20.3	21.5	14.5	16.7	4.7	2.73	22

Figure.2 Order of ranking of Variable factors and Mean severity index bar chart plot

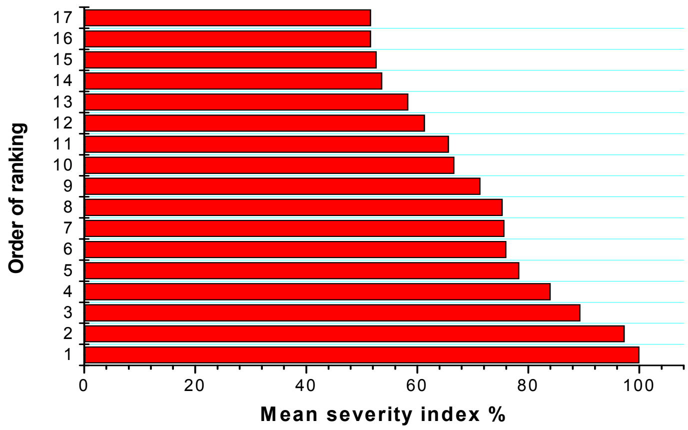

Figure.3 Order of ranking of Variable factors and standard mean error bar chart plot (respondents degree of disagreement)

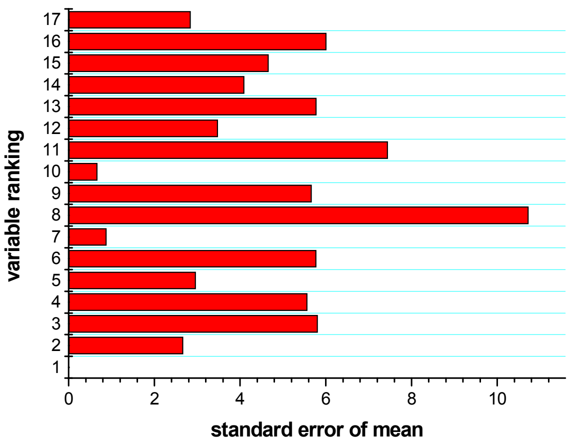

Table 5. Variable factors ranking and codes using their Mean severity index magnitudes

Ranking positions	Variable factors	Variable codes
1	Price fluctuations	17
2	Financing and payment of completed works	1
3	Poor contract management	2
4	Delays	19
5	Changes in site conditions	5
6	Inaccurate estimates	18
7	Shortages of materials	4
8	Imported materials and plant items	9
9	Additional work	20
10	Design changes	7
11	Subcontractors and nominated suppliers	3
12	Weather	6
13	Non adherence to contract conditions	11
14	Mistakes and discrepancies in contract document	8
15	Fraudulent practices and kick backs	21

Table 6. Actual Ranking of the major variable factors from estimated Net difference between Mean, Severity Index and Standard error of mean.

Actual ranking	Variable Factors	Variable code
1	Price fluctuations	17
2	Financing and payment of completed works	1
3	Poor contract management	2
4	Delays	19
5	Changes in site conditions	5
6	Shortages of materials	4
7	Inaccurate estimates	18
8	Design changes	7
9	Additional work	20
10	Imported materials and plant items	9
11	Subcontractors and nominated sub suppliers	3
12	Weather	6
13	Fraudulent practices and kick backs	21

6. HIGHWAY DATA ANALYSIS AND REGRESSION PLOT

Having analysed the actual causes of project cost escalation in Nigeria, the next stage in this investigation is to analyze its possible effects. Data in Tables 7 and 8 of some completed highway projects in Nigeria from the Federal Ministry of Works as mentioned previously in the methodology is presented in summary in Table 9. From Table 9 above, the descriptive statistics of the effects of project cost escalation is summarised in Table 10.

To increase the probability of the calculated mean because of the variations in items of the given data in Table 9 to a standardised mean value or sample mean that could effectively approximate the given set of data, the following equation was applied.

Practical (sample) mean = *Mean + Z (SEM)*………………………………….. (4)

where: the standardized critical value *Z* = ***1.645, SEM*** is the standard error of mean and the results obtained are shown in Table.11:

All the relevant plots stated in the methodology were initially plotted linearly. In checking for the curve that could give a suitable model that best represents the set of data, two basic conditions were employed, namely:

- Comparing the parameters of each linear plot to their corresponding second and third degree polynomial parameters.
- Check if the plot meets practical trend or expectation.

Having satisfied the two basic conditions above, the following relationships were developed:

$$E_C = 4.866 + 0.027\, E_P \quad \text{...(8)}$$
$$E_C = 30.7 – 3.65P_d + 0.11P_d^2 \quad \text{………………………………....(9)}$$
$$E_P = 157.420 – 5.15x10^{-4}\, S_e \quad \text{...(10)}$$
$$C_P = 2.56 + 1.38E_P – 6.58 \times 10^{-3}\, E_P^2 + 9.86X\, 10^{-6}\, E_P^3 \quad \text{………....(11)}$$

Table 7. The Highway Project status report showing financial progress

Contract code	Estimated contract sum (N X 10^3)	Value of permanent work to date (N X 10^3)	Variation of cost of Materials and freight (N X 10^3)	Subtotal expenditure to date (N X 10^3)
1	12050	9386	1633. 0	9550
2	17632	10098	-	11628
3	16336	13835	268. 0	14067
4	8843	7952	119. 0	8015
5	54660	49097	3338.6	54509
6	69070	48691	9191. 4	62888
7	52555	47217	1841. 0	48809
8	11067	7700	531. 4	8193
9	6357	4406	130. 0	4874

Source: [Data from Mansfield *et al.* (1994)]

Table 8. Highway Project status report showing durations, expenditures and work progress at time of reporting

Contract code	Duration months	Completion of Project work to date %	Lapse of contract Period and freight %	Expenditure to date %
1	12	76. 87	141. 67	79. 25
2	23	65. 08	97. 83	65. 92
3	12	80. 56	91. 67	86. 11
4	24	97. 36	126. 92	90. 64
5	27	100. 00	106. 20	100. 26
6	30	100. 00	175. 00	91. 05
7	15	94. 00	120. 00	92. 87
8	28	93. 79	100. 00	74. 03
9	7	99. 00	342. 90	76. 68

Source: [Data from Mansfield *et al.* (1994)]

Table 9: A brief summary of Highway Project status report

Contract code	Estimated contract sum ($Nx10^3$)	Cost of permanent work to date ($Nx10^3$)	Subtotal of expenditures to date ($Nx10^3$)	% Escalation cost to date	% Escalation period to date	% completion of Project work to date	Duration of contract (months)
1	12050	9386	9550	1.75	141.67	76.84	12
2	17632	10098	11628	15.15	97.83	65.08	23
3	16336	13835	14067	1.68	91.67	80.56	12
4	8843	7952	8015	0.79	126.92	97.36	24
5	54660	49097	54509	11.02	106.2	100.00	27
6	69070	48691	62888	29.15	175	100.00	30
7	52555	47217	48809	03.37	120	94.00	15
8	11067	7700	8193	06.4	100	93.79	28
9	6357	4406	4874	10.62	342.9	99.00	7

Table. 10. Descriptive Statistics of the Effects of Project cost escalation

Effects of Project cost escalation	Descriptive statistics		
	Mean (%)	Standard deviation (SD)	Standard error of mean (SEM)
% Escalation cost (E_C)	8.88	9.10	3.03
% Escalation period (E_P)	144.69	78.76	26.25
% completion of project work (C_P)	89.54	12.6	4.15

Table. 11. Standardized or Sample mean values

Effects of Project cost escalation	Standardized mean (%)
% Escalation cost (E_C)	14
% Escalation period (E_P)	188
% completion of project work (C_P)	96

7. CONCLUSION AND RECOMMENDATIONS

Contrary to the Mansfield et al investigation, the ranking of any factor in a survey of this magnitude can only be explicit if done on the basis of the net value between the mean severity index and the standard error of mean, instead of either of these in isolation. The ranking carried out with the net difference in this study revealed shifts in ranking positions of notable causes responsible for project delay and cost escalation (see Table 5 and 6).

The ranking accorded to fraudulent practices and kickbacks, in spite of its notable prevalence in the construction industry in Nigeria, was questionable. It was argued from available evidence that fraudulence is predominant within the rank and file of contractors, consultants and the public clients in the construction industry. Most regrettably, it was only these classes of respondents that were used in the investigation to define the extent of severity of each of these factors. In quantifying further the significance of fraudulent practices and kickbacks using the severity index accorded it by respondents amongst the other variable factors responsible for project cost escalations i.e. its percentage of the selected 17 variable factors:

{[Mean severity index for variable factor 21] x [total Mean severity index of the 17 selected causes]$^{-1}$}100%

It was alarming from the above expression that fraudulent practices and kickbacks amounted in effect to just 4.36% of the total selected causes. If we decide to eliminate fraudulent practices and kickbacks and check what effect it has on percentage project escalation cost E_C and percentage project escalation period E_P , 4.36% value was of no significant impact. This discovery is no doubt completely at variance with the obvious in the Nigeria construction industry which calls in question the relative ranking accorded fraudulent practices and kickbacks by respondents.

Nevertheless, this study has definitively established the minimum percentage escalation cost of projects in Nigeria at about 14%. The approximate minimum mean percentage escalation period of project in Nigeria from this study was 188%. In spite of these severe loses, the mean average percentage completion of work was just 96%. This damaging trend has prompted the development of enabling equations for future forecast of these effects in Nigeria.

Moreover, procurement guidelines should be effectively followed as it will definitely improve standards in many ways while excluding unqualified competitors from the bidding process. This process would encourage the active involvement of qualified contractors and suppliers in the bidding process. It would also limit the recurring incidence of fraud.

As a means of improving the present project financing strategy, private sector participation is to be encouraged in financing public projects as a way of checking insufficient funding. This strategy would enhance greater involvement and commitment to project delivery. Contract methods in public private partnership (PPP) such as build-own-operate-transfer (BOOT) schemes could be introduced to encourage contactors to participate in financing new projects (Hallmans, 1999)

The minimum 14% escalation cost of projects in Nigeria established from this study had reinforced the call for a more reasonable percentage increase in contingency allowance from the current 5-10% in Nigeria to about 15-20%, as recommended by the United States Department of Energy (DOE) for budget estimates (Abinu and Jagboro, 2002). There is the need to remove all forms of bureaucracy militating against project development in order to create an enabling environment for potential investors (Abinu and Jagboro, 2002; Frimpong *et al*., 2003; Oglesby *et al.,* 1989). Stakeholders in the construction industry should as a matter of urgency establish an efficient and sustainable material management or expansion of local resource base and manpower development systems.

For future investigation, the number of respondents should be increased to enhance a wider aggregate representation of views.

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INVESTIGATING THE EFFECT OF MACROECONOMIC VARIABLES ON THE COST OF CONSTRUCTION OF SCHOOLS IN EGYPT

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ABSTRACT: The relationship between macro, international and local economic variables and the construction industry outcomes in Egypt is investigated. From 1999, Egypt started to experience unfavourable economic conditions, ultimately leading to two currency devaluations during the period 2001-2003. The value of the exchange rate of the Egyptian currency settled at nearly 50% of its previous value. This research draws on a unique panel dataset based on the Egyptian national project to construct 1500 standardised design schools every year. This allows product factors to be effectively standardised. The dataset is rich in variation in terms of economic variables. This permits the analysis to examine the impact of both economic variables and local factors on project cost. The paper concludes by mapping out future and ongoing work aimed at establishing and developing a cost model likely to have a considerable value to planning authorities and contractors.

Keywords: building economics, cost modelling, Egypt, macroeconomics variables

INTRODUCTION

Egypt is an emerging country where a third of the population is under the age of 14. Only 57% of its 75 million inhabitants can read and write. With thousands of years of civilisation, Egyptians want to equip the next generation with the skills to enrich the economy and create wealth.

During the period from 1992-2003 'The General Authority of Educational Buildings' (GAEB) built 13350 schools contributing to more than a third of the total number of schools of Egypt ; 36332 schools servicing 15 million students (of which 48% are girls) equating to about 21% of the population.

GAEB applied standard designs for different stages. Each Key stage had only a few standard designs to fit different locations. This meant that the same design was applied to many schools in different locations. The concept of standard design has been a trend the government has introduced to other sectors like health services buildings and state housing.

Moreover, the Egyptian government intend to extend this project due to the prevailing demand triggered by what seems to be ever lasting uncontrolled growth in population.

Over recent decades, Egypt has been burdened by the consequences of many years of war and a political system that has very much controlled the economy. Despite the different reform programmes attempted since the 80's, the Egyptian government is still facing huge challenges.

The construction industry is one of the main constituents of the Egyptian economy and contributes about 4.7% of GDP. In addition construction provides employment to large numbers given that it is a labour intensive industry.

Demand for school buildings is a derived inelastic demand due to the demographic factors. Yet the construction firms constituting the supply side are a relatively fragmented group. There is a need for an effective industry body to defend their rights especially in public sector projects where the Government imposes unfair contracts that secures its rights and hardly considers the consequent liabilities. The only existing body, the General

Federation for Building Contractors, is ineffective as the government indirectly controls it. In general the government being the main client is able to control the demand within the construction industry.

In 1999, GAEB could not pay contractors their invoices for three months as the Government could not pay GAEB the 4th quarter instalment. As the fiscal year in Egypt starts on the 1st of July, Contractors had to until the last quarter of the following fiscal year for their payment as their accruals were shifted to provisional accounts in the new Budget. Such accounts have low priority and are subject to availability of resources.

On average, each contractor had 1,000,000 L.E. (Egyptian Pound) blocked. This is significant when compared with the average capital of contractors ranging from 500,000 – 1,000,000 L.E. With interest rates at 14 -16% and the majority of contractors being financed by banks, many faced serious repercussions. The average contractor incurred 200,000 L.E. extra costs in addition to being short of liquidity.

The recent privatisation of several cement factories led to an unprecedented fluctuation in cement prices. Local and foreign investors competed to acquire the lucrative business especially with the introduction of new environmental regulations in most of the southern Europe countries once used to be the main producers of cement in the international market and main exporters to the Egyptian markets. Consequently, the construction market witnessed a period of price instability that extended over three years with prices fluctuating from as low as 100 L.E. per ton to as high as 280 L.E. per ton, sometimes within the same month. Prices were set on a day by day basis with no defined or even predictable pattern.

The steel producers with heavy debts, mainly to national banks, forced the government to intervene by imposing new taxes (dumping tax) on all steel imports. They claimed that this was the only way they could pay their debts and justified their right to be protected against what they described as subsidised exports. This created Oligopoly and coupled with the two devaluations of the currency, prices increased nearly three-fold in three years (from as low as 1100 L.E/ton in 2001 up to 3000 L.E./ton in 2003).

With steel and cement contributing to more than 40% of the total cost of school buildings, cost estimating and price forecasting became very hard. Yet the major challenge was faced by those contractors who already had significant work in progress and were bound by fixed price contracts to public sectors like GAEB

PROBLEM IDENTIFICATION

The problem lies in a three dimensional perspective:

1. The economic turbulence through which Egypt has been struggling to survive has existed since the mid seventies. The government, being the policy maker, does not seem to have had a structured approach to ensure the effectiveness of using the construction industry as one of the tools to regulate the economy. This had severe implications on both contractors and projects. The GAEB had to adjust prices every year from 1999 until 2004, which indicates a reflective and reactive rather than planning role.
2. In Egypt, contractors, the majority of them being small or medium size companies, lack the expertise to provide any reasonably accurate cost estimating. The detailed economical appraisal of the current situation is far beyond their capabilities. The contractors, who have recently suffered huge financial repercussions due to delayed payments in 1999, were faced by another shockwave over the period 2001 until 2003 due to the devaluation of the currency. This led to

a notable increase in bankruptcy cases and the delay or complete stop of some projects.

3. The slowdown of the labour intensive construction industry in Egypt caused serious social implications due to massive layoffs. The slowdown also caused problems in many intermediate industries.

The government advocating new standard design for education, health and housing projects has offered researchers an unprecedented opportunity to investigate such relationship. The standard design eliminates many variables related to the product, hence focusing more on the effect of macroeconomic variables on the cost of construction.

The aim of this study is to try to provide the cost planning authority as well as the contractors for school buildings in Egypt with a cost model that stretches the scope of the cost estimating process beyond the traditional cost items including risk reserves and contingencies (hardly considered in our case) to embrace a rational forward looking approach utilising the forecasted economic indicators. As we shall be targeting the short-term (less than one year), we may reasonably assume that the use of official forecasts for the relevant economic indicators will not be detrimental. This preliminary study is the first step to developing a model that aims to enhance the accuracy of cost estimating especially in volatile economic conditions.

LITERATURE REVIEW

Economics is a social science not a pure science. There are many untested and untestable models. There are divisions between different schools of thoughts. The economic journals indicate that many of the most prestigious academic economists are working on theoretical mathematical models that begin with entirely arbitrary and unrealistic assumptions and lead to precisely stated and irrelevant conclusions as far as the real world is concerned. Too often in economics, the choice is between being roughly accurate or precisely wrong (Raftery 1991).

Throughout the development of economics as a subject area, the questions examined by various schools are usually those, which are of contemporary relevance at a particular point in time in a given set of circumstances. (Raftery 1991).

Hence, reviewing the literature on building economics, a substantial majority of previous work is either country or region specific. Among the countries covered in the literature, for example, are Ghana and Tanzania (Ofori,1984), Singapore (Ofori, 1998), Greece (Dawood, 2000), Taiwan (Wang and Mei, 1998), Portugal (Lopes and Ribeiro, 2000), Sub-Saharan Africa (Lopes, Ruddock and Ribeiro, 2002), Libya (Omar and Ruddock, 2001), Malaysia (Ruddock, 2002), UK (Rawlinson and Raftery,1997; Akintoye, Bowen and Hardcastle, 1998; Fitzgerald and Akintoye, 1995 and others), Hong Kong (Ng et al, 2000; Tse and Ganesan, 1997), and Indonesia, (Kaming, 1997)

There is a clear gap in the literature in covering the Egyptian case. The aforementioned literature emphasises the need for a specific investigation in order to derive a relationship between the macroeconomic variables and the cost of construction projects in Egypt due to different underlying circumstances and prevailing trends

Many researchers have investigated the techniques of cost estimating of construction projects. In establishing the relationship between determining factors and cost, (Trost and Oberlender, 2003; Ling et al., 2004) applied the ordinary least square regression approach and developed a model based on the coefficient of multiple determination or the R^2 value.

Kaming et al (1997) applied factor analysis, and extracted 'factors' or 'components' out of the original variables. Chan et al. (2001) grouped a large number of variables into the reduced number of 'factors' whose loadings indicate the relative importance of each factor.

The regression analysis, used in this paper, has been applied by many researchers; Neale and McCaffer (1974); Ashworth et al. (1980); McCaffer et al. (1983); Fellows, (1988); Akintoye and Skitmore (1994); Songer and Molenaar (1997); Konchar and Sanvido (1998); Smith (1999); Ameen et al (2003) and others.

Ruddock (2002) addressed the crucial problem of the quality of statistical data and the limitations of existing data sources. In pursuance of Ruddock's recommendations, macroeconomic data used in this paper are based on recent official statistics to offer the maximum available validity and reliability.

AIMS AND METHODOLOGY

The study focuses on the construction costs of education buildings in Egypt. A sample of 122 schools built in the period from 1995-2003 was collected. The sample included schools built in different locations in 13 governorates (provinces), spreading from Upper Egypt (Luxor, Qena) to the Northern Coast. The main characteristics of the standardised design applied may be summarised as follows:

- the main building is a multiple of a fixed module
- the skeleton specifications are the same in terms of material and statement of work
- the finishing specifications are the same in terms of material used

The elimination of the data on foundation, landscape and other facilities that vary from one school to the other is intended to bring focus on the super structure of the main building meanwhile reducing the number of project variables; hence, we may be able to emphasise the effect of the macroeconomic variables.

The macroeconomic variables investigated are GDP, interest rates and exchange rates ($ vs. L.E.), both official and unofficial rates . The study also included US. GDP and interest rates due to the strong ties between both countries in terms of economic influence. The Egyptian currency like some other Middle-East currencies is srongly related to the U.S. Dollar.

The model is estimated using ordinary least squares (OLS) regression. To normalise the data, and to aid interpretation of the coefficients, a log-log functional form is used. The underlying objective is to test the hypothesis that macro and international economic variables are significant predictors of project cost even after accounting for project specific design differences.

The simple initial model includes the natural log of project cost as the dependent variable. A vector of explanatory variables measure variation in project size and design while a set of macro economic variables proxy economic trends and conditions both in Egypt and in the United States. Variables describing economic conditions in the latter effectively proxy import / export conditions between Egypt and abroad. All time series macro variables are also measured in natural logs.

EMPIRICAL RESULTS

The final column in table 1 indicates the tolerance of each explanatory or independent variable with respect to the set of other explanatory variables. The measure represents the residual or unexplained error that results when the other explanatory variables are used to predict the independent variable. For example, the tolerance of L_RCSK (0.031) shows that an R square of 0.969 results when the other explanatory variables are used to predict L_RCSK. The tolerance measures are very low for a number of the explanatory variables suggesting the presence of multicollinearity. The strong explanatory power of the model coupled with low t statistics is also suggestive that this is the case. The result is that the coefficients and corresponding t statistics cannot be relied upon as unbiased estimates.

One possible solution to the possibility of multicollinearity is to drop combinations of variables that are highly collinear with other predictors. However, the approach adopted here is to further explore the collinearity with the set of explanatory variables using principal component analysis. One advantage of this approach is that information from all of the original variables can potentially be retained in the resulting factor scores.

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Table 1. Preliminary estimation results

Variable	Label	Coefficient	t statistic	Tolerance
Constant		**-4.114**	**-0.355**	
L_PCSK	**Plain concrete in skeleton**	**0.051**	**1.315**	**0.312**
L_RCSK	**Reinforced concrete in skeleton**	**0.378**	**2.318**	**0.031**
L_DOORS	**No of doors**	**0.025**	**0.269**	**0.086**
L_WIND	**Area of windows**	**0.138**	**1.833**	**0.102**
L_SBRI	**Brick work in sq m**	**0**	**-0.004**	**0.129**
L_CBRI	**Brick work in cu.m.**	**0.113**	**0.991**	**0.087**
L_PLAST	**Quantity of plastering**	**0.196**	**1.28**	**0.036**
L_PAINT	**Quantity of Paint works**	**-0.071**	**-3.14**	**0.463**
L_ILLUM	**No of illum. points**	**0.119**	**2**	**0.171**
L_UGDP	**US GDP**	**1.15**	**1.205**	**0.028**
L_EXO	**Exchange rate to $, official rate**	**-0.221**	**-0.772**	**0.097**
L_URI	**U.S. interest rate level**	**1.017**	**0.852**	**0.218**
L_EUGDP	**Egy/US. GDP**	**-0.196**	**-0.232**	**0.073**
L_OFUN	**Official/unofficial exchange rate**	**-0.615**	**-0.837**	**0.156**
L_EUROI	**Egy/US. Interest rate**	**-0.392**	**-0.858**	**0.203**
R Square		**0.948**		
Adj. R Square		**0.935**		
F statistic		**72.891**	***	

The principal component analysis uses Varimax factor rotation to maximise the meaning of the factor scores (new variables). This method of rotation tends to result in factor scores that load heavily on a relatively small number of original variables. To further aid interpretation of the new factors, two separate rounds of principal component analysis are undertaken using only physical descriptors of project size in round one of the analysis and only macro economic variables in the second round.

The results of the first round of factor analysis suggest very strong correlation within the set of project specific variables. A single component or factor accounts for more than 80% of the variance or information contained within the original set of variables. In order to retain as much information as possible about the physical description of each construction project, the eigenvalue threshold is set at 0.5 rather than 1.0 and this results in the creation of two principal components. On Varimax rotation these respectively describe 62% and almost 26% of variance in the original set of 9 variables. Table 2 sets out the rotated component loading matrix.

The rotated factor loading matrix shows that factor 1 loads heavily on a number of project specific variables including plain concrete, reinforced concrete, number of doors, number of windows, square metreage of brickwork, cubic metreage of brickwork, quantity of plasterwork and number of lighting points. The second factor loads primarily on quantity of paintwork although quantity of reinforced concrete, number of doors, number of windows and number of lighting points are also correlated with this factor.

Table 2. Loading matrix for the project specific variables

	Component	
Variable	1	2
L_PCSK	0.861	0.165
L_RCSK	0.858	0.457
L_DOORS	0.794	0.512
L_WIND	0.787	0.500
L_SBRI	0.826	0.361
L_CBRI	0.878	0.389
L_PLAST	0.87	0.418
L_PAINT	0.303	0.926
L_ILLUM	0.759	0.518
Initial Eigenvalues	7.392	0.540
Initial % of Variance	82.138	6.002
Rotated % of Variance	62.259	25.882

A second round of factor analysis focuses on the macro economic variables as noted earlier. This round of analysis also results in the creation of two uncorrelated principal components or factor scores as shown in table 3.

The factor analysis shows that the 9 macro economic variables can be reduced to an uncorrelated set of 2 principal components or factor scores. Together these contain more than 93% of the variance or information in the original set of 9 correlated variables. Table 3 sets out the loading matrix following Varimax rotation.

The loading matrix shows that factor 1 loads heavily on GDP for Egypt and the United States and both the official and unofficial exchange rates and negatively with the interest rate level of both Egypt, and the Egyptian interest rate level relative to that of the United States. The second factor loads mainly on Egypt and US GDP and inversely on US interest rates as well as the ratio of the official to unofficial exchange rates.

Table 3. Loading matrix for the macro economic variables

Variable	Label	Component 1	Component 2
L_EGDP	Egy. GDP	0.614	0.767
L_UGDP	US GDP	0.607	0.781
L_EXO	Official exchange rate	0.905	0.361
L_EXU	Unofficial exchange rate	0.828	0.522
L_URI	US int. rate	0.116	-0.949
L_ERI	Egy int. rate	-0.938	-0.258
L_EUGDP	Egy GDP/US GDP	0.606	0.726
L_OFUN	Off. ex. rate/unoff. Ex. rate	-0.275	-0.892
L_EUROI	Egy int. rate/US int. rate	-0.984	0.071
Initial Eigenvalues		6.697	1.752
Initial % of Variance		74.408	19.468
Rotated % of Variance		50.597	43.279

The final model estimation substitutes the four new factor scores in place of the original sets of project specific and macro economic variables. The results are shown in table 4

Table 4. Final estimation results

Variable	Coefficients	t statistics		Tolerance
Constant	13.41	670.325	***	
Macro factor score 1	0.098	4.443	***	0.961
Macro factor score 2	0.076	3.838	***	0.983
Project specific factor score 1	0.553	27.395	***	0.995
Project specific factor score 2	0.217	10.76	***	0.962
R Square	0.929			
Adjusted R Square	0.925			
F statistic	233.915 ***			

The results clearly show the dominant influence of project specific factors in the determination of total project costs. Given the log-log specification of the model, the coefficients can be interpreted as elasticities. In other words, a 100% increase in the "size" of a project gives rise to an approximately 77% rise in project costs (summing the elasticities of the two project specific factor scores). Meanwhile, both of the macro economic factor scores are statistically signifiance at 1% but have much lower coefficients or elasticities. However, some generalisable predictions can be made about the role of the macro economic factors in the determination of project costs:

A 100% rise in factor 1 would give rise to an approximately 10% rise in project cost. As noted earlier, macro economic factor 1 represents US and Egyptian GDP, the exchange rate (relative value of Egyptian currency) and the inverse of the Egyptian interest rate level. The most interesting finding is that project costs tend to rise when the Egyptian interest rate decreases relative to US interest rates, all other things being equal.

Meanwhile, a 100% rise in factor 2 would give rise to an approximately 7.6% rise in project cost. This factor partly reflects divergence between the official and unofficial exchange rates given that this factor loads on unofficial, but not official exchange rates. The implication is that an increase in factor 2 represents an increase in the unofficial exchange rate (number of Egyptian currency units required to purchase a dollar) with respect to the official fixed rate. This gives rise to an increase in project costs. The results therefore suggest that project costs increase when economic conditions call for devaluation in the Egyptian currency and where those conditions are not met by an official devaluation.

CONCLUSIONS AND FURTHER DIRECTIONS

The paper has investigated the relationship between the macroeconomic variables and the cost of school buildings in Egypt. The findings may be summarised as follows:

- Not surprisingly, project costs are dominated by project specific variables.
- Macro economic variables are statistically significant.
- It is worth remembering that the underlying variation in macro economic variables is smaller than project specific variables (i.e. the data contain variation in project sizes) but the variation in a short-time series will be limited for the macro variables.

Also, for further directions:

- Future specifications of the model will include lagged time series variables in an attempt to capture dynamic adjustment.
- Consideration will be given to extending the length of time series.
- Consideration will be given to the identification of locational (probably regional)variables

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SIMULATION MODELLING OF COST OVERRUNS IN BUILDING PROJECTS

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ABSTRACT: In the domain of construction, cost overruns from tender Bill of Quantities (BOQ) to final account are common in almost every project. The aim of the study based upon which this paper is produced is to identify and analyse the building construction cost overruns in Sri Lankan construction industry. The factors affecting the building construction cost overruns were identified and quantified. A preliminary questionnaire survey was conducted to identify the building projects and detailed case studies were carried out on thirty building projects in order to quantify the factors such as variation, extra work, increase or decrease of value of BOQ item, price fluctuation, day works and others that are affecting building cost overruns and to establish the distribution curve for such factors. Accordingly, a probability distribution was established for each factor identified and subsequently a simulation model was developed to quantify the cost overruns.

Keywords – Building Projects, Construction, Cost Overruns, Simulation, Sri Lanka

1 BACKGROUND

It is very important in a building contract, that its objectives are met to the satisfaction of the parties involved. The major targets of the building contracts such as cost, time and quality play an important role in achieving objectives/goals expected. These three factors are interrelated and interdependent. Therefore it is essential to maintain a proper balance between the three so that the product can be constructed in time, within the budget and at the required quality. However, it is an admitted fact that in Sri Lanka, the majority of contracts suffer undue time extensions and /or additional cost to the client and /or inadequate quality of work.

Cost overruns and time overruns can be either avoidable or unavoidable. Overruns due to design plan or project management problems are avoidable because they could have reasonably been foreseen and prevented. However, there are some unavoidable costs such as those due to unanticipated events which cannot reasonably be prevented. Cost overruns may add value to projects when extra work is done with the intention of producing a better output. Overruns may also add value when they involve work that was omitted from design plans but clearly needed to be done. However, some overruns may not add value and represent wasted money if they do not result in a better product.

Cost overrun of a project refers to the actual 'cost increase' to the client during construction of a building project (Janaka, 1992). It is merely the difference between the value originally envisaged for the project and the value reflected in the final certificate. Cost overruns occur from overspending the allowances, making changes and encountering unforeseen problems. Proper planning can greatly reduce cost overruns.

The causes for cost overruns differ from country to country. According to a study done in Kuwait by Koushki et al (2005) the three main causes of cost overruns were identified as contractor-related problems, material-related problems and, owners' financial constraints. Another study from Indonesia revealed the three most frequently occurring causes of cost overruns are materials cost increases due to inflation, inaccuracy of quantity take-off and cost increase due to environmental restrictions (Kaming et al, 1997). But in general it is found that the variation was a main source of cost overrun and the design team believes that the client predominantly creates variations which lead to many problems in building contracts. However, the design team must examine their activities critically and ensure that they do not mislead the client in an attempt to cover their own inadequacies. Hence, one of the objectives of this study is identifying the factors influencing the cost overruns in Sri Lankan construction industry.

2 AIM AND OBJECTIVES

The aim of the study reported in this paper is to identify and analyze the building construction cost overruns in Sri Lankan construction industry. To achieve this aim the following objectives are set. They are;

- to identify the factors influencing the building construction cost overruns.
- to identify the current view of cost overruns in Sri Lankan construction industry
- to quantify the percentage of building construction cost overruns factors.
- to establish probability distribution for identified factors
- to develop the simulation model

3 SCOPE AND LIMITATIONS

Due to time constraints, this research is limited for the building projects with the value of more than five millions and projects built in the western province. The data were collected from the building projects undertaken by contractors who posses The Institute for Construction Training and Development (ICTAD) grades M1, M2 and M3 in Sri Lanka. ICTAD, which is the regulatory authority of construction in Sri Lanka, categorises the contractors into grades based on the value of the project they undertake and their performance. In this regard the M1, M2 and M3 grade contractors are eligible for construction of buildings over Rs.300, between Rs.150 and Rs 300 and between Re 50 and Rs 150 million in value respectively.

4 DATA COLLECTION

This research mainly focuses on the factors influencing the cost overruns of building construction. A preliminary questionnaire was carried out among the M1, M2 and M3 grade contractors in order to identify the building projects with the value of more than 5 million within the Western province. In total 50 questionnaires were distributed to collect the project details where only 30 were responded.

A case study approach was used to identify the factors affecting the building cost overruns and to quantify the identified factors in monitory terms. Comprehensive case studies were carried out on **thirty building projects** that had been selected through the preliminary questionnaire survey. In general, the case studies are the preferred research strategy when the focus is on a contemporary phenomenon within real-life context. Case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (Yin, 1994). A multiple case studies approach was designed in order to study and quantify the factors affecting cost overruns. Data collection has been done both by interviewing professionals associated with the selected projects and by reviewing documents. Table 1 shows the composition of building types chosen for the study. The types of buildings include residential, commercial such as office buildings, shopping complex, administrative buildings etc. and other types such as educational, medical etc. The type of contract of 25 projects out of 30 is measure and pay. This is because the measure and pay system has the highest share among all the other types of procurement systems in Sri Lanka (Rameezdeen and De Silva, 2002). Please refer Appendix 1 for the details of projects that have been taken into analysis.

Table 1: Composition of Building Types

Type of building	No of projects	Percentage
Commercial building	17	57%
Residential buildings	06	20%
Other buildings	07	23%
Total Buildings	**30**	**100%**

5 FACTORS INFLUENCING BUILDING COST OVERRUNS

The factors affecting the cost overruns of building projects are identified through the case studies. They are; Variations, Extra work, Increase or decrease the value of the BOQ items, Price fluctuations, Currency fluctuations, Day works and other (Arbitration awards, Claims, Termination of the contract, and Compensations)

Average cost overruns identified in each factor were computed as a percentage of total cost overruns. Figure 1 shows the break down of the total cost overruns where average value of each factor can be seen.

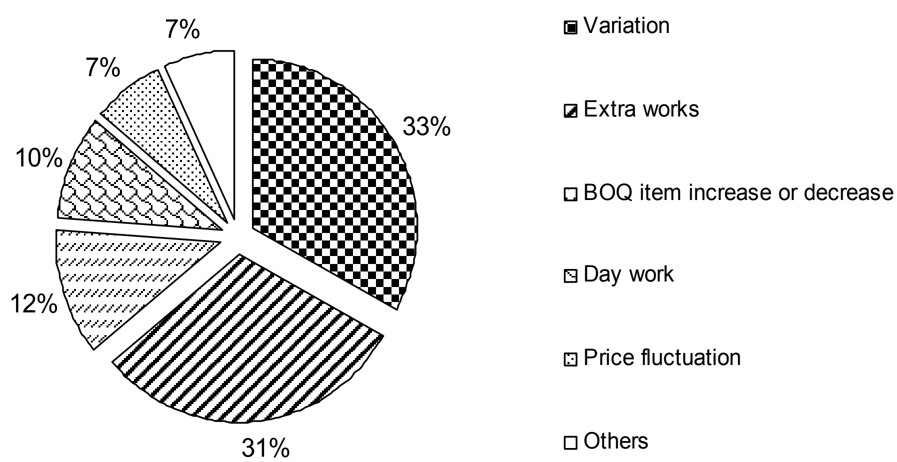

Fig 1: Breakdowns of Cost Overrun

It is clearly seen from the above analysis that the significant cost overruns are mainly due to Variation and Extra work. Thus, the average cost overruns identified in variation and extra work were of 33% and 31% respectively of the total cost overrun. 12% of the total cost overrun is due to the increase or decrease in the value of BOQ items. The day works account for 10%. All the other causes are below 10% of the total cost overrun.

The sources of variations and extra work can be classified into client initiated variations, consultant initiated variations and unforeseeable variations. The main reasons behind the higher percentages in variation and extra work are identified as design changes during the construction stage, improper management, ineffective communication and incorrect assessment of brief. Lack of information about the actual design during the tendering stage and inaccurate quantities of tender BOQ also ultimately lead to variation and extra work. There are instance where the actual quantities of work included in the bills of quantities, may change probably due to bill errors and / or changes in the provisional sum and prime cost sums. The provisional sum inserted in the bill of quantities will only be confirmed when the work is carried out actually. Similarly a prime cost sum which is a sum provided for work or services to be executed by a nominated sub contractor, a statuary authority will be known only at the time of the execution of work. Therefore the amount allocated in the bill will not always be equal to the final value thus will lead to cost overruns. The cost overruns can occur even due to fluctuations which includes both price and currency fluctuations. Day works occur when a need arises to carry out a work that cannot be quantified. In such an instance a daily or an hourly basis rate will be agreed. Other factors which cause cost overruns include claims, termination of contract, compensation etc.

From each case the average cost overrun was calculated against each factor and the mean and standard deviation of each factor were computed. The results are listed in Table 2.

Table 2: Mean and Standard Deviation of Factors

Factors of Cost Overruns	Mean	SD
Variation	5.34	6.62
Extra Works	4.86	2.20
BOQ Item increase or Decrease	1.83	9.74
Day Works	1.56	0.81
Price Fluctuation	1.18	0.93
Others	1.13	2.12

6 SIMULATION COST MODELS

A model is a logical description of how a system performs. A simulation model seeks to duplicate the behaviour of the system under investigation by studying the interactions among its components. It is a powerful tool for analyzing, designing and operating complex systems.

Simulations involve designing a model of a system and carrying out experiments on it as it progresses along time. However a simulation experiment differs from a regular laboratory experiment in that it can be conducted almost totally on the computer. The relationships in the data are able to be gathered in very much the same way as if the real system was being observed. The nature of the simulation, however, allows us much greater flexibility in representing complex systems that are normally difficult to analyse by standard mathematical models. Simulation can, however, be time-consuming particularly where we try to optimize the model (Ashworth, 1999). But one major benefits of a model is that you can begin with a simple approximation of a process and gradually refine the model as your understanding of the process improves. This “step-wise refinement” enables you to achieve good approximations of very complex problems surprisingly quickly. As you add refinements, the model becomes more and more accurate.

The term simulation describes a wealth of varied and useful techniques, all connected with the mimicking of the rules of a model of some kind. Simulation techniques are used extensively in industry. For instance, flight simulators, which are used to train pilots, can introduce all type of hazards to the pilots by simulating the live situation. In construction, the use of simulation has many possible applications such as construction planning, construction estimating, life-cycle costing etc. (Ashworth, 1999) Forecasting of construction cost is a difficult task for estimators as most of the factors involved in pricing are uncertain. Price prediction is not a precise scientific exercise, but an art which involves both intuition and expert judgment. Despite the undoubted desirability of an unbiased price prediction, there exists no objectives test of the probability that a particular forecast will be achieved. Since a price prediction is the sum of many parts, any such objective evaluation of its precision is possible only by the use of statistical techniques. An estimator can use Monte Carlo simulation to solve this problem. The Monte Carlo technique is a commonly used method and is based upon the general idea of using sampling to estimate the desired result. The sampling process requires describing the problem under study by an appropriate probability distribution from which the samples are drawn. The distributions in a simulation exercise are at the centre of the technique, since it is from these that sampling will take place. These distributions can only be determined from data which have been carefully collected over a period of time (Ashworth, 1999)

In this regard this study has used the Monte Carlo technique which identifies the probability distribution of various factors affecting the cost overruns of the building projects. Monte Carlo analysis is from of stochastic simulation. Stochastic or realistic means that the technique concerned is with controlling factors that cannot be estimated with certainty. It is called Monte Carlo because it makes use of random numbers to select outcomes.

7 A STEP BY STEP APPROACH TO MONTE CARLO SIMULATION

The Monte Carlo procedure is now described in more detail. Monte Carlo analysis proceeds by generating a series of simulations of a proposed project, each simulation giving a price prediction for the cost overruns of the project. The predictions are plotted, first as cumulative frequency curve and secondly as a histogram. Visual Basic and MS Excel are used to construct the model. The steps of this analysis are elaborated in detail below:

7.1 Step 1: Developing Probability Distribution for Selected Variables

Firstly the problem should be described under an appropriate probability distribution from which the samples are to be drawn. This is the crucial and most difficult part of the analysis. As the determination of the distribution is very vital the historical data on cost overruns factors have been collected very carefully. The next crucial step is to choose the appropriate probability distribution for the data set collected. The historical data of cost overruns give us measures of centrality (the mean) and dispersion (the variance) which the probability distribution must also exhibit. It is desirable, in addition, if the statistical distribution which was used includes the following two characteristics: the distribution is easily identifiable from a limited set of data, and the distribution is easily updated as additional historical data are introduced to the analysis.

There are various distributions which can be used for this purpose. The more simplistic approaches to Monte Carlo simulation use the uniform distribution, the triangular distribution, or the normal distribution. However, the one set of probability distributions which adequately displays all of these characteristics is known as the beta distribution. The beta distribution has the following equation

$$P(x) = \frac{1}{B(p, q)} \frac{(x-a)^{p-1} (b-x)^{q-1}}{(b-a)^{p+q-1}}$$

Where; P(x) = frequency density function

a = minimum cost overruns

b = maximum cost overruns

p,q = parameters of the distribution; p,q >0

B (p, q) = beta function

Here $B(p, q) = \int x^{p-1} (1-x)^{q-1} dx$ where $0 \leq x \leq 1$, $(a \leq x \leq b)$, and p,q >0

The first point to note is that the appropriate beta distribution is determined completely by the parameters ‘p’, ‘q’, ‘a’ and ‘b’, which themselves are generated easily from the actual data to which the distribution refers. Being ‘a’ and ‘b’ are the lowest and highest values respectively in the data set the values for ‘p’ and ‘q’ are then calculated from the following equations:

$$p = ((\mu_1 - a)^2/(b-a)) \times (1-((\mu_1-a)/(b-a))) \times (\mu_2/(b-a)^2)^{-1} - ((\mu_1-a)/(b-a))$$

$$q = ((\mu_1 - a)/(b-a)) \times (1-((\mu_1-a)/(b-a)))^2 \times (\mu_2/(b-a)^2)^{-1} - (1-(\mu_1-a)/(b-a))$$

Where; μ1 = mean

μ2 = variance

Table 3 shows the actual values of the parameters for each variable that is used to determine the beta distribution.

Table 3: Values of the parameters for cost overrun variables

Variables of Cost Overruns	Mean(μ1)	Variance(μ2)	a	b	p	q
Variation	5.34	43.28	0.54	17.39	0.096	0.241
Extra Works	4.86	28.46	0.20	21.00	0.368	1.275
BOQ Item increase or Decrease	1.83	91.76	0.00	29.57	0.028	0.419
Day Works	1.56	0.64	0.00	3.54	1.686	2.140
Price Fluctuation	1.18	0.84	0.00	4.40	0.945	2.578
Others	1.13	4.51	0.00	6.89	0.073	0.371

As per Table 3 there are six variables that influence the cost overruns in building projects. The values of the parameters ‘a’, ‘b’, ‘p’ and ‘q’ of each variable were applied in the beta distribution formula. Thus the beta distributions were established for all six variables through the following formulae

1. Variation $P(X) = 16.85^{0.663} / ((X-.0.54)^{0.904} \times (17.39 - X)^{0.759}) \times 3.14$ Here, $0.54 \le X \le 17.39$
2. Extra work $P(X) = ((21-.X)^{0.275} / (X-0.2)^{0.632} \times 1 \times 20.8^{0.643}$ Here, $0.20 \le X \le 21.00$
3. BOQ item increase or decrease $P(X) = 29.57^{0.553} / X^{0.972} \times 3.14 \times (29.57-X)^{0.581}$ Here, $-21.21 \le X \le 29.57$
4. Day works $P(X) = 6 \times X^{0.686} \times (3.54-X)^{1.14} / 3.54^{2.862}$ Here, $0 \le X \le 3.54$
5. Price fluctuations $P(X) = 3 \times (4.4-X)^{1.578} / 4.40^{2.523} \times X^{0.055}$ Here, $0 \le X \le 4.40$
6. Others $P(X) = 6.89^{0.556} / (6.89-X)^{0.629} \times 3.14 \times X^{0.927}$ Here, $0 \le X \le 6.89$

Based on the above formulae the data are represented in the form of beta distribution curves as follows where the X axis gives the percentage of each variable and the Y axis gives the cumulative probability.

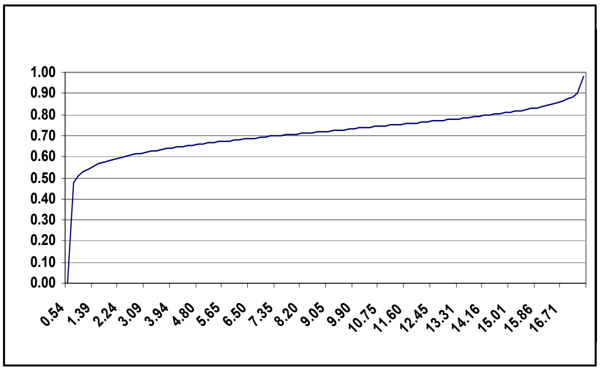

Fig 2: Beta distribution for Variation

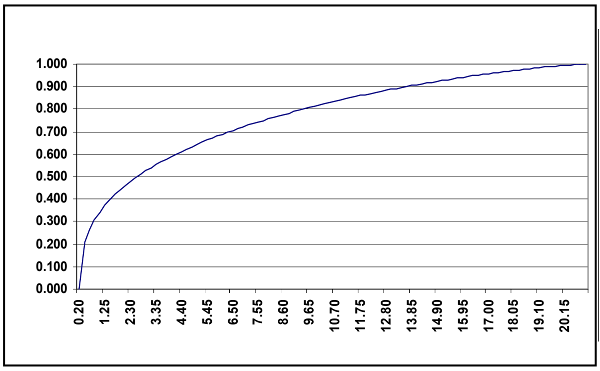

Fig 3: Beta distribution for Extra works

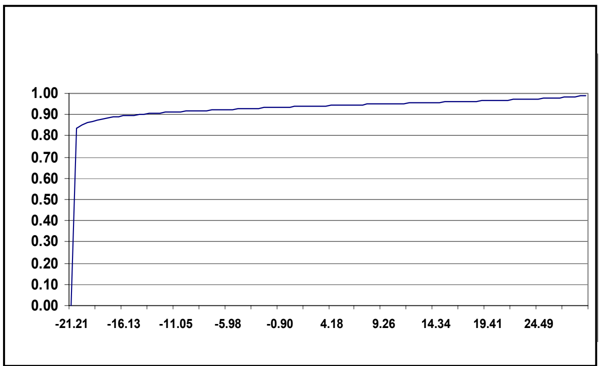

Fig 4: Beta distribution for BOQ item increase/decrease

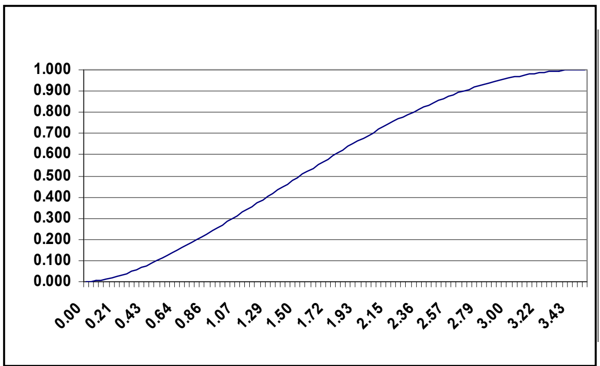

Fig 5: Beta distribution for Day works

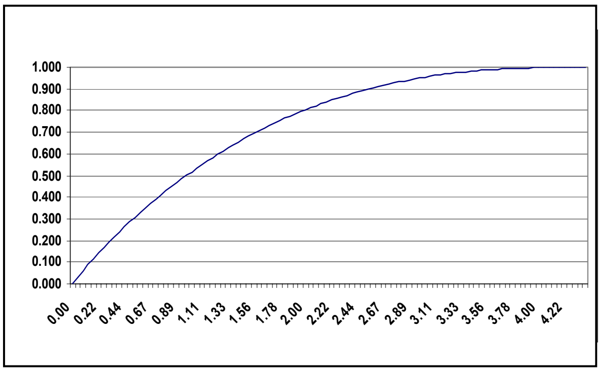

Fig 6: Beta distribution for Price Fluctuation

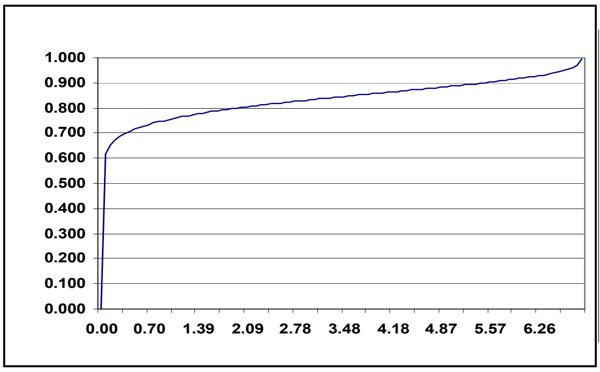

Fig 7: Beta distribution for others

The overall process of Step 1 is illustrated in Fig 8.

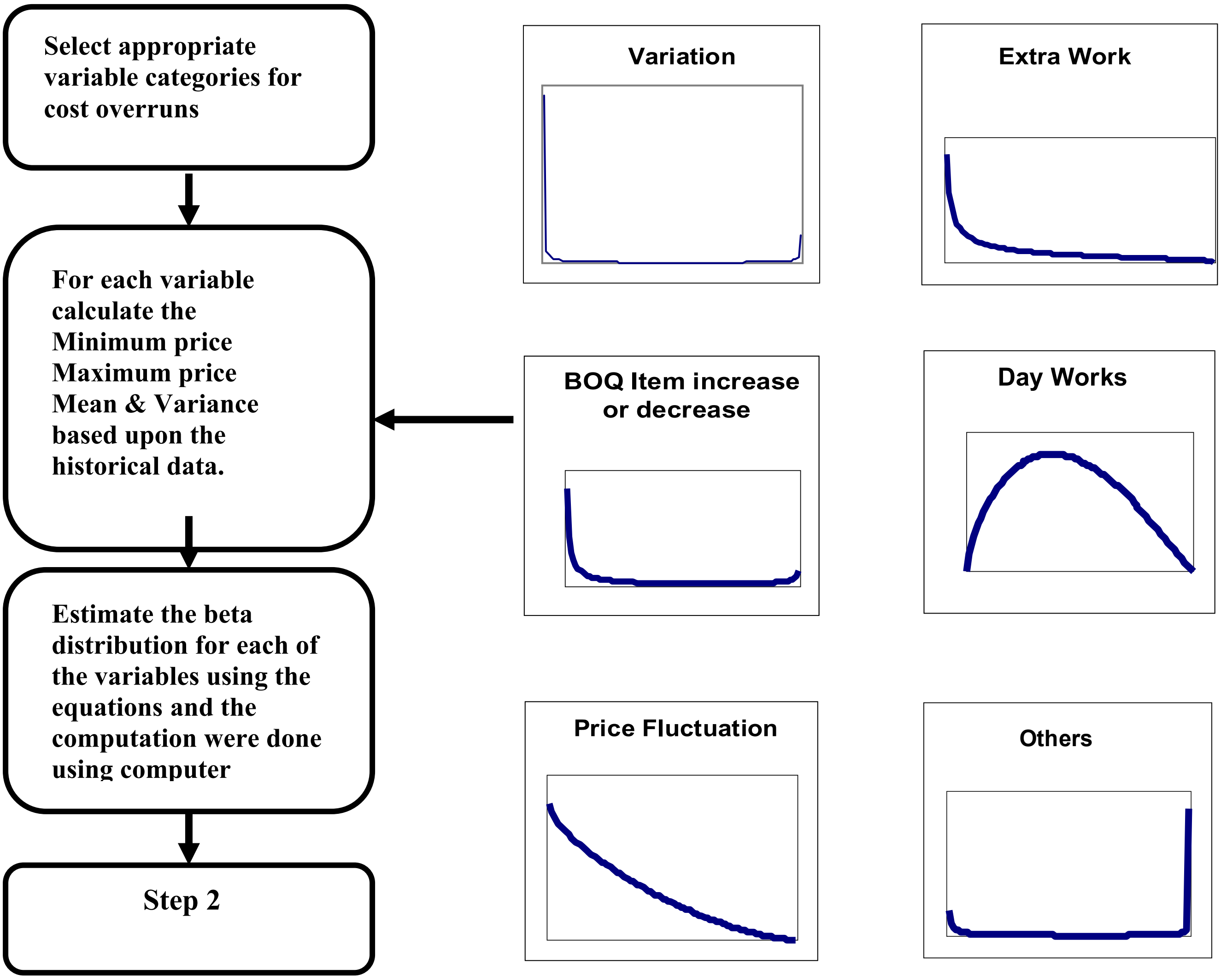

Fig 8: Step 1 of the model development process

Source: Flanagan and Steven (1992)

7.2 Step 2: Sampling based on random numbers

As the next step sampling will take place based on beta distribution for each variable of cost overruns. In simulation models sampling from any probability distribution is based upon the use of random numbers (Ashworth, 1999). Thus it is a simple concept of selecting a random number from the probability distributions developed. Random numbers could be selected in a variety of ways, such as picking a number out of the hat, throwing a die, using a computer etc. In this research the selection of random numbers was easily achieved by using a pseudo random number generator from the computer.

7.3 Step 3: Computation of total cost overruns

The results obtained thorough each variable were added together in order to determine the total cost overruns. The following formula was used to calculate the total cost overruns. All the calculations were done using MS Excel.

Total cost overruns (in %) = V% + Ex% + BOQ % + D % + P % + O %

Where;	V%	-	Percentage of Variation
	Ex%	-	Percentage of Extra work
	BOQ %	-	Percentage of BOQ item increase or decrease
	D %	-	Percentage of Day work
	P %	-	Percentage of Price fluctuation
	O %	-	Percentage of Others

This exercise was repeated 500 times to get the output for every simulation. This process can be understood from Figure 9 where cost overruns were iterated from1, 2, 3, …500 times.

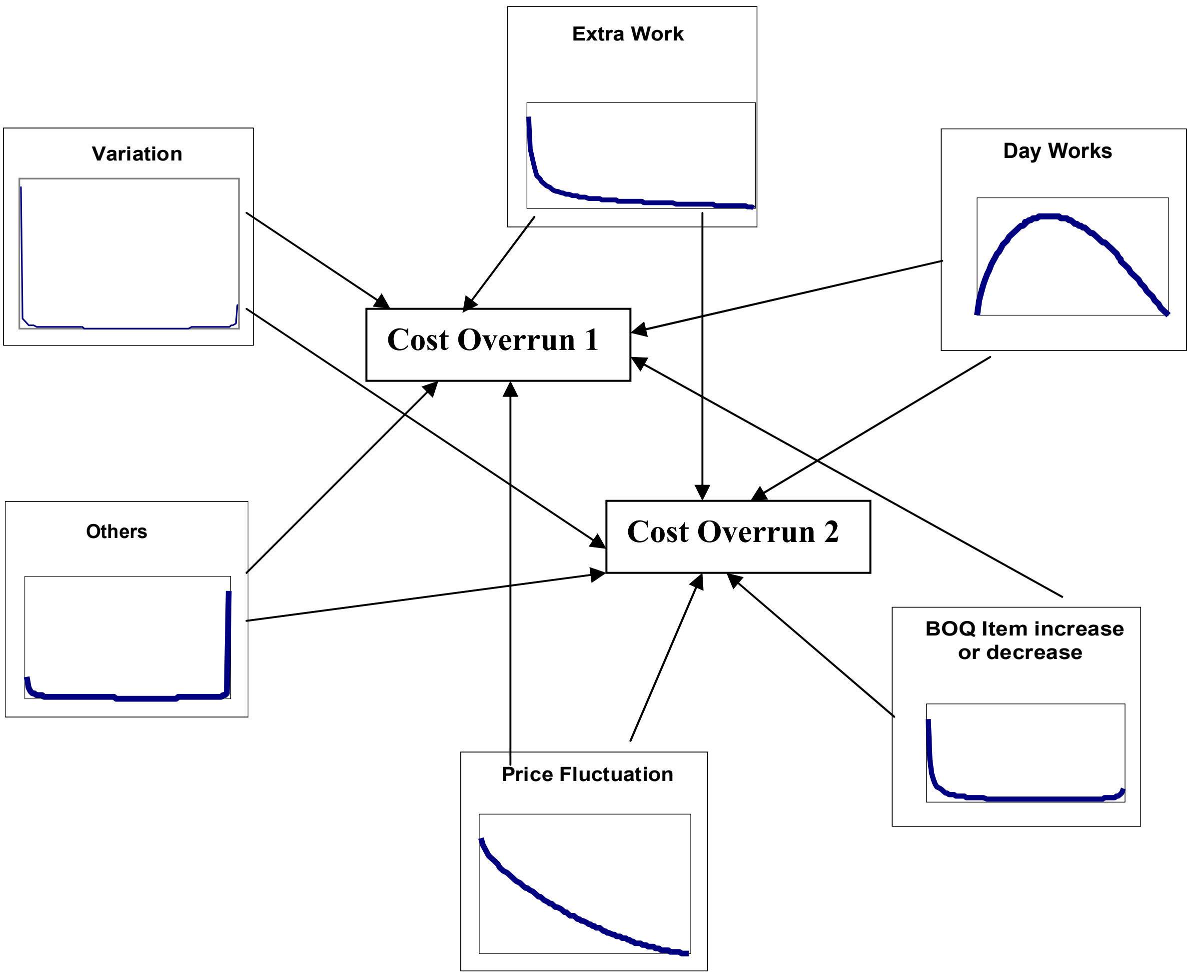

Fig 9: Process of generating cost overrun possibilities

Source: Flanagan and Steven (1992)

7.4 Step 4: Construction of model

Finally the 500 values (i.e estimates) obtained through Step 3 were plotted as a cumulative frequency curve and as a histogram. Here the determination of n (in this research n = 500) is very important in deriving the shape of the probability distribution. A lager value of 'n' is preferable as it would result in a smoother cumulative frequency curve and histogram.. The data were then transferred to a cumulative probability distribution that demonstrates the probable cost overruns as shown in Figure 10.

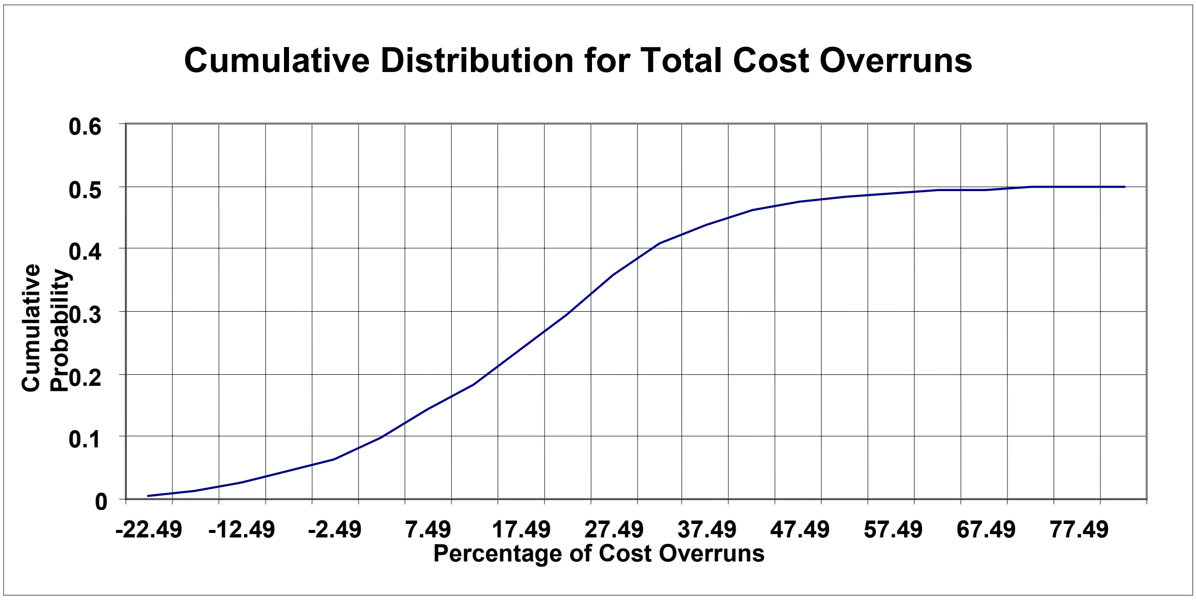

Fig 10: Simulation model for cost overruns in building projects

The histogram in Fig 11 is used to supplement the cumulative frequency curve, since it indicates the most likely cost overrun range for the building projects. From the Histogram it can be seen that the cost overruns for sixty-five building projects out of 500 are expected to be 27.49% of the contract sum. Most of the projects are concentrated in the middle range of the distribution.

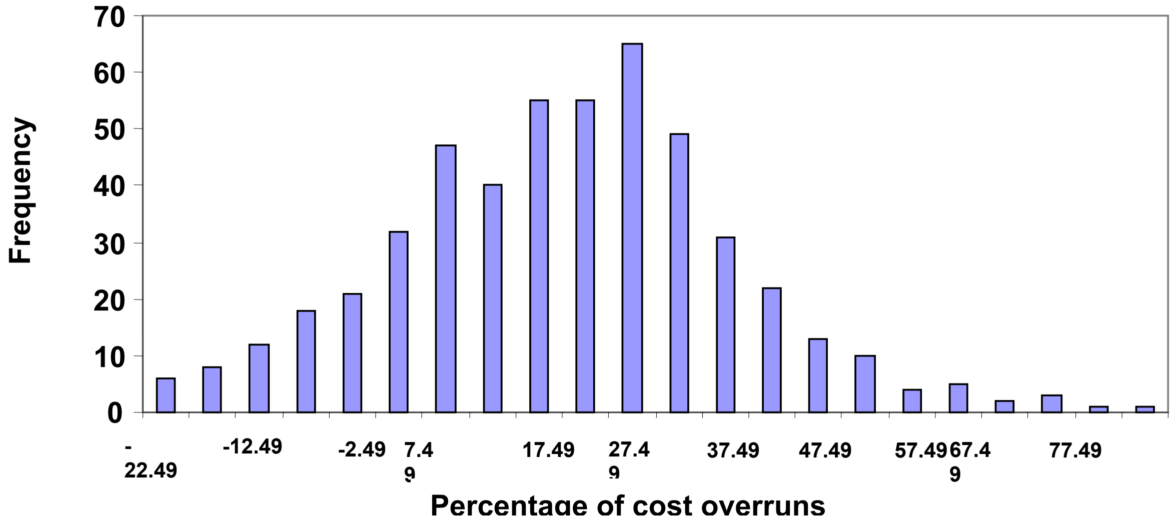

Fig 11 : Histogram for total Cost Overruns

7.5 Limitations of the Model

The probability distributions are derived from limited number of building projects and this is one of the main limitations associated with eh model. For the analysis of cost overruns, number of iteration is taken as five hundred, even though there is a possibility for unlimited iteration.

8 CONCLUSIONS

In the domain of construction, cost overruns from tender Bill of Quantities (BOQ) to final account are common in Sri Lanka in almost every project. Main reason for this is tendering with very limited or inadequate information. In the requirement of design the scope and complexity of the project should be clearly defined, no matter how much changes are subsequently made in the design. However, it should be noted that change is not always a threat, but can be an opportunity to save cost and make the client's money more valuable when it is managed effectively. The aim of this study is to identify and analyse cost overruns in building projects in the Sri Lankan construction industry. The factors affecting the cost overruns were identified and quantified. Probability distribution was established for each factor identified. The simulation model was developed to quantify the cost overruns.

It was found from the study that significant cost overruns are mainly due to variation and extra work. Thus, the average cost overruns identified in variation and extra work were of 33% and 31% respectively of the total cost overrun. The reasons for these results could be mainly attributed to the design changes during construction stage, improper management and ineffective communication. Lack of information about the actual design during the tendering stage and inaccurate quantities of tender BOQ also ultimately lead to cost overruns. 12% of the total cost overrun is due to increase or decrease in the value of BOQ items. The day works account for 10%. All the other causes are below 10% of the total cost overrun.

This research has developed a computer based simulation model to carry out construction cost overruns in building projects. The simulation model has been developed in visual basic on the Monte Carlo analysis. The calculations of the model are adhered to the cost overruns factors identified in the research. The model simulates possibilities of cost overruns represented in terms of probability distribution where the probability distribution was objectively derived from the past records collected through detail survey. Figure 2 shows the cumulative probability of cost overruns.

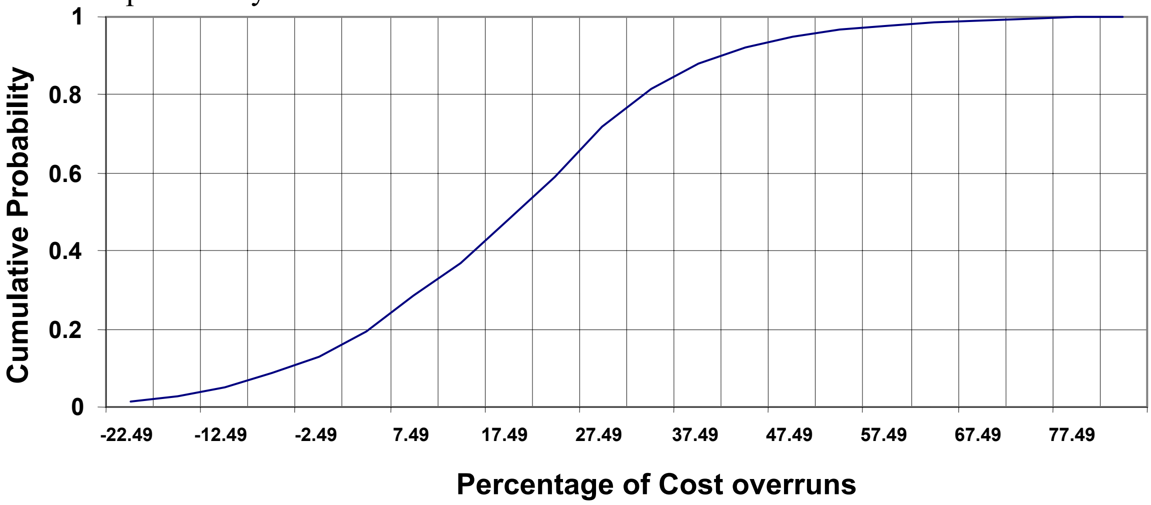

Figure 12 Simulation model for cost overruns

According to this model the cost overrun is less than 42.49% of the contract sum in 90% of the building projects. Only a very few projects are above 67.49%. This model provides the client with a range of possible cost overruns and their probability occurrences. Based on the outcome of this model an effective decision making can be done by the contractor using the information appropriately. This simulation model not only assists contractor in decision making but also provides contractor with an appropriate frame work for managing of and responding to cost overruns.

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Appendix 1: Details of the Projects that were taken into analysis

Project Name	ICTAD Grade	Type of Contract	Type of building	Contract sum (Rs Million)	Final A/C Sum (Rs Million)	Total Cost Overruns (%)
P1	M1	MP	R	21.28	24.35	14.47
P2	M3	MP	C	12.47	18.71	50.20
P3	M3	MP	R	5.63	7.94	41.04
P4	M2	MP	C	19.19	24.41	51.69
P5	M3	MP	C	15.38	17.12	11.18
P6	M1	MP	C	108.3	114.62	6.44
P7	M1	MP	O	52.27	60.33	14.16
P8	M1	MP	C	148.78	205.34	38.00
P9	M1	DB	C	15.80	19.67	24.30
P10	M1	MP	C	23.45	25.75	9.77
P11	M1	DB	O	19.06	19.83	3.99
P12	M1	MP	C	15.00	14.57	1.87
P13	M2	MP	C	9.76	10.88	11.99
P14	M1	MP	C	19.05	19.43	1.94
P15	M2	MP	O	8.41	12.83	52.44
P16	M2	MP	C	10.09	11.84	17.15
P17	M2	MP	R	12.73	11.73	-7.93
P18	M1	MP	C	63.60	58.39	-8.19
P19	M2	MP	R	5.96	6.80	13.93
P20	M2	MP	C	8.21	10.39	26.55
P21	M1	MP	C	51.62	61.83	19.84
P22	M2	MP	O	300.54	310.54	3.47
P23	M1	LS	O	119.58	126.05	7.92
P24	M1	MP	R	11.30	12.00	6.11
P25	M1	DB	C	20.00	22.00	24.75
P26	M1	LS	O	28.50	37.50	31.58
P27	M1	MP	C	9.60	10.19	6.15
P28	M2	MP	C	32.17	33.51	4.13
P29	M3	MP	C	13.15	13.72	4.41
P30	M1	MP	O	36.90	34.42	-6.72

THE REASONS FOR SHORTAGES IN HOUSING IN LIBYA

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ABSTRCT: Since the oil has been discovered and exported in the beginning of 1960s, Libya took more care of housing sector. In the 1970s housing sector saw a wide boom, even the supply of houses became more than the demand in this period. But in the beginning of 1980s housing crisis appeared in Libya and continued until this time.
There are numerous reasons behind the housing shortage, some of them are internal, and others are external. The internal reasons comprise; great targets had adopted while the authority could not achieve them, the unstable administrative system, low experience levels of local companies, decreased financial resources and the general targets were vacillated. On the other hand, the external reasons can be summarized in; the UN and USA sanction which led to a decrease in oil export revenues, which resulted in financial resources decrease, and foreign companies boycott of Libya.
This paper is an attempt to spotlight on the reasons of shortage in housing in Libya, and it is a part of PhD study entitled "How Attract FDI to Invest in Housing in Libya"

Key words: Housing, Libya, Reasons, Shortage.

1 INTRODUCTION

Researchers in the housing sector in the Libyan economy know well the fact that despite the lack in the number of houses before 1970s, housing shortage problem was not appearing. In the early 1970s the housing sector has seen a great boom after oil has been discovered and exported in the beginning of the 1960s, so the poverty ghost disappeared from the Libyan economy. Indeed, both of public sector and private sector condensed their forces in huge participation to built hundreds of thousands of housing units.

Libya after its independence until 1961 was one of the poorest countries in the world, and it accepted aid from foreign countries and organisations. Then Libya became one of the wealthiest countries as a result of huge oil exports revenues. This prosperity enabled the country to put and implement development plans. Housing sector acquired considerable care especially after September 1969 revolution; while the revolutionaries tried to gain public support when they tried to solve the problems that touched people's life directly.

Most of the development plans give a special care to the housing sector; where by criticism arose to planners because of their ambitious targets which they could not achieve them in many occasions. According to statistical numbers which was published in a bulletin of General People's Committee of Planning, Economic and Trade in 1997, the amount which allocated to housing sector in the development plans in the period 1962 – 1969 was 109.3 million Libyan pounds (Libyan currency changed from pounds to Libyan dinars after the revolution), while the real expenditure in housing sector in the same period was 165.8 with a percentage of actual to allocated funds was 151.6%, the bulletin illustrate the allocated amount to housing sector in development plans in the phase 1970 - 1996 was 3686.6 million LD, the actual expenditure was 3009.6 million LD, with a percentage of 81.6%.

Previous data manifest the actual expenditure ratio in the development plans to allocated amount in 1962 -1969 higher than that one in 1970 -1996 despite of the amount was less in the first period.

2 VERIFICATION OF HOUSING SHORTAGE EXISTANCE

When you survey the related data to the housing it will be noted that the shortage appeared twice; the first in the 1960s in particular in the end of this period, whereas the shortage in 1969 was 185000 units 120000 of them were unsuitable for residence and needed to be replaced with new dwellings (General Council for Planning, 2002:7). The second shortage appeared in the beginning of the 1980s which will be the focus of this paper.

The shortage which still affects the society till this time, according to table (1) appeared since 1982 when the effects of law No: 4 for year 1978 appeared to form a problem, where the housing supply were less than the demand.

Table 1. Demand and supply amounts from housing units 1973 – 1995

Year	Supply of residential units	Demand of residential units	Difference
1973	404317	387043	17274
1974	414767	405448	9319
1975	426682	417206	9476
1976	433582	429305	4277
1977	447130	441755	5375
1978	464065	454566	9499
1979	476815	467749	9066
1980	489565	481314	8251
1981	498890	495272	3618
1982	504790	509634	-4844
1983	510128	524414	-14286
1984	515465	554174	-38709

Year	Supply of residential units	Demand of residential units	Difference
1985	543512	557136	-13624
1986	548412	573293	-24881
1987	553312	589919	-36607
1988	563708	607027	-43319
1989	582423	624630	-42207
1990	600412	642745	-42333
1991	603964	661385	-57421
1992	609467	680566	-71099
1993	640550	700302	-59752
1994	673218	720611	-47393
1995	708188	727523	-19335

Source: Shamiah A. & Kaebah M 1996, population growth and its impact on the housing market in the Libya economy.

As shown in the previous table, despite in the period from 1973 to 1981, the abundance in housing decreased yearly, where the surplus was 17274 units in 1973 became 3618 units in 1981. Also it can be noted the shortage trend increased rapidly from 1982 to 1995 except some years. The shortage reached the peak in 1992 where the shortage was 71099 units. In spite of several attempts from the authorities to rein in the shortage, but it still continued.

Housing in Libya is classified to sixteen kinds as in table (2), public housing come in the fist grade with a percentage of 25% of executed dwellings in the period 1970 – 1996, then houses by loans and mortgages from commercial banks and co-operatives are in the second grade with 21.2% from total executed dwellings, private financial houses come next with 21% of executed units, after that houses by loans from Saving and Real Estate investment Bank with 16.5%, the rest together constitute about 17%.

However, inasmuch the government possess the lion share in commercial banks, it can be said that the government sustained the large burden of the housing sector directly by building houses and allocating them, or indirectly by steering commercial banks to give loans for residential purposes, by that the government's participation was about 62.7% of executed houses in this period.

Table 2. Number of Completed dwelling units 1970 – 1996

Kind of Residence	Number of executed units	%
1- Public Housing	95567	25
2- Agriculture housing	13827	3.6
3- General public projects houses	3521	0.9
4- New cities and villages	6319	1.6
5- Residential city Albriga	3056	0.8
6- Residential city Ras-lanof	1510	0.4
7- Administrative centre houses Sert and aljefrah	4198	1.4
8- Houses of middle area valleys	531	0.1
9- Saving and Real Estate investment Bank houses	2737	0.7
10- Houses of national secretariat of residential investment	8500	2.2
11- Social assurance housing	8980	2.3
12- Housing of Libya insurance company	1335	0.3
13- Housing of national investments company	7776	2.0
14-Houses by loans from Saving and Real Estate investment Bank	63250	16.5
15- Houses by loans from commercial banks & co-operative	81194	21.2
16- Private financial houses	80329	21.0
Total	382450	100

Source: General Secretariat of Planning, Economic and commerce, Executed of national economy during twenty seven years, 1996.

As it can be noted, that private investment companies in housing sector were absent because of the establishment of some legislations which prevent leasing when the country adopted the socialism ideology, as a result of this legislations which led to the investors withdrawing from the housing sector.

3 REASONS OF THE SHORTAGE

Libya has faced difficult circumstances in the last three decades which caused many economic and social problems; the housing crisis is linked to these problems. There are a number of reasons behind this shortage in housing, some of them internal and others are external;

3.1 Internal Reasons:

These reasons comprise the following;

3.1.1 Adopting Overambitious Targets

As a result of abundant oil revenues, Libya was released from its debts and started to be self sufficient, so it became able to start developmental projects in various economic fields. Thereby an enormous amount of money has been allocated for development plans in particular in the housing sector. Table (3) illustrates the allocated amounts compared with actual expenditure amounts in these development plans in the housing sector in the period 1970 - 1996.

Table 3. Allotted amount and Actual expenditure in development plans in housing sector in the period 1970 - 1996

year	Allotted amount (AA)	Actual expenditure (AE)	% AE to AA
1970	32.8	37.5	114.3%
1971	39.9	39.4	98.7%
1972	72.9	72.2	99.0%
1973	76.9	60.9	79.1%
1974	148.2	146.9	99.1%
1975	142.7	128.3	89.9%
1976	150.5	138.3	91.8%
1977	185.0	175.1	94.6%
1978	231.0	152.7	66.1%
1979	166.0	167.8	101.0%
1980	231.7	224.0	96.6%
1981	288.2	294.6	102.2%
1982	245.6	237.0	96.4%
1983	217.6	221.3	101.7%
1984	208.2	184.0	88.3%
1985	168.6	143.6	85.1%
1986	167.5	126.6	75.5%
1987	142.0	58.8	41.4%
1988	138.8	77.3	55.6%
1989	91.8	97.6	106.3%
1990	100.0	86.9	86.9%
1991	289.7	49.8	17.1%
1992	70.0	19.1	27.2%
1993	==	==	==
1994	70.0	12.6	18.0%
1995	3.0	14.7	490%
1996	8.0	42.6	532.5%

Source: General People's Secretariat of Planning, Economic and commerce (1997), The National Accounts 1980 – 1996 , PP 21 – 28.

One can recognise that there was a rapid increase in the allocated amount in development plans in the housing sector in the period 1970 - 1981, in addition to that the actual expenditure was more than the allocated amount in some years for example actual expenditure ratio to allocated amount was 114.3% in 1970 and 102.2% in 1981.

Allocated amounts for the housing development plans started decreasing from 1982 when Libya cut back expenditure after the USA sanctions in 1982 because of the Lockerbie incident, whereas allocated amounts decreased to arrive at 9.8 million Libyan Dinars in 1989, as well the actual expenditure dropped, for instance it was 41.4% in 1987. After that the decreasing in allocated amounts for housing has continued where 70 million Libyan Dinars was fixed in 1994, and the real expenditure percentage was 18%, then a decrease happened sharply in 1995 and 1996 where the allocated funds were only 3 million LD and 8 million LD on respectively .

Since year 1982 the actual expenditure started decline irregularly. Where, the actual expenditure ratio dropped to 17.1% in 1991 and 18% in 1994, this decrease in actual expenditure verify that the housing projects in development plans need to be prearranged more than the authorities financial ability.

3.1.2 Administrative System Instability

From the 2nd of March 1977 Libya adopted a socialism regime, which resulted in a lot of changes in the Libyan government administration. Both high level (decisions makers) and low level (decisions implementers) has been changed several times often in convergent periods. Merging some of General Peoples' Committees (ministries) some times, even the abolishment in other times. According to the new regime the General Peoples' Committee for housing has been established on 2nd March 1977, subsequently it merged with the General Peoples' Committee for Utilities named the General Peoples' Committee for Housing and Utilities on 3rd March 1982. Next change was the abolishment of the General Peoples' Committee for Housing on 7th October 1990, then the General Peoples' Committee for Housing has established again on 29th January 1996, once again General Peoples' Committee for Housing was abolished and it became a subordinate of the Assistant Secretary for Services Affairs - General Peoples' Committee 2001, then became independent administration headed by the General Auditor which is a subordinate of the General Peoples' Committee in 2002 (General Peoples' Committee, 2005). On the other hand, changes in low levels are more rapid than high levels some times where change happens every year or less.

The merger and separation of provinces (administrative districts) was one of significant causes which resulted in administrative instability, as a result of this instability the national and local public housing projects contracts were confused, in the same time contractors could not carryout their commitments an were undermined in their rights, which made them unable to accomplishment their contractual commitments. Administrative instability has been considered one of most significant causes which led to the decline in development levels in the Libyan economy (Al-Megharbi. M, 1993)

3.1.3 Population Increasing

After the oil heyday, Libya population has seen high growth level, whereas it reached 4.3% in 1972 (Lahmeyer, 2003). As in Figure (1) the families' numbers rose from 387043 families in 1973 to 727523 families in 1995 (Shamiah A. & Kaebah M, 1996), however numerous people postponed their marriage plans until acquiring a house. This increase in families' number resulted in the increase of housing demand, where the housing supply did not accompany demand.

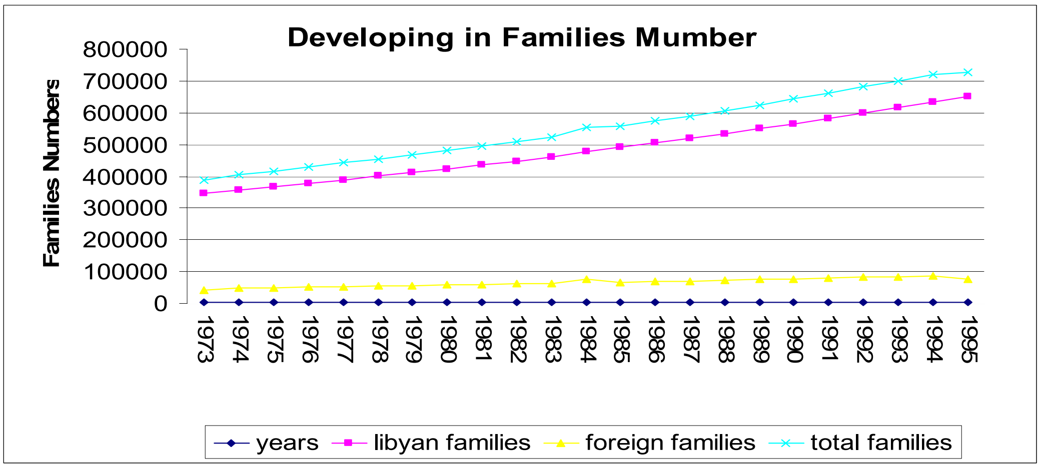

Figure (1) Developing in families' number during 1973 -1995

3.1.4 Local Contractors' Experience Inadequacy

According to the policy trend of contracting local national contractors in executing and sometimes investing in the Libyan housing sector it became apparent that most of the local contractors suffered experience weaknesses in executing large scale housing projects. As a result of the deterioration of the contracting apparatus and in spite of attempts to re-organisation many times it became even harder to satisfy the stringent demand in this sector. Absence of local qualified manpower and skilled labour in the construction sector led to near total dependence on foreign companies and labour (General Council of Planning, 2002). The most significant cause for the decline of implementation levels is that the government did not complete its contractual commitment with contractors in augments about hard currency payments, and delays in payments instalments (General Board for Housing, 2003).

3.1.5 Establishment Legislations That Prevent Leasing

When Libya adopted the socialism regime which prevented the ownership for leasing purposes "*…No one has the right to build a house, additional to his own and that of his heirs, for the purpose of renting it, because the house represents another person's need, and building it for the purpose of rent is an attempt to have* .." (Muammar Al Qathafi, 1975:16), consequence legislation that prevents leasing has been established. One of most important laws is Act no: 4 for year 1978 which prevented leases. As a result of these laws which prevent activities for profit purposes and stopped housing rent and prevented the private sector to build houses for leases purposes.

3.1.6 Decrease in Financial Resources

To finance the housing sector three ways has been adopted in Libya; first of all financing by government, where it was part of the planning budgets allocated especially in the early years because of ample oil revenue and government's desire to reform the internal situations. Because of oil price drop from $35.69/barrel in 1981 to $11.21/barrel in 1998 (BP, 2005), in addition to other political issues which caused the decline in exported oil quantities and therefore revenues. This affected development budget negatively, and led to decrease the financing ability. Next kind of financing, was by loaning and mortgages from commercial banks but it suffered procedures complication and restricted laws, where it became inefficient. Third direction was dependent on individuals savings in the society, however, the majority of public employees' monthly income are low, where 95.7% of them gain less than 500 LD, and 85% less than 300 LD (General Board of Information, 2002:51), this low levels of income are not enough to get essential goods for the majority in comparison with incomes levels in the UK where £ 1 = 2.367 LD (Central bank of Libya, 2005).

3.1.7 Vacillating Public Targets

The crucial feature in the beginning of the period 1970 - 1995 was the government's total service provision to all people, these services included housing. Therefore, huge amount of development budgets has been allocated to the housing sector. As a result of economic and political events in the first half of 1980s which led to the decrease in devoted amounts for the housing sector as previously mentioned, which resulted in changing targets and priorities.

From another angle, the political problems that Libya had been involved in, led to the expenditure of resounding amounts of money to rectify old mistakes (Libya paid $2.7 Billion for the USA and UK to resolve the Lockerbie issue.)

3.1.8 Lack of Adequacy in Urban Planning

According to a study on housing policies prepared by the General Council for Planning No: (23) for year 2002, that pointed to the shortage causes in housing was the lack of contemporary urban planning. Whereas the current plans end in year 2000 (General Council for Planning, 2002), yet, the exerted efforts to prepare new urban plans still suffered a lot of complications, hence, the lands' prices increased rapidly and sharply.

3.1.9 Changing in the Residential Behaviour of the population

The period before oil discovered in the end of 1950s, most of Libyans dwell in cottages and tents in steppes, the period 1960 - 1970 people started moving to live in cities looking for better jobs as a result of the oil boom. This period was characterised by the appearance of inhabitant gatherings in cities outskirts. And most houses were occupied by more than to two families in most times as cited by census of 1964, also most families were in rented dwellings. Since 1970, housing behaviour for inhabitants changed while the families stop sharing houses as result of housing sector boom, and Libyans were affected by new cultures and trends, as a result of this consumption behaviour effects, housing changed, this led to the increase in demand on housing, this increase through time brought about shortage in housing which was not accompanied by supply.

3.2 External Reasons

These reasons could be divided into;

3.2.1 Economic Sanction Effects

Libya has faced sanctions because of political issues; the USA hurried to impose sanctions on Libya in 1982, and continues, despite attempts of US business groups, led by oil companies that hold concessions in Libya to persuade the administration of President George W. Bush to ease a trade ban that was imposed on Libya in 1986. Thereupon the UN Security Council imposed sanctions on Libya in 1992 to press Tripoli to hand over two suspects wanted for the 1988 bombing of a US Pan American Airways airliner over Lockerbie, Scotland. These sanctions put Libya in hard circumstances, and this led to economic shrinkage in all economy sectors and development receding. This harmful economic situation affected the housing sector, similar to the rest of economy.

3.2.2 Foreign Companies Boycott

Many foreign companies boycotted Libya, obedience to the UN decision No: 748 for year 1992 and decision No: 883 for year 1993 which put Libya under sanctions. Departure of these companies led to stops and delays in many projects whereby the housing sector has been affected. Lack of hard currency and payment delays also led to the withdrawal of many other multinational companies; as a result completion dates were delayed extensively (Benkrima 2001 and El-hasia 2005). For instance according to decision of Secretary of General People's Committee of Housing and Utilities No: 191 for year 2000, seventeen companies withdrew from housing projects by mutual agreement most of them Turkish companies (General Board for Housing, 2003: 43-46).

3.2.3 Decrease in Oil Revenues

The effects of decrease of oil revenues started appearing after the USA administration imposed sanctions on Libya in 1982, thereby, coerced US companies to stop dealing with the Libyan oil sector in particular. As a consequence, the cost of production in oil sector increased and oil revenues declined (Alavi, 2003). The UN decisions in early of 1990s made the situation worse, additionally oil prices fluctuation participated creating instability in the economy and made development plans establishment more difficult. Based upon the disturbances that dominated the oil sector which affected all economy sectors including the housing sector, devoted funds for the housing sector has decreased.

4 CONCLUSION

This paper discussed the main reasons of the shortage in the Libyan housing sector by reviewing the official data and government perception of the problem. This was accompanied by the author's analysis of the facts and probable effects in a general fashion.

Both internal and external reasons interrelation and effect on each other in many times, played a role in the shortage in the housing sector indirectly, as it has mention above the external reasons played crucial role where the sanction led to harmful effects affected the oil sector which consider leader sector in Libyan economy, one can not ignore as well the importance of foreign companies boycotted Libya, which led to stopping housing projects. the internal causes played more significant role, whereas adopting overambitious targets without consider to the local capability led to confuse development plans, the administrative system instability was a cause of confusing the implementation of housing projects as well, and establishment legislations that prevent leasing played significant role which made the private sector escape from housing sector. However, the internal issues could be resolved internally, because the decision is between the authorities' hands, but decisions were taken without the sufficient studying. Because of administrative instability which affects the other reasons by various shapes, most of internal reasons were related to administrative instability and weakness in planning.

This kind of work is paramount, because it considers first steps to treat the shortage problem in the housing, by quantifying the size of the problem and attempting to present credible causes, whereby one could not give right prescriptions if causes of problem are not explicit.

Finally it is important to recognise that in order to tackle this problem head-on, internal and external efforts should be integrated to overtake this deteriorated situation. This paper will be part of a PhD research entitled, "How to Attract FDI to Invest in Housing in Libya?"

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ISSUES CONCERNING HOUSING FOR THE ELDERLY IN MALAYSIA

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ABSTRACT: Malaysia has laid down its social and housing policies in its Development Plans since the Colonial Administration and Pre Independence period (1950-1954) until the latest Eight Malaysian Plan (2001-2005). In general, the delivery of social service in Malaysia has been divided into two main categories consisting of housing and other social services such as local authorities, fire & rescue services, sports, culture, library services, information and broadcasting, and community and family development. The needs of the elderly in housing seem to lack attention in the housing programmes of Malaysia. The separation between housing and home for the elderly under the different social programmes has contributed many issues regarding 'adequate shelter' for the elderly in Malaysia. This paper seeks to identify the issues concerning housing for the elderly in Malaysia from both of the social policy programmes in Malaysia. This paper presents the justifications leading to the PhD research project which is titled of Opportunities for the Transfer of Best United Kingdom (UK) Practices to the Provision of Homes for the Elderly in Malaysia.

Keywords – Homes for the Elderly, Elderly, Issues

1. INTRODUCTION

As one of the developing countries, Malaysia is still backward in terms of the provision of homes for the elderly as compared to the UK. Also, the separation between housing programmes and social programmes contribute to various issues regarding the need of the elderly to be housed efficiently. Fortunately, in the recent years, the awareness for adequate housing and appropriate homes for the elderly has been taken into account in many discussions and forums in Malaysia. Faced with such problems, the issues on adequate shelter for the elderly in Malaysia need to be understood and identified in line of the culture which exists in Malaysia. Therefore, this paper seeks to identify the issues concerning housing for the elderly in Malaysia from both of the social policy programmes in Malaysia. This paper also presents the justifications which will lead to the PhD research project which is titled *Opportunities for the Transfer of Best United Kingdom (UK) Practices to the Provision of Homes for the Elderly in Malaysia.*

2. WHO ARE THE ELDERLY?

As the beginning of *older age* is not precisely defined, this makes comparisons between studies and between countries difficult (Krug et *al.,* 2002, Ohara, 2004). In Western societies, the start of old age is usually considered to be coinciding with the age of retirement, which is from 60 to 65 years of age (WHO, 2005). In accordance to the United Nations World Assembly on Ageing held in Vienna in 1982, in which the age of 60 years and above was adopted for deliberating issues on ageing, Malaysia has also adopted this age range in formulating and implementing plans for its senior citizens with the present age of 55 years of age (Phillip and Chan, 2002). According to Campbell (1999), if we equate old age with exit from economic activity we find that, although average life expectancy has increased, the average of exit from the labour market has continued to fall. Appleton (2002) expressed that an average old age may, stretch from the early fifties into the eighties and beyond. However, if we take functional capacity (the ability to move around freely and to live independently) as the threshold, which is the entitlement for a person who is 65 years of age in the UK, it is still inadequate. Krug et *al,*. (2002) believed that old age is regarded as that time of life when people, because of physical decline, can no longer carry out their family or work roles. As elderly people are not a homogeneous population when it comes to their age ranges, the circumstances of individuals are enormously varied (Appleton, 2002). Hence, for the purpose of this research the author regards being 60 years of age and above as old age.

3. PROVISION OF HOMES FOR THE ELDERLY IN MALAYSIA

The provision of homes for the elderly in Malaysia is not considered as part of the housing programme. It has been separated and considered as a different social policy programme under the community and family development allocation. With regards to this, in the context of governance, a formal and informal housing provision in Malaysia is managed by the Ministry of Housing and Local Government (MHLG), whereas the provision of homes for the elderly is managed by the Ministry of Women, Family and Community Development (MWFCD). In the social services programme, the community and family development division is managing by MWFCD (Ministry of Women, Family and Community Development, 2006). At the state level the management of elderly people in Malaysia is organised by the Department of Social Welfare (DSW). The homes for the elderly in Malaysia are provided by three main parties. They are the government or public sector provider known as DSW, the non governmental organisations (NGOs) which respond to the needs of older people as well as to the encouragement by the government and the third provider is the private sector, which is motivated by profit and for which the ability to pay applies. **Figure 1** below shows the provision of homes for the elderly in Malaysia.

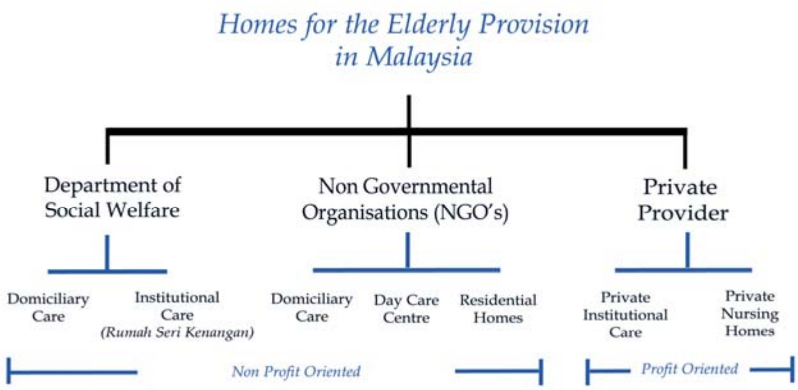


Figure 1: Homes for the Elderly Provision in Malaysia

In Malaysia, the provision of homes for the elderly is regulated under the Care Standard Act 1993 (Reprint 2002). Under Section 2, this act has defined *home for the elderly* as *a residential care centre and a day care centre.* In depth, subject to Section 3, the act defines a *day care centre* as *any premises at which four or more persons are received for care for a continuous period exceeding three hours between the hours of sunrise and sunset in a day,* *and for at least three days in a week, whether for reward or otherwise; but in the case of a premises operated or managed by a natural person, a person who is a relative of that person shall not be reckoned in determining the number of persons received at the premises for the purposes of this definition.* In Malaysia, the official definition of *vulnerable people* has been formatted recently. The elderly are considered to be as part of the vulnerable people in the context of housing in Malaysia. This definition has been defined by the Human Rights Commission of Malaysia (*Suruhanjaya Hak Asasi Manusia*-SUHAKAM). SUHAKAM is a very active NGO which is concerned about the needs of the elderly to be housed. In 2003, SUHAKAM officially defined *vulnerable people* as *the urban and rural poor, single mothers, the elderly, people suffering from mental illness and indigenous people* (SUHAKAM, 2003). Before this, in the context of housing, the definition of *vulnerable people* was never specifically mentioned. SUHAKAM believes that there is also a need to increase the level of accessibility to basic support for the vulnerable people in Malaysia (SUHAKAM, 2003). Under the provision of the Care Centre act 1993, a resident in the care centre has been defined as *a person who has been received for care as a resident at the residential care centre.*

4. ISSUES CONCERNING HOMES FOR THE ELDERLY IN MALAYSIA

Creswell (2003) stated a *research problem* is the issue that exists in the literature, in theory, or in practice that leads to a need for the study. A research problem might emerge from experiences researchers have had in their personal lives or workplaces, it could come from an extensive debate that has appeared in the literature for several years, develop from policy debates in government or top executives. Research problem is already complex but researcher need to read further and to begin to see significance in the study (Creswell, 2003). Based on this statement, the justifications for undertaking a research on transferring best practice process are as follows:

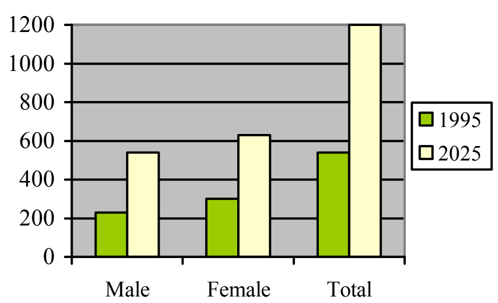
4.1 Lack of Standardisation and Best Practices Guidance

Without proper standard and good practice guidelines, it is easier for malpractices to occur than best practices to be implemented. A *standard* is *a recognised document that defines good practice. Its can be applied to products, services and processes* (British Standard Institute, 2005). Damelio (1995) defined a practice as *a method or technique used to perform a process step. Practices describe how we perform a step within a work process* and *best practices* are *those methods or techniques that result in increased customer satisfaction when incorporated into your operation.* However, until now, there is no single definition of *best practice* because best is not best for everyone, what is meant by *best* are *those practice that have been shown to produce superior results; selected by a systematic process; and judged as exemplary, good, or successfully demonstrated* (Jarar and Zairi, 2000). By providing best practice guidance, standards help organization to assess their processes, allowing them to take steps to increase efficiency and become more profitable. This is because the quality of goods, services, and processes might already be high, but ultimate users only have your word for it. Organisations are not legally obliged to introduce standards. And while there are other options, compliance with standards is a convenient and reliable way of ensuring that the goods, services, and processes meet its regulatory obligations (British Standard Institute, 2005). It has been mentioned that UK is far ahead in terms of the provision of homes for the elderly. As Malaysia does not have social housing provision in its housing programmes, homes for the elderly would be the alternative choice for the elderly to be housed in. Various types of homes for the elderly have been developed in Malaysia since the 1950s as in the **Figure 1**. Unfortunately, until now, only one act has been enforced known as Care Centres Act 1993 to ensure that a certain standard of care and service is provided to the elderly. In particular, there is no *formal standard (publicly available, published documents that are established by a broad consensus of industrial experts and representatives of government; business; research, test and certification organization; academia; consumer interest groups and trade unions)* and best practice guidance which has been established to protect the rights and needs of the occupants at the homes for the elderly in Malaysia either operated by Department of Social Welfare, NGOs or by the private sector.

4.2 The Increase of Ageing Population

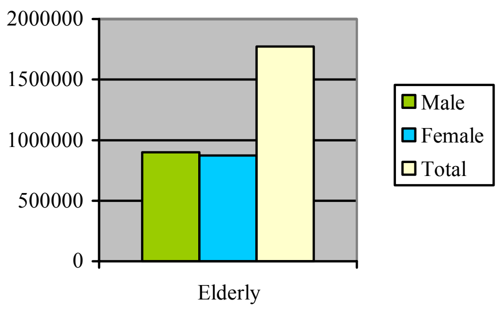
It is predicted that by the year 2025, the global population of those aged 60 years and above will more than double, from 542 million in 1995 to about 1.2 billion. See **Figure 2** below. The total numbers of elderly people living in developing countries will also more than double by 2025, reaching 850 million or 12 percent of the overall population of the developing world. Throughout the world, 1 million people are believed to reach the age of 60 years every month, 80 percent of whom are in the developing countries (Randal and German, 1999). Since the Second World War, Asia has also been the most successful region of the world in reducing fertility. Among Asian countries, Japan is the leader in the process, while in Southeast Asia, countries like Singapore, Thailand, Indonesia and Malaysia are similarly involved. An important consequence of these changes taking place is rapid increase in the elderly population (Arokiasamy, 2005). The Malaysia Census 2000 showed that 6.2 per cent, 1.452 million, were aged 60 or over, but demographic ageing is occurring and, by the year 2020, 9.5 percent of the country's population will be age 60 years and above (Phillips and Chan, 2002).

Figure 2: Projected growth in the global population aged 60 years and older, 1995-2025



Source: World Health Organisation (2002)

Figure 3: Population of Elderly in Malaysia by age (60-75+) in 2005



Source: United Nations Statistics Division (2005)

According to the National Council of Senior Citizens Organizations Malaysia (NACSCOM) the ageing population is increasing in Malaysia. United Nations Fund for Population Activities (UNFPA) stated that Malaysia will be categorized as an ageing nation when the older population reaches 7.2 percent (1.8 million) by 2005 (NACSCOM, 2005). However, statistics from the United Nations revealed that the total elderly population in Malaysia has already reached 7 per cent of the total population. **Figure 3** above shows that the male elderly is about 900,550 and the female elderly is 873,810 out of 1.77 million of total elderly population around the world (United Nations Statistics Division, 2005). Housing is one of the most important components of wealth for a large part of the elderly which serves not only as an asset but also provides consumption services. Therefore, appropriate housing in terms of financial and physical needs determines to a great extent the well being of the elderly (Tatsiramos, 2004). Instead of having adequate and healthy housing, Ohara (2004) cited that heading into a society where aging is progressing, and where even among elderly people there is an increasingly larger class of older senior citizens, the increasing number of elderly people requiring personal care (or nursing care) will be an even greater issue of importance. By the year 2025, it is projected that the elderly will number to about 1.2 billion (14 percent of the total) of which three quarters will be in the developing countries. In the developing countries, Arokiasamy (2005) stated that between 1980 and 2020, the total population is expected to increase by 45 percent while the elderly group will increase by 80 percent. To cope with the increase in elderly, Malaysia needs to undertake careful social and housing policy planning, and this would also imply health maintenance and promotion for all ages especially the elderly.

4.3 Adequate Housing for Elderly is a Need

According to Da Vanzo and Chan (1994), and Martin (1989), more than two-thirds of Malaysians age 60 or over co-resides with an adult child. The benefits of co-residence range from companionship and emotional support to the fulfillment of the physical and financial needs of parents and children (Da Vanzo and Chan, 1994). However, as people become older their housing needs become more increasingly entwined with their health and care needs (Boaz et *al.,* 1999). According to Pleace (2002), the housing related support needs for older people can be summarised as in the **Table 1** below. Without a doubt, some older people wish to stay in their homes independently for as long as possible, but the infrastructure needed to support this choice is often inadequate. Moreover, staying at home may not always be appropriate and practical. According to Boaz et *al.,* (1999), older people identify a need for flexible home care, which puts the needs of the older person at the centre of a care package. Other services, such as good transportation system, healthy homes, and accessibility, are also seen to be important to older people living in their own homes.

Table 1: Housing Related Needs for Older People

	Categories of Needs	Description
1.)	Low level support needs	Older people may not have anyone who can provide social support, advice, help with shopping or other low level support which a carer or relative would otherwise provide
2.)	Needs related to suitable accommodation	Ensuring that an older person's home is warm, dry and in a good repair
3.)	Security needs	Ensuring that an older person lives in a home in which they feel safe and secure from crime
4.)	Needs related to adaptations	Ensuring that housing is suitable and usable for an older person who has become disabled
5.)	Social needs	Older people should not become socially isolated while living independently
6.)	Ensuring housing related needs are met as part of a package care	Any housing related support needs will need to be met as part of any package of care being received by an older person in the community
7.)	Advice and information needs	Older people may need advice and information in order to access the housing related support services and other services that they require
8.)	Needs for grouped housing services for people over retirement age	Life in independent housing can become impractical or undesirable for some older people, the option to move to a housing setting specifically designed for their needs can be very important for this group.

Source: Pleace (2002)

Ytrehus (2001) cited that the residents of social housing, including the elderly should have a certain minimum standard and the rent ought to be justifiably fixed according to income. The goal was *a good residence with affordable prices.* In order to fulfill the minimum standards of needs for older people, Article 25(1) of the Universal Declaration of Human Rights 1948 (UDHR) also states that *everyone has the right to a standard of living adequate for the health and well being of himself and of his family, including food, clothing, housing and medical care and necessary social services and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.* The right to adequate housing is embedded in the Universal Declaration of Human Rights 1948 and in major international human rights treaties such as the International Covenant on Economic, Social and Cultural Rights. In 1996, world leaders reaffirmed the right to adequate housing when adopting the Habitat Agenda at the Second United Nations Conference on Human Settlements. These instruments and declarations have shaped a global social contract designed to ensure access to a secure home for all people in all countries (UN-HABITAT, 2002). United Nations Committee on Economic, Social and Cultural Rights identified seven aspects that form the integral component of human rights consisting of legal security of tenure; availability of service; material; facilities and infrastructure; affordability; habitability; accessibility; location; and cultural adequacy (Ismail and Sulaiman, 2004). In addition to these seven components; as a part of social services; housing should also convey value in social policy to the society such as individual and social well being; solidarity; rights; justice; freedom; democracy; welfare and equality (Spicker, 2005).

4.4 Increasing Demand of Institutional Care for Elderly

Recent research mentioned that such co-residence may be declining in some Asian countries, such as Japan, South Korea, and Taiwan (Da Vanzo and Chan, 1994). As the world is changing, Malaysia is similar to other developed countries which have shown an increment in the percentage of homes being developed in order to cater for the needs of the elderly people to reside and to be taken care of (Syed Mustafa et *al.,* 2005). Herne (1994) identified that among the reasons why the families present a less feasible option for the growing numbers are;

i. A decreased birth rate leads to fewer children to share the responsibility for care of an elderly parent or parents;
ii. Greater numbers of divorces may reduce contact with children and in-laws;
iii. Geographical mobility of family members could leave an elderly person with no relative living without easy traveling distance; and
iv. Most importantly, women have usually taken on the majority of care of the elderly for their own parents and often for those of their spouses. In recent times the increase in the numbers of women working both full time and part time has left less time for carrying out care duties.

According to Arokiasamy (2005), Malaysia can be considered a Demographically Middle Age Country and having rapid economic development. In terms of providing health infrastructure development, Malaysia is having more recent initiatives in development of health services for older citizens. In terms of the development of institutional care for the elderly, the Seventh Malaysia Plan (1996-2000) and Eighth Malaysia Plan (2001-2005), mentioned that there were an increasing number of nuclear families and longer life expectancies in Malaysia. This plan specifically stated that *the concurrent phenomena of* *decreasing family size and increasing number of older persons, as well as other demographic and social factors affecting the family structure, such as the demographic role of the extended family, will require the establishment of formal institutions to share take over the traditional responsibilities of families.* In conjunction with the International Year of Older Persons in 1999, the Action Plan for the National Policy for Elderly was implemented to ensure integration and participation of older persons in society. Under the Seventh Malaysia Plan (1996-2000) the elderly who were poor and had no dependents were provided with 14 homes for the elderly with capacity 2,500 by the government. See **Table 2**. The government also added one more home for the elderly in the Eighth Malaysia Plan (2001-2005). In addition to that the NGOs, with partial assistance from Government, established 132 homes to provide care for about 1,000 elderly people (Economic Planning Unit, 1996). Instead of having these homes for the elderly, the government has also approved the establishment of 9 day care centres during the Seventh Malaysia Plan (1996-2000) and 19 day care centres in the Eighth Malaysia Plan (2001-2005) for older people during the day in the absence of family members. In addition, a toll free phone line was provided to enable older peoples to have access to counseling and information services (Economic Planning Unit, 2001). Kin Tuck (2004) stated the government should particularly allocate financial provision for a five year plan for the needs of the elderly in the rural and urban areas. NACSCOM identified that Malaysia needs to build up more day care centres throughout the country. In response to this, in the Budget Speech 2006, government allocated MYR 130 million (15 million GBP) to the NGOs to help the development of institutions for the vulnerable groups (Budget 2006, 2005). In the 1/12/2005 Parliament Draft Report (2005) another 10 day centres have been approved to be developed during the Ninth Malaysia Plan (2006-2010). The centres will be managed by the identified NGOs. WHO (2005) stated that social, economic and cultural changes taking place in some of the developing societies will leave families less able to care for their frail relatives and thus portend an increasing demand for institutional care. In an Asian country like China, the expectation of institutional care for older people is becoming a norm. In Taiwan, institutional care has rapidly overtaken family care for the elderly (WHO, 2005). Even more than two thirds of Malaysians age 60 or older co-reside with an adult child. In general, institutional care is no longer considered unacceptable for an older person but is seen as an alternative for families to take care of their third age member (WHO, 2005).

Table 2: Total Number of Homes for the Elderly Provided by Department of Social Welfare 1952-2002

Location (State)	Occupancy Provision	Location (State)	Occupancy Provision
1. Bedong, Kedah	320	8. Taman Kemumin, Kelantan	250
2. Taiping, Perak	350	9. Kangar, Perlis	34
3. Tanjung Rambutan, Perak	300	10. Sri Pritchard, Kinarut	155
4. Cheras, Selangor	320	11. Sri Harapan, Sandakan, Sabah	71
5. Seremban, Negeri Sembilan	270	12. Sri Harapan, Tawau	50
6. Cheng, Melaka	320	13. Kuching, Sarawak	n.a
7. Johor Bahru, Johor	320	14. Sibu, Sarawak	n.a

Source: Adapted from Syed Mustafa *et* al., (2005)

4.5 Conflicts between the Structure of Social and Housing Policy

According to Bauer and Gergen (1968), the term policy is used to describe *those parameter shaping acts* and *strategic moves that direct an organisation's critical resources towards perceived opportunities in a changing environment*. Policy is designed *to give direction, coherence and continuity to the courses of actions* (Lichfield, 1978). Housing has been one of the four major pillars of the welfare state including social security, health and education (Kemeny, 2001, Spicker, 2000). On the contrary, housing differs from the three other pillars of the welfare state in being characterized by high capital intensity and has huge capital investments. Kemeny (2001) summarized the four pillars as in the **Table 3** below.

Table 3: Type and intensity (high, medium, low) of welfare pillar

Welfare Pillars	Cash Transfer	Salaries	Capital
Social security	High	Low	Low
Education	Low	High	Low
Health	Low	High	Medium
Housing	Low	Low	High

Source: Kemeny (2001)

To begin with the ambiguous relationship between social and housing policy, Clapham *et al.* (1990) open their book 'Housing and Social Policy' with the statement that *this book focuses on two key relationships: that between housing policy and social policy, and that between the provision of housing and the provision other welfare services such as health service, the education system, the personal social services and the social security system.* However, there is unjustifiable theoretical background between social and housing policy (Sprigings and Somerville, 2004). In the housing studies, many scholars have neglected the social needs in housing and in the studies of welfare system they have also widely discussed the social and welfare regimes with housing separately. The ambiguous and widely varying role of housing in systems of welfare is perhaps one important reason why so many pioneering studies of comparative welfare have ignored or omitted housing from their consideration (Kemeny, 2001). Sprigings and Somerville (2004), in their discussion of housing policy, also mentioned that *...the edges of the housing and social policy jigsaw are hard to identify, and the direct causal links, which policy makers would love to find in order to achieve their objective through precisely targeted interventions, remains elusive*. In truth, Lowe (2004) cited that national housing policy structures interact closely with other areas of social policy structure. The nuts and bolts of housing service delivery in the public sector often link housing needs issues with other welfare services. **Figure 4** portrays the eighth values of social policy in the concept of adequate housing. In addition to this, seven aspects that form the integral component of housing rights are also need to be fulfilled.

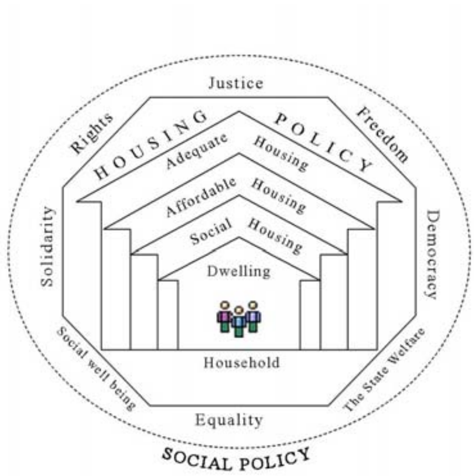


Figure 4: Housing Policy & the Eight Values of Social Policy

In Malaysia, the ambiguous structure of social and housing policy has obviously appeared in the structure of social services. The structure of housing programme and other social services such as local authorities, fire & rescue services, sports, culture, library services, information & broadcasting and community & family development were prepared separately in the Five Year Development Plans since the Colonial Administration and Pre Independence Period (1950-1954) until the latest Eighth Malaysia (2000-2005). For that reason, therefore, the eighth values of social policy are not really conveyed to the people with vulnerabilities such as the elderly from the sphere of housing policy. Sulaiman et *al* (2005b) brought the evidence that private sector developers in Malaysia contributed less in the provision of housing for needy people in Malaysia. To summarize, social policy and housing policy is very different in the nature of their organisation. They are universal in one sense or another. The extent to which housing and home for the elderly organised in Malaysia depends on a considerable extent on how the mode housing provision and mode for the homes for the elderly is structured.

4.6 Lack of Contribution from Public and Private Sector Housing Developers

The role of the public and private sectors in housing provision and welfare provision varies between countries not just quantitatively but, more importantly qualitatively (Kemeny,2001). In terms of state responsibilities in delivering adequate shelter, Paragraph 61 of the Habitat Agenda (1996) cited that *all government without exception have a responsibility in the shelter sector, as exemplified by their creation of ministries of housing agencies, by their allocation of funds for the housing sector and by their policies, programmes and projects. The provision of adequate housing for everyone requires action not only by governments, but by all sectors of society, including the private sector, non governmental organizations, communities and local authorities, as well as by partner organizations and entities of the international community. Within the overall context of an enabling approach, Government should take appropriate action in order to promote, protect and ensure the full and progressive realization of the right to adequate housing.* Ismail and Sulaiman (2004) brought the evidence that public and private sector developers in Malaysia contributed less in the provision of affordable and quality housing for needy people in Malaysia. The obligation to deliver adequate housing for needy people was only limited to the development of low cost housing units which contributed to only 30 percent of the total development units. Regrettably, the needs of vulnerable people such as the urban and rural poor, single mothers, the elderly, people with disabilities, people suffering from mental illness and indigenous people is always left behind in either quantitative or qualitative ways such as the housing design. Sachar (2002) noted that, in accordance with international human rights principles, obligations for the fulfillment of the human right to adequate housing are primarily held by the State. In order to encourage the contribution from the private sector, the UN-Economic and Social Council (ECOSOC), mentioned that States may impose duties on a person in subject to their jurisdiction. Furthermore, Eide and Rosas in Eide et *al* (2001) affirmed that the imposition of duties, such as the duty to respect the rights of other people and the duty to contribute to the common welfare makes it possible for the State to assist and to provide ways which enable everyone to enjoy their economic, social, and cultural rights, including the right to adequate housing. SUHAKAM claimed that the right to live a dignified life cannot be achieved unless all basic necessities of life are adequately and equitably available to *everyone* in Malaysia (SUHAKAM, 2003). Agus (2003) and Yahya (2003) agreed that the public or private sector should bear the obligation for fulfillment of the right in housing, particularly among the disadvantaged such as the poor. Furthermore, if private sector housing developers fulfill their social obligations to the people, public sector involvement could be substantially reduced. This is also in conjunction with the Eighth Malaysian Plan (2001-2005) which is the private sector, as well as NGOs will also be encouraged to provide facilities to care for the disadvantaged (Economic Planning Unit, 2001). This concept of corporate social responsibility (CSR) is an expression used to describe what some see as a company's obligation to be sensitive to address both its own competitive interests and the interests of the society. In the UK, for example, according to Harriot and Matthews (2004) the hybrid mode of housing provision for the elderly exists, known as Abbeyfields societies and Almshouses trusts (non-profit housing provider). They are the major providers of housing specialized to the elderly.

4.7 'Learning by Doing' from UK to Malaysia

In the UK, progressive housing developments were started before the Industrial Revolution in the late 1700s (Chartered Building Societies Institute, 1987). The evolution of the UK housing industry also passed through the critical period during the First and Second World Wars, and made the UK housing industry more mature in terms of providing housing. Historically, since the early 1920s, social housing in the UK has undergone several distinctive stages known and modelled as mass model, worker's cooperative model and residual model (Harloe, 1995). In short, social housing provision has emerged in the UK for more than 80 years. From the end of the First World War to the early 1980s, councils were indisputably the key providers of social housing. This has been agreed by Kemeny (2001) which mentioned for the first quarter of a century after the Second World War when, in most countries, welfare systems were being established and developed, providing sufficient housing of adequate standard was a high priority. Political and economic pressures then led to the weakening of the municipal provider role and as a result, Conservative governments since 1979 ended council housing provision and instituted a system of *social* rented housing based on the housing authorities and private landlords in the UK (Harloe, 1995). Since then, until now, progressive government intervention; appropriate changed and amended legislation; stability within social and housing policy; continuously introduced government documents plans and strategies, has made the UK housing industry far better. Interestingly, British debates and experiments were often followed with great interest by housing reformers in other countries. In the UK, there are 677 housing associations which deal with the institutional care for older people. Abbeyfield societies and almshouses trusts are major providers of services for older people. Decent, good quality, appropriate housing is vital in improving their quality of life. The value of housing in helping older people stay independent has also been widely acknowledged (Housing Corporation, 2002). Theories, ideas and *learning by doing* experiences have been central in much housing in developing countries, but always within the constraints of macro economic development and underdeveloped institutions in housing and urbanization (Sulaiman et *al.*, 2005b). Malaysia also developed housing policies from experience gathered from developed countries. Goh (1988) stated that in early 1970s, Malaysia adopted an extensive system of planning controls based on the planning system used in England and Wales. Forrest *et.al* (2000) revealed that the concept of housing systems in South East Asia countries, including Malaysia, tend to be largely developed from literature and research in Western countries. Although social definitions of housing for the elderly vary from one to another, housing for the elderly in the West has been well documented in the literature (Dapaah and Wong, 2000). In addition, there are various types of homes for the elderly provision either developed by housing association or other private organizations such as Sheltered Housing, Extra Care Housing, Close Care (very sheltered housing), Care Homes, Care Homes with Nursing and Dual Registered Homes which are well established with some having their roots back to the 12th century. Therefore, it would be very beneficial if Malaysia can adapt and adopt the provision structure and identify best practices from the provider of the homes for the elderly in the UK. As mentioned by Yusuff et *al.,* (2004) properly designed, the living environment can increase the comfort, safety and health of the elderly. Above all, some different situational factors might have occurred in the policies, demographic and pattern of economic growth, uncertain income levels of the elderly, different culture and technology in a way to transfer the best practices from UK to Malaysia. However, undoubtedly, instead of low cost and no wasting time, the lesson learnt from the best practices transfer process would be very useful to reduce pitfall among the homes for the elderly providers in Malaysia.

5. SUMMARY

The aim of the ongoing research is to identify the *Opportunities for the Transfer of Best United Kingdom (UK) Practice to the Provision of Homes for the Elderly in Malaysia.* Accordingly, Malaysia has organized its own formation of housing and homes for the elderly. The edges of the housing and social policy jigsaw are also difficult to identify in Malaysia. As much as the issues were described earlier, the provider of homes for the elderly should try to take steps by all appropriate means to increase their efficiency in providing homes for the elderly. The seven aspects of human rights to housing, and the eighth value of social policy should be considered at all times. As the concurrent phenomenon of decreasing family size and increasing number of older persons exists in Malaysia, the establishment and identification of best practices in the provision of homes for the elderly will provide a reliable benchmark against which performance can be judged. In addition, compliance with standards and best practices is a convenient and reliable way of ensuring that services in the homes for the elderly meets it regulatory requirements. This is especially important when there are links between housing, health and care and support for the elderly. Prominently, the three main parties who operate the homes for the elderly in Malaysia must never ever lose sight of the prime objective of homes for the elderly which is to protect the needs of the elderly. For this reason, this research is believed beneficial to be undertaken by the researcher.

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AN INVESTIGATION INTO PROJECT MANAGER DEVELOPMENT IN LIBYA

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ABSTRACT: This paper reports on a current doctoral research project investigating the development of project managers in Libya. Project Management (PM) was first, developed in America and Europe, provoking the existence of a number of well-established Project Management approaches in the form of Bodies of Knowledge. In Libya however, there are problems relating to the development of project managers. Firstly, there is no comparable parallel development of the profession of project management. Secondly, there is no educational strategy for developing professional project managers both for industry and academic. As a consequence, there is a need for professional project management development of project managers in Libya. This paper describes an approach adapted to survey major industrial public companies in Libya, and presents preliminary findings of the determinants of PM in Libyan's industrial companies as well as project managers' competencies on the parameters of knowledge and experience in order to identify project manager's development needs. It concludes with a brief discussion and summary of the results.

Keywords*:* project management; project managers, body of knowledge, developing countries.

1 INTRODUCTION

Modern project management has its roots in the Second World War, and developed in a limited number of engineering based industries. In the 1950s, project management has become an important part of achieving project successful outcome due to the increase of projects complexity and the need to manage multiple projects at several locations. In the 1960's, the Project Management Institute (PMI) was formed in the USA, with the objective of promoting the development of PM, and spreading the technology and PM training methods. Parallel to the development of PM in North America, The Association of Project Management (APM) was established in UK in 1972 with the intent of developing and assessing project manager practitioners. (Ghaleb and Al-Mharmah, 2000)

Some other European professionals from Sweden, France, Holland and Germany started a dialogue for creation of a debate forum on PM implementation. In 1965, an international network was formed in Europe to promote PM. In 1979, the International Project Management Association (IPMA) was formally established. Later, and in various countries of Western Europe and the Near East, National Associations such as the Australian Institute of Project Management (AIPM) were born (Morris, 2001).

In developing countries the implementation of PM development approaches is still in its early phases. The existences of several social, political, cultural and economical factors hinder the development of PM in developing countries, which lead to poor management performance. Developing countries, in seeking to adapt or enhance the implementation of PM, might capitalize on the experience gained in developing countries and adapted to their needs (Al-Mharmah and Abbasi, 2000). Although, project management continues to grow and mature in the Twenty-First century in the Western World and North America, the importance and benefits have yet to be recognized in the developing countries such as Libya. Currently in Libya there is no educational strategy for developing professional project management practitioners for both industry and academic in the region.

In the last two decades the country strategy was to develop the nation's technological advancement to a high level through building, as rapidly as possible, a strong industrial base. A great amount of money was allocated in order to establish many different industrial complexes in various fields. The industrial sector's share was 19.2% of the total investment (General office for documentation, 1999). As a result a number of training centers were established and more departments concerned with management development were opened in different universities.

However, despite all these efforts the decrease of productivity capacity is still a persistent disease, which public enterprises do not seem to overcome. Previous studies partially attribute that to the inefficiency of management. For example, personal management is practiced without effective methods and as a result of the scarcity of well-qualified workforce, the return of investment in the industrial base is woefully inadequate and in spite of the investments allocated to the industry for development, there is a noticeable drop in the efficiency of its companies (Agnaia, 1997).

Libya is now seeking massive investment to boost its energy, housing, industrial and servicing sectors. Libya began to advocate and promote decentralisation in an attempt to reduce heavy reliance on oil and gas revenues and focus its development plans on economic diversification. Further, Libya began talks with the World Trade Organization (WTO) on admission to the 147-member body as it seeks to end decades of international isolation (World Trade Organisation News, 2004). Thus, human resources professional development was found to be critical of management reform in the industrial companies.

Morries (1997) argues that the move to increased professionalization is a major development in project management. Partly this is a result of a trend in society towards continuous education and the emphasis on competence-based training. Largely it is the result of the maturing of the discipline itself. Crawford (1997) claims cultural and language difference, national interest, different regulatory systems have made progress towards internationally accepted project management standards difficult. However, with the exception of Egypt**,** (PMI, 1999) no single country in North Africa is a member of those associations or has a comparable body least of all Libya.

There is now a body of literature on the discipline of project management. However, there is relatively paucity on the development of project managers. Management development is defined by Mumford (2004) as 'An attempt to improve managerial effectiveness through a planned and deliberate learning process. McCreery (2003) argued that training and development of project managers is challenging for at least two reasons. First, the relevant knowledge base is very large. Second, the discipline of project management is both theory-and practices based. This research aim to embed the concepts in management development combined with project management knowledge to develop project manager.

1.2 Research methodology

This paper aimed to identify project managers' professional development needs, and determinants of project management in the industrial companies. A survey was undertaken to identify problems in project management practices and key gaps in project manager development needs.

Multiple research approach was applied in this research project. It comprises of multiple research methods of quantitative (questionnaire) and qualitative (interview) survey approaches, in addition to observation. The aim of the surveys was to capture the tacit and explicit knowledge about project managers' competencies in order to identify further key gaps.

The interview survey was based on the use of semi-structured face-to-face interview – onto which the interviewer directly recorded the interviewee's responses. The interview guide was structure to elicit the general and technical background of the practising project managers. This comprised both the academic and experiential aspects of their development. The interview also elicited the determinants of project management by identifying major internal and external obstacles in delivering project in the industrial companies. The interviews were written up as soon as possible after the interview to maintain a high level of observer recall and relative accurate interpretation.

The questionnaire survey was used to capture the experience and knowledge of project managers in project managements. The parameters of project management knowledge and experience in this research used to come from amalgamations of the IPMA International Competence Baseline (IPMA, 1999) and the outcome of an analysis on the topics used and needed by people in project management (Themistocleous and Wearne, 2000). It used a set of 44 topic complied by from various body of knowledge 'elements' (i.e. APM, AIPM, PMI) to identify the relative frequency on the most used topic in PM. The parameters of unnecessary duplication were removed, through making a serious of comparison and attempt to locate each core parameter in the specific theme to which it most readily applies. The parameters are divided into 7 themes based on the research of the APM body of knowledge (APM, 2000). It is used to divide the 40 parameters for knowledge and experience in project management. These include: General, Strategic, Technical, People, Control, Commercial and Organisational)**.**

1.3 Population and sample

The target industry for this research is, Industrial Companies, which include; General electronic, Steel and Mould, Libyan Company for Tractors and Cement Industry. The population under investigation for this research is project managers from the above industries. A total of 25 project managers were interviewed. Unlike the random sampling the choice of subjects was partially determined by access to project managers in different organizational settings. Morton Williams (1985) described this as 'purposive sampling'. The snowball sampling strategy was also used in the interview survey (Fink, 1995). This simply meant that the name of other companies, including the name of individuals in a few cases, could be obtained during a particular research visit.

2 FINDINGS

The primarily findings are presented into two parts. Firstly, the determinants of project management can be summarized into four main categories as follows: Organizational, Technological, Social and Cultural, economical, Political and Legal environment. The view points of the interviewees are presented in Italic. Secondly, the statistical analysis of the how project managers' performance on a project management knowledge and experience parameters relate the significance of these parameters.

2.1 Organizational

Project manager mission

Most writers agree that there is a need for a project manager as a single point of authority either implicitly, e.g. (Turner, 1993, Hamilton, 1997) or explicitly (Morries, 1994 and Gabrial, 1997). There are a number of issues concerning the function of project manager in Libya. '*The project manager needs more support and authorization from the company. Sometimes our mission is not clear. Our responsibilities are both technical and management and also responsible before senior management and project client. There should be balance between responsibilities, power and benefit. The current situation is that the project manager has a load of responsibility, well-restrained power and little benefit.'*

Co-operation between different departments

Co-operation between different departments in different organisations is problematic at times. This is due to the lack of experience of staff members or some staff member disagreeing with each other for their own benefits. '*There are problems in the co-operation between different specialists in different departments. There is lack of efficiency in terms of communication. The information flow from a project to senior management is usually delayed. If there is some kind of change regarding a project, or the client makes a change with one speciality, he may forget to inform the other specialties regarding the change. This in turn will cause delay, significant waste of time of other specialists.'*

Communication

Effective communication plan with all stakeholders is fundamental to project success. A communication plane is often developed at the beginning of a project (Dixon, 2000). From the interview, a number of interviewees complained about the communication in their company. '*There is lack of efficiency in terms of communication. The information flow from a project through a function department to senior management usually delayed. Unless the project manager builds his own network within the organisation in order to facilitate communication channels with senior management, he/she will keep encountering such problems and it is sometimes very costly in terms of time and money.'*

Project decision-making

Management style plays an important role in facilitating the organisational procedures. Organisations have different attitudes about what to do regarding the decision – making, centralization and authority delegation. For example, Arab management style is often described as paternalistic and authoritarian resulting in high centralization of decision – making (Atiyyah, 1993). As some interviewees said '*The degree of senior management involvement in project decision limits the role of the project manager as the overall project coordinator and diminishes his authority before his subordinates.'*

2.2 Issues relating to the technological dimension in Libya

Technology know-how

Libya is a developing country and still relays heavily on the importations of technologies for most of its industrial base to run operation of most projects. Local managers are not involved at the implementation phase. Kumar (1999) commented and strongly recommended if managers in developing countries want to be involved in their country's development, they must posses a greater understanding of how to acquire and implement technology. From interviews '*…too much attention is still given to the acquisition of hardware or embodied components of technology, but little attention to those who will operate the imported technology. Training is limited to the skills necessary to operate the imported technology.'*

Information management

Project manager's function is an information-dependent function with its diversity of forms of information, planning, organising, drawing, documenting and so on. Former research indicate that accurately and timely documented information is vital for the project participants because it forms the basis on which decisions are made and physical progress are achieved. The wasting of time and money can be traced back to poor coordination caused by inadequate information (Tam, 1999). From the interviews, it was found that '*Information management is not efficient. Information and documents are stored in a traditional way and at times either cannot be found or extremely difficult to trace.'*

Delay of materials and supplies for project

Marshalling tools, materials, equipments and plant is a necessary for operation of most projects, which occupies a large amount of productive time. Workers time can be rendered inactive or non-productive due to the lack or delay of materials and supplies of a project. Material and supplies of a project therefore have an impact on the productivity and performance of a project (Pheng and Chuan, 2005). Libya is a developing country; some of the tools, materials and technologies that are integral to the conduct of projects are imported from overseas. Custom's regulations are too strict and bureaucratic for allowing the importations and entrance of some technological and other materials into the country. Some interviewees indicated that; '*Customs rules and regulations for the importations of materials from oversees are time consuming, cause delay on the delivery of a project and workers time becomes non-productive which means loose of money as well.'*

2.3 Issues relating to the social and cultural environment

Top management support

Organisations today exist in an environment characterised by continues changes due to different factors. This requires the continued development of practices and procedures in order to adapt the changes. Thus top management must be aware of these issues. Mondy and Noe, (1996**)** stated that support of top management must be real and not merely lip service and this must be communicated to all concerned in the organisation. Some interviewees pointed out that, '*senior management support is influenced by personal connection and loyalty to top management.'*

Relationship with the client

The most important thing for the project manager is client satisfaction (Plant, 1989). There are problems concerning developing good relationship with the clients in Libya. Sometimes the client requires changes in the contract during the work, which is not lawful. This will lead to serious quality problem for the project. The client, in other words is not a real person but a government body, then changes must be accommodated. '*Because the client sometimes is a government body, the project manager has to accept the sudden changes, but still have to deliver on time. This means we will have to work too fast, and when we do that a lot of problems may occur. For example, quality problems will be inevitable.'*

Social environment

The social environment in Libya is characterised by extended family, tribe, clan and Islamic religion. Personal relationships and family ties play a major role in management procedure in Libya (Agnaia, 1997). The dominance of state-owned enterprises in Libya's industrial and service sectors, together with extensive state intervention through the economy, has sustained the premium on good political skills over modern management capabilities. As some interviewees have indicated '*the social experience of the project manager is very important. The project manager has to deal with different types of people. They are government personal and department, civil servants, bank managers, customs and tariff, materials and suppliers.'*

Co-operation between different departments

Co-operation between different departments in different organisations is problematic at times. These due to the lack of experience of staff members or some staff member disagree with each other for their own benefits. '*There are problems in the co-operation between different specialists in different departments. There is lack of efficiency in terms of communication. The information flow from a project to senior management usually delayed. If there is some kind of change regarding a project, or the client makes change with one speciality, he may forget to inform the other specialties regarding the exchange. This in turn will cause delay, significant waste of time of other specialist.'*

2.4 Issues Relating to the Economical Environment in Libya

Privatisation and market

The trend in Libya now is to move from a centralised economy to a decentralised one. However, due to long-term influence of traditional system the State Owned Enterprises particularly the industrial sector have not yet adapted to the demand of market economy. Some of these companies are weak in technical innovation, have a surplus of employee and heavily in financial debt and social burdens. Some interviewees said that '*The enterprise culture of the state owned companies is quite bureaucratic with a lack of innovation. They are heavily dependent on the government financial support to remain in the market, which makes privatisation at this stage difficult if not totally possible.'*

Salary and incentive system

Handy (2005) points out that if an organisation is looking for success, it has to take into consideration the political reality. For example, the legislation on wages in Libya means that organisations cannot devise their salary structure in such way as to reward good performance, and there are also laws defining employees' rights (e.g. equal opportunities) and employers' responsibilities (e.g. health and safety). Also, the job is characterised by the symptom of a secured job, which challenges the authority of the project manager in terms of bonus and penalty. Interview findings support these problems '*The salary system is based on the job title, not by the work people are doing. Whatever the level of one's performance, the poor and the excellent performance will be equally rewarded. It does not provide for incentives or motivations and cannot compete with the private sector.'*

Economic factor

The existence of several social, political, cultural and economical factors hamper the development of PM in developing countries, which lead to poor management performance (Ghaleb and Al-Mharmah, 2000). Thus, the economic circumstances influence the effectiveness of project managers. Interviewed project managers indicated *'The market is unstable and in continues change, due to the lack of standard policy particularly the importation of goods and materials which affects our turnover*.'

2.5 Issues relating to the political and legal environment in Libya

Relationship with the client

The most important thing for the project manager is client satisfaction (Plant, 1989). There are problems concerning developing good relationships with the clients in Libya. Sometimes the client requires changes in the contract during the work, which is not lawful. This will lead to serious quality problems or delay for the project. The client, in other words, is not real people but a government body. '*Because the client sometimes is a government body, the project manager has to accept the sudden changes, but still have to deliver on time. This means we will have to work too fast, and when we do that a lot of problems may occur. For example, quality problems will be inevitable.'*

Contract and formal bidding

Politicians define the laws and generally economic and social policies in which organisation works, and regulations and restrictions imposed by laws and policies tend to influence the decision-making system (Handy, 2005). From the interviews, '*To conduct a project outside the company for private organisations, a prior approval from higher authority must be sought before conducting or bidding on any project. The government sets our project schedule, which makes it difficult to work within that schedule without breaching normal procedures. Further, the government selects the supplier, which may not be suitable for the company.*

Country's laws and policies

Managers in general including project managers have to deal with the laws, system, legislations and charters that govern relationships and regulate management processes. Handy (2005) pointed out organisation operates in the context of national politics, which influence the function of all members of organisation and if these companies are looking for success, they have to take these changes into account. Interviewed project managers indicated, '*The working environment is unstable with many laws, regulations had changed many times. Too many rules and regulations conflict with each other. Some of these regulations may be good in theory, but are not practical. They create a lot of bureaucracy without improving the job function. Furthermore, central authority intervention influences day-to-day operation such as organisation structure, authorized budget, employment conditions and personal and management appointments.'*

3. STATISTICAL ANALYSIS FOR THE QUESTIONNAIRE SURVEY

The questionnaire survey composed of 40 parameter of knowledge area was used to elicit the relative significance of the parameters. The questionnaire invited the respondents to use a scale of 1-5 to assess the frequency, crucial and expertise of the parameters. Frequency and crucial formed a double Likert Scale (Levermore, Lowe et al, 1999) for the significance of knowledge and experience. The Significance is defined in this research by:

Significance = Frequency * Crucial

From this a score can be calculated to simplify the results. From these questions a score can be derived by multiplying and normalizing the frequency and crucial scores for each parameter. This yields a score between 1 and 25. The response to the questions can be drawn graphically to provide a 'fingerprint'. The perceived level of significance for each parameter was established by applying equation 1. For question, or parameter x, the Parameter Significance Score (PSS) is;

$$\text{PSS} = \frac{\sum_{j=1}^{m} i_{jx} l_{jx}}{M} \qquad (1)$$

Where: J represents the questionnaire number; x represents the question number, i represents the frequency rating taking the value between $1 \leq i \leq 5$; ι represents the crucial rating taking the value between $1 \leq \iota \leq 5$; m represents number of filled-in questionnaires.

From the answers, the parameters of highest and lowest ranking can be determined.

The PSSs are then ranked to form the fingerprint as depicted in Figure 1.

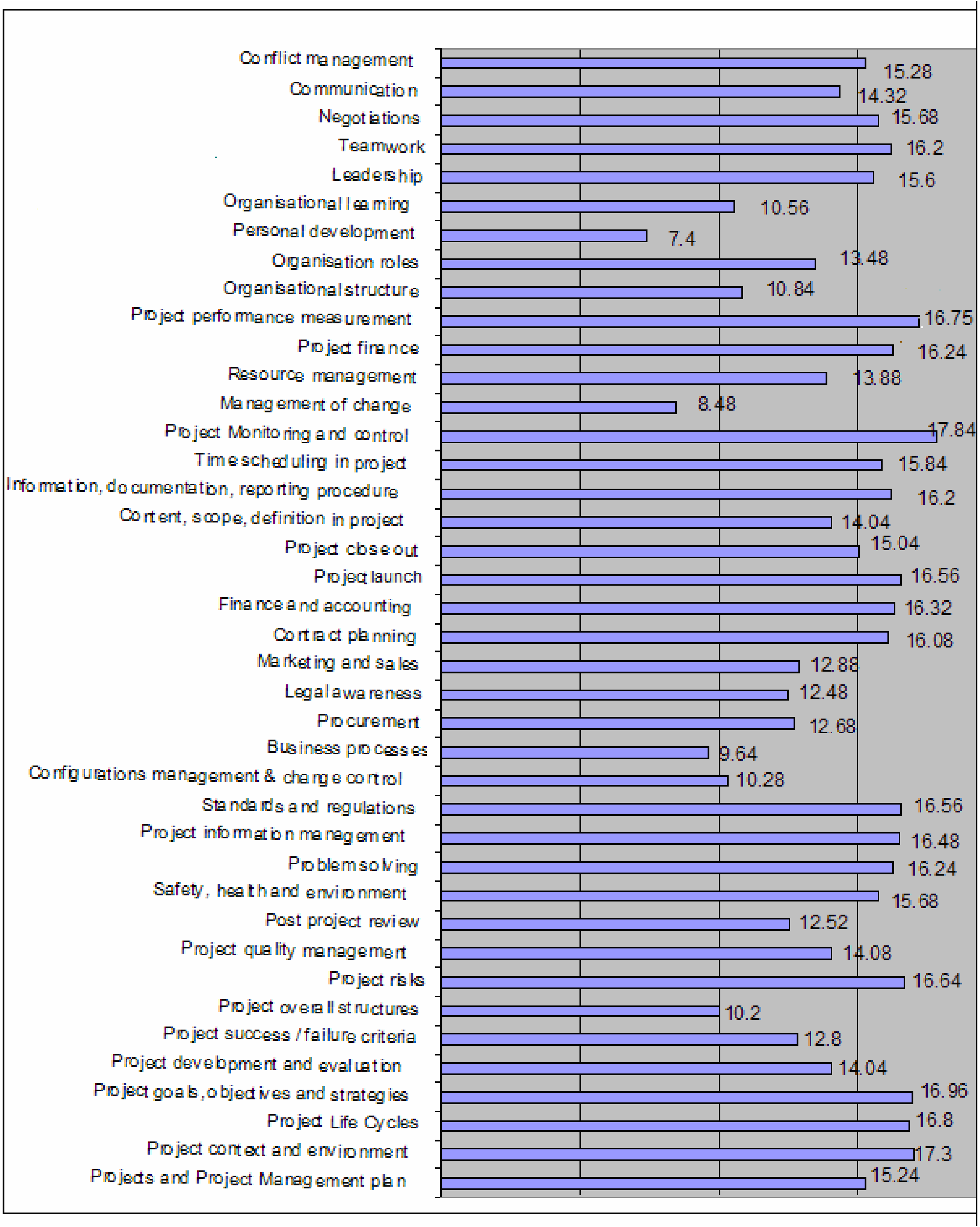

Figure 1 Parameters of significant scores

The result shows that the most significant parameters for project managers' practitioners under investigations in the industrial companies are:

(1) Project monitoring and control (17.84)
(2) Project context and environment (17.3)
(3) Project goals, objectives and strategies (16.96)
(4) Project performance measurement (16.75)
(5) Project risks (16.64)

Project monitoring and control is a function that involves monitoring and comparing actual performance with planned performance and taking corrective action (or directing or motivating others to do so) to yield the desired outcome when significant differences exist.. It is the process of comparing actual performance with planned performance, analyzing the differences, and taking the appropriate corrective action. *Project context and environment* on the other hand sets the context of the project. It includes accommodating to the external environment into which the product of the project will be launched. This could be simply the management structure of the parent organisation or the greater environment beyond. It also includes accommodating to the technology vested in the project, and the four internal constrain and interactive objectives of 'scope', 'quality', 'time', and 'cost' (Field and Keller, 1998)

Project objectives, goals and strategy are those things the organisation wants to achieve, the 'whats' of the organisation. It is the product or service that will be brought into existence or modified through the agency of the 'project'. This entails that action is required in order to achieve a *goal*. This calls for a project strategy. Projects should have a high level comprehensive definition of the way they are to be developed and managed. All major issues should be such as financial, technical, time, organisational, quality, technology, human resources, information systems as well as procurement and safety should be addressed. The strategy will usually be developed as apart of the initial project plan development and will ultimately be reflected in the project management plan (Wideman, 2000)

Project performance measurement is the means used to monitor the accomplishment of project goals. The APM Body of knowledge (APM, 2000) describes performance measurement as the concept used to represent physical progress achieved in relation to cost and schedule performance by means of introducing the calculation of earned value. It is a technique used to measure progress of both cost and schedule against original estimate.

Project risk is the cumulative effect of the chances of uncertain occurrences, which will adversely affect the project scope (i.e. expressed in terms of outputs, required resources and timing) (Wideman, 1999). Risk is an element that is embedded in the implementation of projects that manifests itself in various types at different stages during the project life cycle. It is characterized by; risk event, risk probability and the amount at stake. (Baldery, 1998)

3.1 Correlations

H_1: Project manager's knowledge on the parameters reflects project manager's perception of significance of the parameters.

Pearson's product moment correlation coefficient (r) is used to test how project managers' performance on a project management knowledge and experience parameters relate the significance of the parameter (Own and Jones 1940). Test statistic r was conducted using the Statistical package for Social Science (SPSS) software package. This paper reports the *t* test (see Table 1). The results calculated by SPSS as follow: As r=.867, it's showing a positive correlation between the two variables.

Table 1. Correlation

		SIGNIFICANCE	EXPERTISE
SIGNIF	Pearson Correlation	1.000	**.867****
	Sig. (2-tailed)	.	.000
	N	40	40
EXPERT	Pearson Correlation	**.867****	1.000
	Sig. (2-tailed)	.000	.
	N	40	40

**** Correlation is significant at the 0.01 level (2-tailed).**

3.2 Significant test for r

Our correlation coefficient seems to be fairly high. However, this result is obtained from a small sample and we have to justify whether the evidence we have validates the conclusion that there is some correlation. Conclusion based on a small sample can be very far from the truth. The obvious way of testing our conclusion is to undertake a significance test on our correlation coefficient.

$H_0 : r = 0$
$H_1 : r \neq 0$

If H_0 is true we would expect r to be distributed about zero with a standard error:

$$S_r = \sqrt{\frac{1-r^2}{n-2}} = \sqrt{\frac{1-(0.867)^2}{40-2}} = .0808$$

This estimate is made with 38 degrees of freedom:

The test statistic $t = \frac{0.867-0}{0.0808} = 10.73$

For a two tailed test with 38 degrees of freedom, the critical value for t is 2.926 (at the 5%). We accept that H0 and conclude our correlation coefficient is highly significant. This indicates that there is a positive relationship between project manager's expertise on the Body of Knowledge parameters and perception of parameter's significance.

4. CONCLUSION

This paper presents the primary findings of an interview survey investigation of 25 Libyans' project managers. The research shows that there are determinants to project management in Libya. These determinants have been identified and discussed. From a statistical test, an association between project manager's knowledge on the parameters of competence and project manager's perception on these parameters has been found. The Libyan economy is in a very delicate situation. It is in great transition. The regulatory systems in industrial companies keep on changing. The state owned enterprises are in transformation. All these provide a dynamic environment for Libyan project managers. With the impact upon Libya to seek membership of the World Trade Organisation, both the

Libyan project managers and the Clients need systematic training in project management knowledge.

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PREDICTING THE DEMAND FOR CONSTRUCTION MANPOWER IN THE UK

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ABSTRACT: The attributes of the variables - construction manpower and output have somewhat become benchmarks for summarizing most of the goings-on of the construction industry, which is beginning to throw up questions: how much information do these variable communicate on skills crisis, what is the nature of their relationship, are there any evidence of 'pattern matching', if any, how significant is it? Thus, drawing on the theory of 'pattern matching' and concept of construct validity. This paper tests the hypothesis that annual manpower employed in the construction industry depends on annual output. The decomposition method of time series forecasting was used as a basis for operationalizing the components of the time series: seasonality, trend, cyclical and randomness. The coefficient of correlation is 'statistically significant', and the null hypothesis is rejected. These findings are also significant to the conceptualization of a 'top-down' simulation model for disaggregating manpower – the final phase of an on-going PhD studies.

Keywords – manpower, output, predicting, pattern matching, top-down model

1. Introduction

The aim of the paper is to investigate the time series components: seasonality, trend, cyclical, and randomness in the variables – construction manpower and construction output; as a basis for conceptualising if a relationship exists between manpower and output. In particular the paper tests the hypothesis that total annul manpower employed in the construction industry depends on total annual output. The paper also outlines the development of a conceptual model for predicting annual manpower demand by output, drawing on the theory of 'pattern matching' and concept of construct validity (Trochim, 2006). This approach should help foster manpower sustainability and desegregations (Makridakis and Wheelwright, 1989; Egan, 2004). Results of this investigation should therefore, complement the work by Olomolaiye et al (2005) on a review of construction skills supply and demand in the Black Country. A novel of UK's construction manpower and output is conversed; 1992 – 2004 time series component analysis (data decomposition) for manpower and output is presented. The theory of 'pattern matching' is examined followed by a section containing statistical description of concept operationalizing and summary of regressing the manpower variable on the predictor variable. The developed model is evaluated, and conclusion arrived at in the final section.

2. State of the Industry

By virtue of its characteristics, the construction and building services industry is deemed vital for the economic sustainability of both the developed and developing countries. UK's construction sector remains one of the strongest in the world with output ranked in the global top ten (dti, 2004; Ejohwomu et al, 2005a). The sector currently accounts for 10% of Gross Domestic Product (GDP) and employees approximately 2 million people with more than 1 in 14 of the total workforce (CITB, 2003). Growth rate in the construction sector has been outstanding, and a stronger growth rate is currently being predicted for 2007, after output fell in 2005 for the first time in 11 years (Construction News, 2006). This buoyant outlook is very much mirrored in the employment trend; overall demand for manpower is also expected to peak continuously (dti, 2005). See figures 1 and 2 for details.

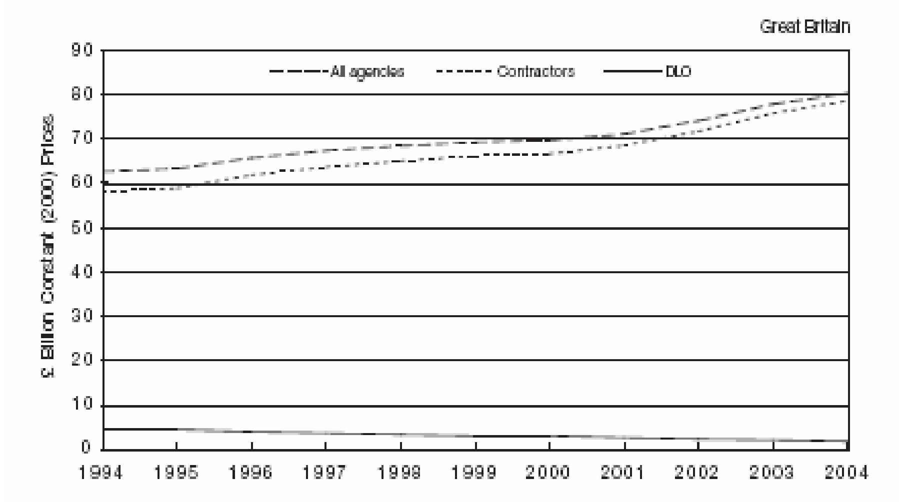


Figure 1: Output – all agencies, constructors and direct labour organisation
Source: construction statistics annual

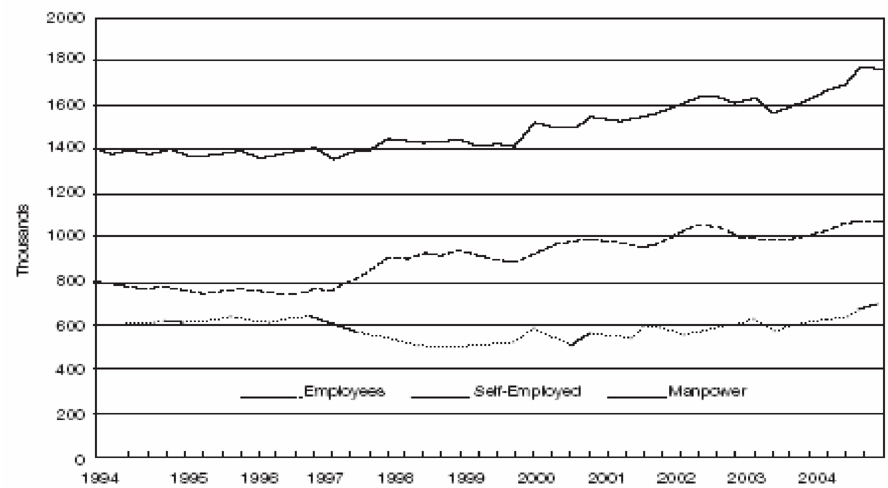


Figure 2: Output – trends in employment and the profession
Source: construction statistics annual

The perception however of the current industry growth forecast is that there will be severe shortage of skills. The implication of which includes:

- Threat to global competitiveness – reduced GDP;
- Skills gap – deficiency in proficiency;
- Unemployment – increased claimant rate;
- Decline in labour productivity;
- Inflationary pressures within the labour market;
- Overstressed workforce;
- More ‘cowboy’ builders;
- Avoidable injuries and death;

3. Theory of Pattern Matching

The inability, to sufficiently model the goings-on of the UK construction sector has been partly blamed on the absence of theoretically founded strategies and models (Mackenzie et al, 2000; Keskola, 2000; Courtney, 2003). Thus, in order to readily match the theoretical realm to the observational realm, this paper is drawing on the theory of 'pattern matching' (Trochim, 2006). Figure 3 captures activities in both theoretical and observational realms. This theory can be used as a basis for generating patterns of predictions. While the theoretical realm is outside the scope of this paper (see Ejohwomu et al, 2005b for theoretical framework), the observational realm is detailed in the subsequent section. However, overall, the theory of 'pattern matching' involves an attempt to link two patterns where one consists of theory – theoretical realm and the other observed data – observational realm.

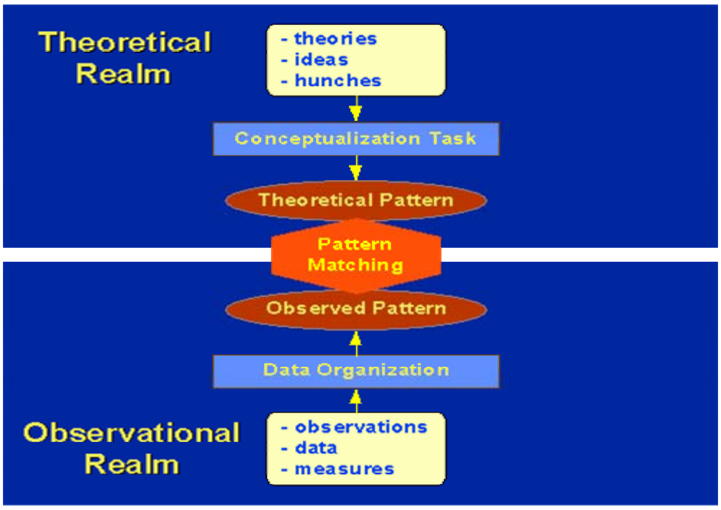


Figure 3: theory of pattern matching
Source: Trochim, 2006

4. DECOMPOSITION OF TIME SERIES COMPONENTS

Given the current 'state' of the UK construction sector, the need for adopting a transparent manpower information systems framework cannot be over emphasized as every constituent attribute of most participating variables are modelled (Heijke, 1994; Olomolaiye, 2005). However, as the graphs of manpower and output data in figure 1 and 2 do not present holistic information on observed pattern; the time series is decomposed. The primary reasons for adopting this decomposition method of time series forecasting are: the nature of the data, and to identify the individual components of the basic underlying pattern, which should form a basis for modelling manpower activities.

4.1 Data Description

The data was obtained from the Department of Trades and Industry – annual construction statistics report which conveniently brings together a wide range of statistics that are available in the UK construction sector. Furthermore, the data, which spanned a 12-year period, was checked for missing observations and inconsistency (Chatfield, 1995). Consequently, the attributes of the variables – manpower and output were operationalized (Makrikadis and Wheelwright, 1989; Kvanli et al, 2003). The general mathematical representation of the decomposition approach is given below: $X_t = f(S_t, T_t, C_t, R_t)$

Where, X_t = time-series value (actual data) at period t
S_t = seasonal component (or index) at period t
T_t = trend component at period t
C_t = cyclical component at period t
R_t = random component (or error) at period t

5. SUMMARY ANALYSIS - MANPOWER AND OUTPUT VARIABLES

The summary analysis and comparism of manpower and output variables is as detailed below. The graphs from manpower decomposition are encapsulated in bold while those of output are in thin lines.

5.1 Original data and trend line

Both variables have shown evidence of a linear trend, which has a comparatively steady increase in time series. The deseasonalized values, which contain no seasonality, were obtained by dividing each observation by its corresponding seasonality index. These values are contained in the time series trend table (under the column labelled D(t)). See appendix for sample table. These trends are most apparent because the deseasonalized values tend to increase with time. The least squares line through the deseasonalized data manpower is TR(t) = 12307.647 + 73.385t while that of output is TR(t) = 1342.308 + 5.263t.

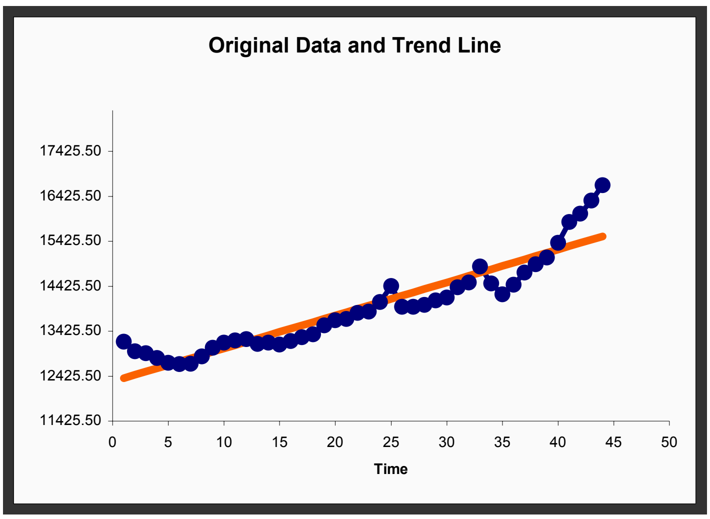


Figure 4: Manpower Trend

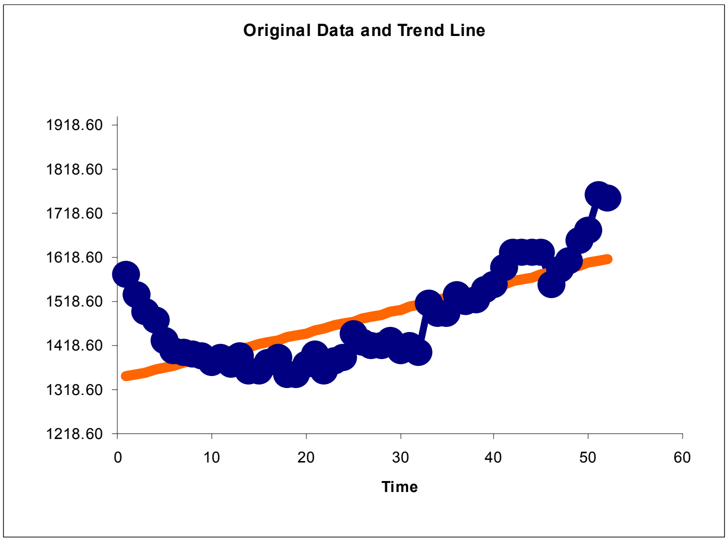


Figure 5: Output Trend

5.2 Seasonality Components

In plotting the seasonality index, the moving average is determined; the sum of the seasonality index is 3.999 for manpower and 4 for output. Details revealed in the seasonality table and plot includes:

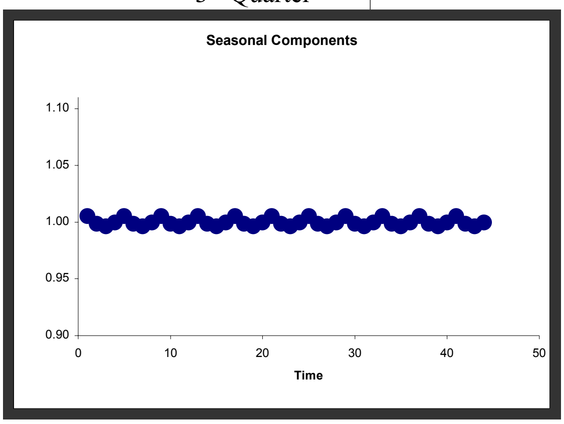
1. Large seasonality index for first quarter, which is indicating a comparatively high manpower demand in this quarter;
2. Low seasonality index for the third quarter and second quarter for output, which is indicating a comparatively low manpower related activity;
3. Manpower activity in a quarterly descending order for both variables is similar.

Manpower

1st Quarter
4th Quarter
2nd Quarter
3rd Quarter

Output

1st Quarter
4th Quarter
3rd Quarter
2nd Quarter



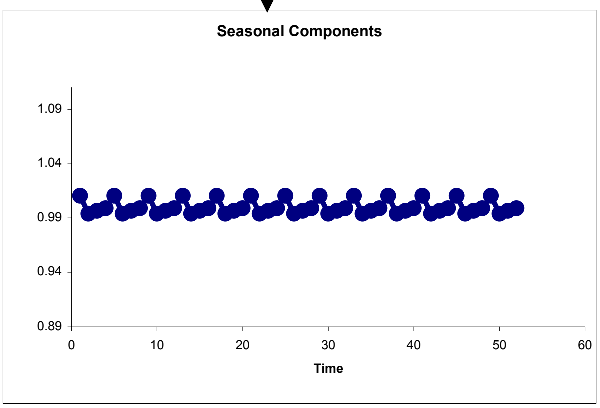


Figure 6: Seasonality

Figure 7: Seasonality

5.3 Cyclical Components

These were obtained by dividing each deseasonalized observation by the corresponding trend value dt / TR_t = dt / d_t = C_t * I_t. The resulting values contain cyclical effects as well as an irregular activity component – this can be reduced by computing a series of three-period moving averages on the C_t * I_t. An observation of the start of the cycle contained in the cyclical components plot for both variables ended in the midst of upward cycles. See figures 8 and 9 for manpower and out graphs for cyclical component.

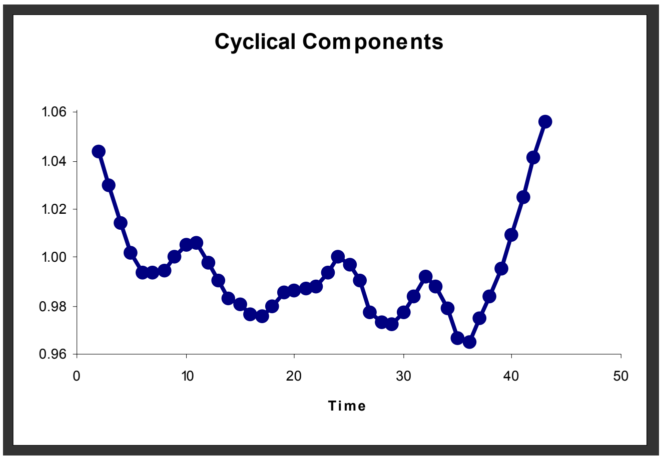


Figure 8: Cyclical

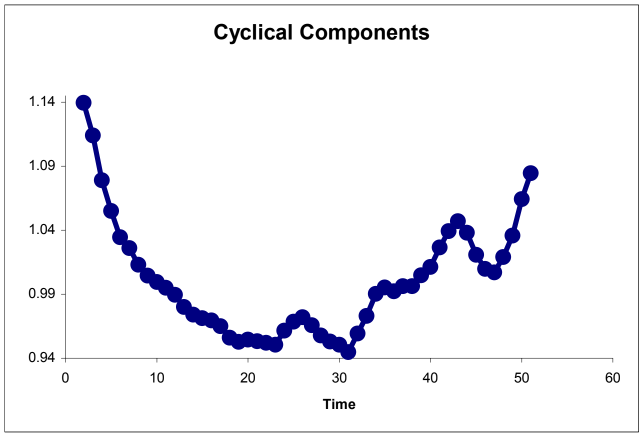


Figure 9: Cyclical

5.4 Noise Component

The graph of irregular activity (noise) contains no obvious pattern, as expected. See figures 10 and 11. However, because the observed pattern and resulting comparism holds no information on the significance of the relationship between manpower and output, the next section would aim at testing if there is a relationship.

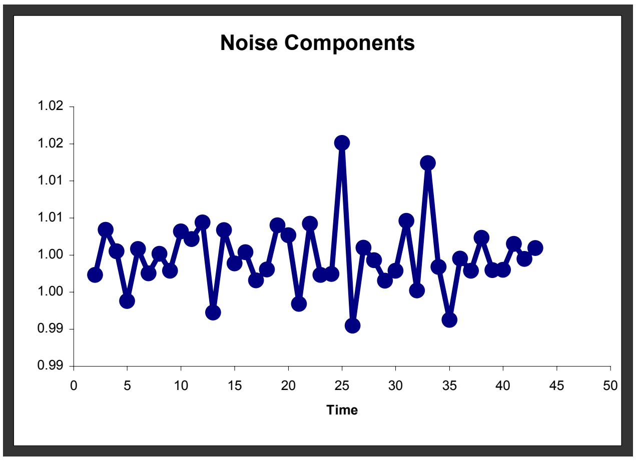


Figure 10: Noise

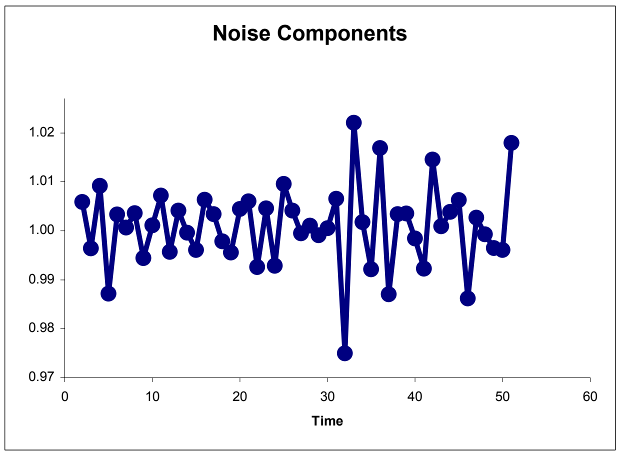


Figure 11: Noise

6. ESTABLISHING VARIABLE RELATIONSHIP: Regression Analysis

The result of operationalizing the time series components confirms evidence of a positive linear relationship in relation to time for both manpower and output. Consequently, this section is aiming to determine if there is a relation between the attributes of manpower and output variables, where manpower is the dependent variable and output the independent. See summary of result as detailed in appendix. In achieving this, the first part of the analysis required a scatter plot of manpower and output variable. This procedure is to determine the degree of relationship between manpower and output. The calculated correlation, r is 0.72; this is a fairly strong positive relationship. In order to reinforce these findings, a second method was employed involving the significance test to determine the probability that the observed correlation occurred by chance. The significance level for entering variables into the equation was 0.05 implying that any variable with sig. value < 0.05 were entered into the regression equation. The value of R = 51.4% implying that the equation accounts for only 54.4% of the variability in the annual manpower. Looking at the significance of the regression coefficient it can be seen that the t-value for manpower is 2.91 with a sig. value = 0.01969 < 0.05 providing evidence that the variable output is a useful predictor of manpower. See appendix for details of ANOVA table.

For the validity of this results it was necessary to test the assumption made that errors are normally distributed with a constant variance. A residual probability plot of the stored residual against expected residuals showed points close to the straight line, indicating that the residuals were approximately normally distributed. See appendix for residual normal probability plot. However, the output residual plot (see appendix) showed no evidence of outlier, which supports the 'goodness' of the model: **manpower** = 3463.774 + 9.34x.

6.1 Limitation of model

The proposed model can be used to produce short-term estimates for operative employee demand for construction and building services activities. Whilst this paper is accepting the argument that models are as good as data used (Agapiou et al, 1995); generating disaggregated forecast on manpower activities would require equations that incorporates both randomness and technological changes. The work presented in this paper is in two-folds:

- Highlighting problems faced in modelling demand for construction manpower;
- A mathematical concept for disaggregating manpower – top-down simulation model is conceived.

Drawing from the results of the regression analysis – positive linear relationship between manpower and output variables, output has been disaggregated by New Housing (NH), Other New Work Non Housing (ONWNH) and Repairs and Maintenance. Manpower will be disaggregated using a top-down simulation model.

7. CONCLUSION

This paper presents an aggregate demand model for manpower activities in UK construction and building services sector using annual data for the period 1992 – 2004. The theoretical realm of the model, which is outside the scope of this paper, was matched with a corresponding observational realm using theory of 'pattern matching'. The observational realm was operationalized using regression analysis and decomposition method of forecasting. This approach was to identify the relationship and underlying behavioural pattern of manpower and output variables. The hypothesis that annual manpower employed in the construction industry depends on annual output was tested. There is a significant positive relationship between manpower and output variables and some considerable evidence of 'pattern matching'.

There are a number of other factors, which may influence the evidence of 'pattern matching'; this may include project location and durability, randomness, migration and technological advancement. In its present form the proposed model can be used in estimating the short-term forecast for construction and building services operatives employees. Overall, the approach for investigating and matching variables has been conceptualized; and the variability in annual manpower and output activities was established. A holistic medium-term model will require further model development, which is part of an ongoing PhD studies.

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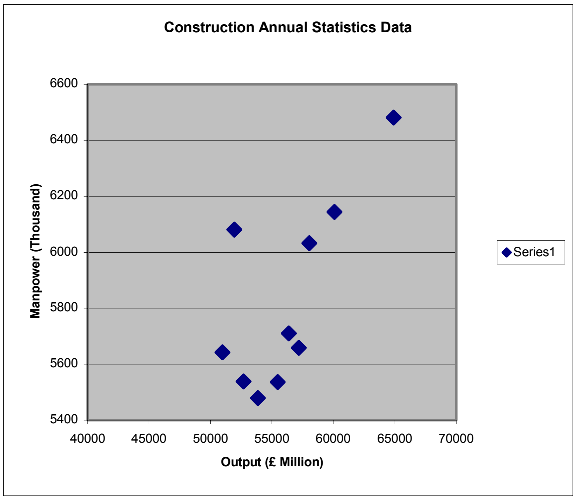
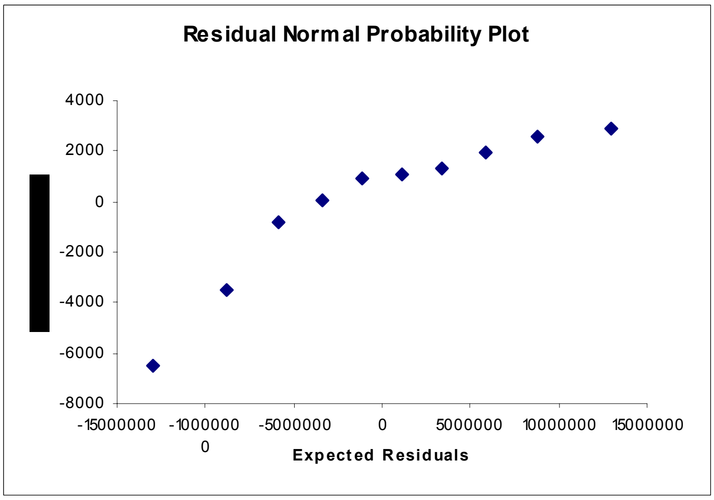
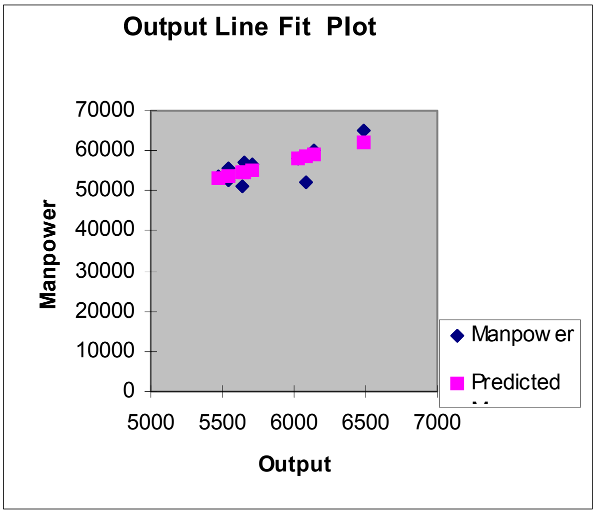
Appendix

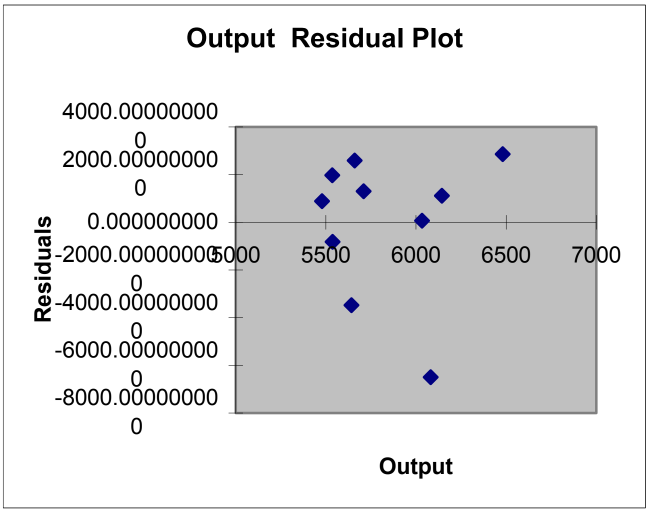
SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.716649232
R Square	0.513586122
Adjusted R Square	0.452784387
Standard Error	3110.254539
Observations	10

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	81712627.21	81712627.21	8.446899147	0.019698845
Residual	8	77389466.39	9673683.299		
Total	9	159102093.6			
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	3463.74435	18155.91704	0.190777714	0.853452286	-38403.9025
Output	9.037280354	3.109489543	2.906354959	0.019698845	1.866779972









Deseasonalized Values
Least squares line through the deseasonalized data is Dhat(t) = TR(t) = 1342.308 + 5.263t

Year	Quarter	t	Y(t)	Seas. Index	D(t)
1992	1	1	1579.	1.010	1562.810
	2	2	1533.	0.994	1542.353
	3	3	1494.	0.997	1499.093
	4	4	1475.	0.999	1476.325
1993	1	5	1432.	1.010	1417.317
	2	6	1409.	0.994	1417.596
	3	7	1403.	0.997	1407.783
	4	8	1398.	0.999	1399.256
1994	1	9	1394.	1.010	1379.707
	2	10	1379.	0.994	1387.413
	3	11	1390.	0.997	1394.739
	4	12	1375.	0.999	1376.236
1995	1	13	1394.	1.010	1379.707
	2	14	1362.	0.994	1370.310
	3	15	1362.	0.997	1366.643
	4	16	1382.	0.999	1383.242
1996	1	17	1392.	1.010	1377.727
	2	18	1354.	0.994	1362.261
	3	19	1355.	0.997	1359.620
	4	20	1378.	0.999	1379.238
1997	1	21	1399.	1.010	1384.656
	2	22	1361.	0.994	1369.303
	3	23	1384.	0.997	1388.718
	4	24	1392.	0.999	1393.251
1998	1	25	1447.	1.010	1432.164
	2	26	1426.	0.994	1434.700
	3	27	1419.	0.997	1423.838
	4	28	1418.	0.999	1419.274
1999	1	29	1429.	1.010	1414.348
	2	30	1409.	0.994	1417.596
	3	31	1418.	0.997	1422.834
	4	32	1403.	0.999	1404.261
2000	1	33	1514.	1.010	1498.477
	2	34	1491.	0.994	1500.097
	3	35	1493.	0.997	1498.090
	4	36	1535.	0.999	1536.379
2001	1	37	1518.	1.010	1502.436
	2	38	1523.	0.994	1532.292
	3	39	1546.	0.997	1551.271
	4	40	1557.	0.999	1558.399
2002	1	41	1594.	1.010	1577.656
	2	42	1629.	0.994	1638.938
	3	43	1629.	0.997	1634.554
	4	44	1629.	0.999	1630.464
2003	1	45	1629.	1.010	1612.297
	2	46	1559.	0.994	1568.511
	3	47	1590.	0.997	1595.421
	4	48	1613.	0.999	1614.449
2004	1	49	1659.	1.010	1641.990
	2	50	1682.	0.994	1692.262
	3	51	1762.	0.997	1768.007

THE IMPACT OF CULTURE ON CAREER DEVELOPMENT OF WOMEN IN CONSTRUCTION

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ABSTRACT: The construction industry is the most male dominated industry and displays a macho culture, where relationships are characterized by argument, conflict and crisis. Male values are the norm and are rewarded and the expectation is that career achievement is paramount in construction. This challenging nature of the construction workplace and its impact on women's career forms the basis for a significantly lower participation of women in the industry. It is also found that the cultural environment is likely to remain problematic for women unless it can be changed in a way that values their contribution. Such changes require a radical shift in middle management attitudes, a departure from current organizational human resource management systems, and a wider acceptance of the need for cultural change within the industry. In this context, this paper presents a review of the literature on experiences of women working in the industry, particularly focusing on whether (and how) the cultural aspects of the workplace environment impinge upon women's career development.

Key words- Career development, Construction, Culture, Women

1. BACKGROUND

As in many developed economies, the construction sector in the United Kingdom remains largely a male preserve. Currently, women constitute less than 10 percent of those working within the industry as a whole (Dainty et al, 2002). The poor image of construction, a lack of role models and knowledge, poor careers advice, gender-biased recruitment literature, peer pressure and poor educational experience have all been cited as militating against women's entry to the industry (Gale and Skitmore, 1990; Coles, 1992; Johnson et al., 1992; Srivastava,1992; Bronzini et al., 1995; Wall, 1997; Dainty et al, 2000). Sommervill et al. (1993) identified both structural and image related barriers to women's entry to the sector, such as facilities, training, career progression, education and the present level of their participation. This replicates the unfortunate position in construction as having one of the worst public images of all industries, being synonymous with high cost, low quality and chaotic working practices (Ball,1988).

Willkinson (1992) found that 20% of employers believed that construction work was "unsuitable for women". According to Greed (1997), the need for identification with values of the construction sub-culture prevents the entrance of people and ideas that are seen as different and / or unsettling. Employer prejudices in this regard may manifest themselves through the recruitment process (Morgan, 1992), particularly as recruitment in construction is often informal and happens through personal contacts (Druker and White,1996). Other women are made to feel unwelcome, and are not encouraged to develop towards the senior positions from which they could contribute to shaping the built environment (Greed, 1997).

Bagilhole et al., (2000) noted that the construction workplace has been described as amongst the most chauvinistic in the UK, with an extremely macho culture which is hostile and discriminatory towards women. This results in gender differentiated career opportunities which have an inevitable consequence of high staff turnover of women in construction companies (Davidson & Cooper, 1992; Brett & Stroh, 1994). Andrew et al., (2000) found that younger women became disillusioned with their career choice more rapidly than men, and sought to leave the industry early on in their careers. This was caused by women having opportunities over-sold to them by target recruitment campaigns aimed at attracting them in to the industry. Very few had been advised to join the industry by their friends and family, and so they had a poor initial understanding of the culture of the industry and the other inherent difficulties of working in such a male dominated and oriented environment.

According to McNamara (2005) the Human Resources Management (HRM) function includes a variety of activities, and key among them is deciding what staffing needs you have and whether to use independent contractors or hire employees to fill these needs, recruiting and training the best employees, ensuring they are high performers, dealing with performance issues, and ensuring your personnel and management practices conform to various regulations. Activities also include managing your approach to employee benefits and compensation, employee records and personnel policies. But Bagilhole (2003) noted that the responsibility for HRM and development tended to have been devolved to line management in an organization. Further, these managers were invariably male, and were untrained in HRM or equal opportunities practice. so they were perceived as having stereotyped expectations of women's career priorities. They preferred to recruit men, whom they saw as being more compatible with their own ethics, and who would reinforce existing culture within the organizations (Bagilhole, 2003). Also, it has been reported that many women saw inter-organizational mobility as necessary to circumvent the barriers obstructing their development. Men, however, preferred to remain within companies where they had a good understanding of the organizational structure and culture that could be used to further their career. This strategy also found that women were forced to expend their efforts in maintaining their positions, or in coping with discriminatory actions perpetrated by their male colleagues, whilst men could expend their efforts in actively developing their careers.

Women now comprise some 18% of the undergraduates on construction related courses within the UK (HEFCE, 2001). Thus, the focus of concern should now lie with ensuring that equal opportunities exist for women working within the sector, in order that they remain within it in the long- term (Bagilhole, 2003). Maintaining an upwards trend in the number of women wanting to enter the industry is difficult when those currently working within the industry are neither evenly distributed throughout the professions, nor appropriately represented at middle and senior level. Further, according to Bagilhole (2003), once women have entered the industry they progress at slower rates than their male colleagues, and confront a greater number of obstacles to their development. Clearly a wide range of interrelated structural and cultural factors have contributed to this disparity, including women's own active strategies in coping with career constraints. This problematic nature of the construction workplace and its impact on women's career forms the basis for a significantly lower participation of women in the industry. In this context, this paper presents a review of the literature on experiences of women working in the industry, particularly focusing on whether (and how) the cultural aspects of the workplace environment impinged upon women's career development.

2. CONSTRUCTION ORGANISATIONAL CULTURE

Within organizational theory the concept of culture tends to be used in two distinct ways: firstly as something that an organization has, that can be construed as an independent variable; and secondly, as something an organization is, a root metaphor (Smircich, 1983). A number of writers (Newman, 1995; Schein, 1992) describe culture as having different layers. Schein (1992) envisages three levels of culture: first artifacts, which includes observable behaviour and processes as well as physical objects; second, publicly espoused values such as mission statements and policy documents; and lastly, the underlying assumptions which are rarely articulated and may conflict with espoused values and even with each other. This framework can be used to explain the gap between rhetoric and reality in equal opportunities for women in organizations. Many companies with espoused "women friendly" policies which may be exposed by women's lack of progress compared to their male colleagues, an artifact in Schein's (1992) terms. The contradiction between espoused value and artifact indicates a conflict between espoused values and underlying assumptions. It is the embeddedness of gendered attitudes and behaviour in organizational culture that is inimical to women, and hinders their progress (Wilson, 1998). This is because that individual can influence the recruitment and promotion of those whom he or she considers to be similar to himself or herself in terms of sex, social, background and education (Kvande and Rasmussen, 1993). The pursuit of self-interest and power is a basic process in all organizations, and should be viewed as a political system (Handy, 1993).

Organizational cultures present problems for Human Resource Management practitioners and researches alike because they are the most difficult part of the organization to change (Itzin and Newman, 1995) and the hardest to measure (Owen, 1993). Despite this, awareness of organizational culture is an essential element of Human Resource Management strategy (Guest,1992). The Human Resource Manager must be sensitive to the organizational culture as a significant determinant of career development (Bagilhole et al, 2000).

2.1 Male Dominated Culture and Environment

The construction industry displays a macho culture where relationships are characterized by argument, conflict and crisis (Gale, 1994). As a result, employees (male and female) find that they are exposed to an extremely hostile environment. Women who are attracted to the construction industry face the same stereotypical barriers as women in other sectors. In this male dominated profession there are added stereotypes regarding the nature of the profession and the professional themselves (Langford et al, 1994). Women who do enter the construction industry in professional positions tend to fill technical specialist positions rather than general managerial posts (Bennett et al, 1999).

This macho environment is also expressed in more disturbing terms, and sexual harassment within the construction industry is a real concern, with almost all reports on women in the industry acknowledging this problem (CIB, 1996). According to professor Michael Romans, a past president on the Chartered Institute of Building, the construction industry is characterized by "a boy's own culture" which is overtly fostered through language and behaviour. Davey et al (1999) highlighted that in the construction industry, male values are the norm such as long working hours, competition, independence, full-time working and that rewards and the expectations for career achievement are paramount. Davidson (1996) and Davidson & Cooper (1992) indicated that women who seek entry into male –dominated cultures either have to act like men in order to be successful, or leave if they are not adaptable to the culture, or they can remain in the industry without behaving like men but maintaining unimportant positions. However, faced with this organizational barrier, some women still seem able to gain a higher degree of career satisfaction and optimism than their male counterparts, as they continue to enter former male roles (Nicholson and West,1988). As discussed in section 2 and 2.1 it is an important issue of identification of organization culture and the male dominated environment in the construction industry. By considering the above, it can be said that it is important to evaluate and have a good understanding about women's career development within the construction industry.

3. THE PROCESS OF CAREER DEVELOPMENT

Theorists such as Super (1957) and Schein (1971) assume that a career is a life–long, uninterrupted experience of work, which can be divided into neat stages of development, starting with initial ideas about working and ending with retirement.

However the patterns of women's career development are frequently affected by family as well as workplace commitments and responsibilities, unlike those of men. Therefore Astin (1984) proposed that career development theory should describe women's career separately from men's careers. Her model of career development is based upon four constructs which she believes shape women's career development. They are: work motivation, work expectations, sex-role socialization and structure of opportunity which includes factors such as sex-role stereotyping, distribution of jobs and discrimination. Larwood and Gutek (1987) concluded that any theory of women's career development must take account of five factors:

1. Career preparation, or how women are brought up to view the idea of a career and whether they believe they will have one or not.
2. Availability of opportunities should be taken into consideration, and whether they are limited for women, compared with men.
3. Marriage, viewed as neutral for men but harmful to the career of women.
4. Similarly, pregnancy and having children inevitabley cause women to take some kind of career break.
5. Timing and age, as career breaks and family relocations often mean that women's careers do not follow the same chronological patterns as those of men.

Powel and Mainiero (1992) claimed that women have two overriding concerns in their lives, for their career and for others (e.g. family and friends). Their model therefore incorporates the influence of personal, organizational and societal factors to describe the balance between work and non-work aspects of life which most women strive to achieve.

3.1 The Nature of Organisational Career Development

The paid work aspects of most careers unfold within an organizational context. As such, it is important to understand the processes that influence organizational behaviour and the development of the individuals within them (Hall and Seibert, 1992). Within organizations, careers can be seen to be determined by the mutually interdependent dimensions of structure, culture and individual action (Dainty et al, 2000). Structure and culture are influenced by the decisions and actions of the individual, while at the same time helping to determine their decisions (Evetts, 1992). This perspective sees individuals as defining their growth throughout their life of work, rather than moving along pre-determined career paths (Sonnenfeld and Kotter, 1982).

Gender is fundamental to the culture of organizations, as has been shown in well known studies within other sectors (Ledwith and Colgan, 1996), and effectively organizations form "gender culture", known to be hierarchical, patriarchal, sex-segregated, sexually divided, sex-stereotyped, sex-discriminatory, sexualized, sexist, misogynist, resistant to change, and to contain gendered power structures (Itzin,1995). The masculinity forms a key element of corporate culture (Hofstede, 1984).

It is clear from this literature review that construction industry culture has an impact upon women's career development from entry in to the industry up till achieving a higher position in the organisations. Therefore Section 4 further elaborates how cultural dimensions affect career development.

4. DISCUSSION

Research findings summarized that construction companies provide a patriarchal workplace environment, where men resent women's participation as professional equals. Gender appears to be embedded within the practices and relationship that construction organization endorse, as the synergy of the exclusionary and discriminatory aspects of the industry's subculture challenge women's success and avert their participation. Hofstede (1991) contented that culture creates an orderly set of rules which allow work to be carried out in a particular way. This reflects the different power of workers and managers to create these practices. According to Brown (1995) Human Resource Managers now claim organizational culture as their "territory". This implies that they manipulate culture through recruitment (control over the types of people that gain entry to the organization), promotion and demotions (control over who reaches positions of influence within the organization), induction and socialization (a strong influence over the social dynamics within the organization), codes of practice, mission statements and reward appraisal systems. Human Resource Managers aim to remove cognitive and behavioural dispositions which deviate from the norm, and to ensure that employees adopt the organization's values as their own behaviour in pursuit of career goals (Baron and Greenberg, 1990). Therefore Human Resource Mangers are the key persons to handle the career development guiders. Such mangers make assessments of their staff's training needs and progression via performance appraisal systems. These male managers stipulate performance criteria compatible with male career development patterns. In particular, working hours and staff allocation are organized in an erratic and ad –hoc manner, which creates difficulties for women with life-cycle restraints (Bagilhole, 2003). According to Bagilhole et al (2000), reaching powerful senior operational positions has proven particularly problematic for women, because in addition to socially excluding them, men appear to overtly attempt to undermine women's contributions in an attempt to preserve their own positions. This demonstrates that cultural conflict exists between the environment offered by the construction workplace and women's career needs expectations. Bagilhole (2003) has highlighted the competitive work environment as a reason, where mangers are in a contest for a limited number of promotional opportunities. Further, they argued that this situation has been intensified by companies continuing to appoint externally to middle management positions, and by the removal of management levels in order to streamline organizational structures. This results in women being perceived as a threat, both in terms of promotional opportunities and to existing cultures. This resentment is manifested in overt discrimination and harassment and informal discriminatory mechanisms. These latter mechanisms include excluding women from out of work events, which offer career enhancing benefits.

According to Bagilhole et al (2000), an organization can be seen as having cultural systems that promote competition and cooperation simultaneously. Members cooperate to carry out tasks while competing for a limited number of career openings (Kvande and Rasmussen, 1994). Such systems form an arena for the manifestation of the power and interests of their members (Mintzberg, 1983). Gender is an essential aspect of an organization's makeup (Ledwith and Colgan, 1996) and women can be prevented from progressing in their careers in parity with men by the cultural environments they encounter (Chi-Chang, 1992 and David and cooper, 1992). Women entering the labour market are expected to fit into career patterns that tend to be full-time, involve a life-time commitment, seek an ordered vertical progression and require employees to exhibit a high degree of career focus.

Nicolson (1996) highlights that the most obvious effect of patriarchal work culture is that they lead to discriminatory practices that in turn undermine, devalue and subordinate women's contributions. Overt discrimination may be manifested in discriminatory remarks and behaviour or in promotional and other policy decisions whereby women are ignored or subordinated in relation to their male peers (Bagilhole et al, 2000). Unconscious forms of discrimination are subtle and non-deliberate, but also have a tangible effect on career development. Discriminatory actions lead to feeling of low power and prestige, and increase the likelihood of conflicts at work for women (Gutek et al, 1996).

5. CONCLUSION

This paper has provided a literature review on the impact on culture in women's career development in construction. The culture of the construction industry has been highlighted by many researchers as one of the major barriers for women's career development, beginning with difficulties in joining the field of construction up to achieving the top position in an organisation's hierarchy. Construction organizations form competitive "power" cultures where women's contributions are marginalized and their careers impeded through a combination of inflexible work practices and discriminatory behaviour (Bagilhole et al, 2000). Further, they argued that these barriers to women's careers are maintained in small project teams by autonomous male operational managers. Therefore this cultural environment is likely to remain problematic for women unless it can be transformed in a way that values their contribution (Bagilhole et al, 2000). This requires a radical shift in middle management attitudes, a departure from current organizational human resource management systems, and a wider acceptance of the need for cultural change within the industry (Bagilhole et al, 2000).

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DEVELOPMENT AND SPATIAL EQUITY OF PUBLIC HIGHER VOCATIONAL EDUCATION AND TRAINING COLLEGES IN LIBYA

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ABSTRACT: In the 1990s, a network of higher education institutions known as Public Higher Vocational Education and Training Colleges (PHVETCs) was introduced in Libya to enhance the supply of skilled manpower. By 2000 there were a total of 85 PHVETCs across the country. The analysis of available statistics, however, suggests unplanned nature of the distribution of PHVETCs. This research has revealed that 21 percent of these colleges accounting for 34 percent of student population were located in just one of the country's 13 administrative divisions. Also, while it is well-understood that Libya requires more professionals in the areas of engineering, medicine and technology, PHVETCs continue to train and produce a significant number of graduates in education. This latter field of study accounted for more than 51 percent to the total courses provided by these colleges.

Keywords- Higher vocational education, spatial distribution, Libya

1. INTRODUCTION

Vocational Education and Training (VET) is an important sub-sector of the public education system in Libya. It has been subjected to an active process of redesign and has become the focus of the government's strategy in more recent years (Gannous, 1999). Accordingly, during the 1990s, a network of Public Higher Vocational Education and Training Colleges (PHVETCs) was established for the purpose of enhancing the supply of skilled manpower. The PHVETCs are post-secondary institutions and cover theoretical and practical curriculum in their courses. They award a qualification which is equivalent to a first university degree. The main objective of these colleges is to provide highly qualified human resource to fulfil the requirement of the economic and social transformation plans (El-Hawat, 1995).

Previous studies on Libyan Higher Education (Attir, 2005; El-Magouri; Aldhaif 2001; Keibah 1998; Alfaidy and Ibrahim, 1997; El-Hawat 1995 and 2003) provide evidence of the unplanned nature of the establishment and locations of Higher Education Institutions (HEIs) in the country, which probably occurred as a result of "social pressure" rather than the real demand of an area. El-Hawat (2003, p. 397) makes the following comment about this:

> "Such Universities are normally established at a quick pace and under social pressure without consideration for the basic requirements of university work…. These universities and colleges tend to produce graduates whose education is mostly inadequate, inflecting negative results on society rather than bringing positive results."

In this study it is hypothesised that the establishment and subsequent distribution of PHVETCs in Libya has been carried out inequitably, neglecting the socio-economic characteristics and the true needs of the different regions of the country. Thus, an attempt is made to analyse the development as well as patterns of the PHVETCs distribution in order to measure the spatial equity of these colleges among the 13 administrative Mintaqahs (provinces) see Figure 1. For this study, data and information has been compiled and/or computed from data generated by GDHVECs of the Secretariat of Education in Libya (GDHVECs, 2000) and from related literature.

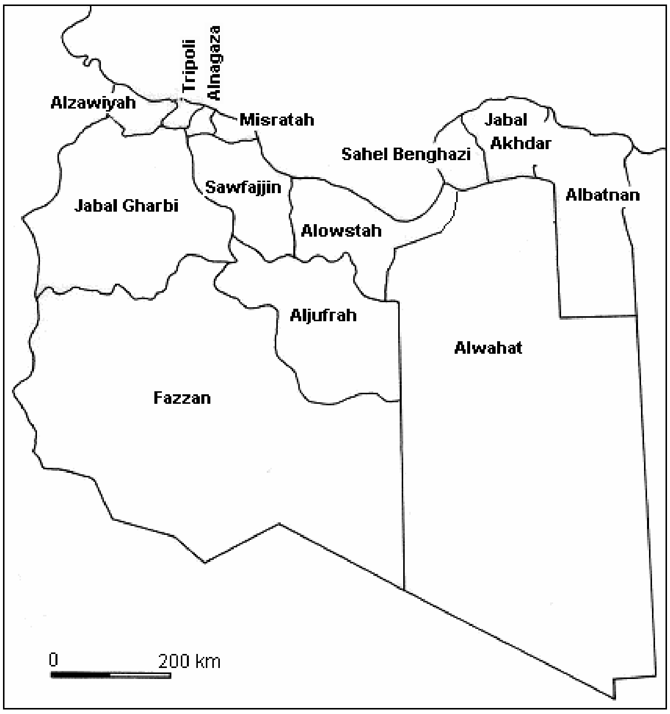

Figure 1: Libya: administrative boundaries of Mintaqahs, 1995
Source**:** Secretariat of Planning, 1978, pp. 25-6 based on data from NAID (no date).

2. DEFINITION OF TERMS

In general terms, equity can be defined as the equality of being equal or fair. In higher education, Teferra and Altbach (2003) identify different aspects of equity in African higher education including the inequitable distribution of and access to HEIs. This includes different positions between regions, men and women, the rich and poor, and rural and urban communities. Truelove (1993) points out that spatial equity "means treating equals equally irrespective of where they live". However, Talen (2001, p. 468) has mentioned four categories of spatial equity as follows:

> Firstly, equity can be defined as equality, in which everyone receives the same public benefit, regardless of socioeconomic status, willingness to pay, or other criteria… Second, equity in the distribution of public benefit can be predicted on the basis of need… Third, the equitable distribution of services or facilities can be based on demand… Finally, equity can be based on market considerations, where cost of service is a key factor in distribution.

In this paper, however, spatial equity of PHVETCs distribution will refer to differences in the distribution of these colleges and related subjects.

3. DEVELOPMENT OF PHVETCS IN LIBYA

Most of the studies that dealt with Libyan socioeconomic issues have mentioned the neglect in the area of manpower development in the country, and consequently have emphasised need for VET as a key factor to address the most pronounced problem of the shortage of skilled labour (Alshaikh 1972; IBRD 1960; UNESCO 1952). Historically, during the colonial period (1551-1951) there were no HEIs in the country. In fact it was not only HEIs that were unavailable, primary and secondary levels also were very few (Algomaty, 1975; Alshaikh, 1972; Wheeler, 1966). However, since the discovery of oil in the country, the provision of education facilities has been given high priority in the country and free education is provided at all levels. As a result the educational institutions and enrolments have increased significantly (Deeb and Deeb 1982; Dughri 1980).

Until 1980 Libyan society did not show much interest in VET especially at tertiary level. This situation aggravated as a result of extended legacy persistent of negative attitude towards technical and manual work (Al-Said, 1990; Alfaidy and Muftah, 1989) on one hand and unpopularity of VET among secondary students on the other (Al-Said 1990). This imbalance in the education system did not assist socioeconomic development plans that the country had embarked on since the early 1970's. Because of this situation, Libya, like other oil exporting countries, has had to rely heavily on expatriate labour to embark on its rapid socioeconomic development (Birks and Sinclair 1980; Secretariat of Planning 1999).

As stated earlier, because of imbalanced education system Libyan education planners came-up with what has been known as the "New Educational Structure Initiative" (Secretariat of Education 1982). This plan placed high priority to vocationalisation of the higher education sector which later became known as Public Higher Vocational Education and Training Colleges (PHVETCs).

Since the mid 1980s, the country has experienced unprecedented expansion in this type of HEIs. The number of colleges increased from 54 in 1995/96 to a country-wide network of 85 PHVETCs in 2000 with growth rate of 55.5 percent. Also, the total students enrolment has increased from 27,584 to 64,870 students with growth rate of 131 percent during the same period (Table 1).

Table 1: Enrolment of PHVETCs in Libya 1999/2000

Type of College	**1996**		**2000**	
	Colleges	**Students**	**Colleges**	**Students**
Comprehensive	14	6,563	23	13,432
Specialized	17	9,589	25	17,938
Trainer Teachers	8	3,510	9	6,714
Teachers Training	15	7,922	28	26,886
Total	54	27,584	85	64,870

Source: GDHVECs, 2000, different pages and NCETR, 1996, pp. 82-88.

Notwithstanding, numbers of the PHVETCs increased substantially during the last ten years or so, there are still some embedded problems in the system that affects its performance. The PHVETCs which are considered as the main supplier of highly skilled manpower, failed to attract required enrolments as the majority of secondary graduates prefer academic HEIs. On the other hand they are also unable to produce required graduates both in quality and quantity. This can be attributed to unplanned nature of the establishment of the PHVETCs in terms physical and human resources (Aldhaif 2001; Alfaidy and Ibrahim 1997; El-Hawat 1995 and 2003).

4. SPATIAL EQUITY OF PHVETCs DISTRIBUTION

This section examines the spatial equity of the PHVETCs. This is measured by using certain spatial and educational indices such as student enrolments to population, females to males and student/staff ratios and some other relevant techniques (Fonseca and Andrews 1993; UNESCO 1964).

Until the late 1970s almost all HEIs in Libya were concentrated in two cities namely Tripoli and Benghazi. These two cities are first and second largest urban centres in Libya respectively. This concentration of HEIs denied some under-represented groups (people from rural and low socioeconomic status) the benefits of higher education learning. This became a strong factor that influenced students from rural areas to migrate to where higher education was available (Harrison, 1967). Some analysts, however, have partially attributed the changes in country's population structure and distribution to the concentration of such education opportunities in certain cities (El-Kikhiya 1995; El-Hawat, 1995; Harrison, 1967).

However, as mentioned earlier since the beginning of the 1980s there has been deliberate policy of the educational planers to place particular importance on ensuring equal distribution of HEIs to all parts of the country (Alfaidy and Ibrahim 1997; El-Hawat, 1995 and 2003). This policy was set to achieve two main goals: a) to maximise equitable access to HEIs, and b) to enhance the supply of skilled manpower needed for the socioeconomic development plans. PHVETCs have been established for this purpose and in 2000 the total number of PHVETCs was 85 (Figure 2).

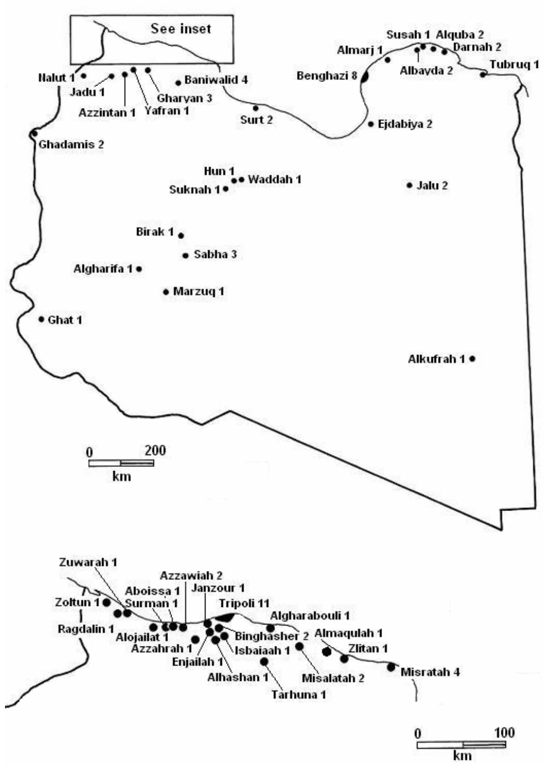

Figure 2: the Distribution of PHVETCs in Libya, 2000
Sources: The Secretariat of Planning, 1978, pp. 25-26, and appendix 1

4.1. The Colleges

These colleges are distributed among the 13 Mintaqahs of the country. Therefore each Mintaqah has at least one College. Indeed, as mentioned earlier, it has been a deliberate policy of the educational planners over the course of past years to spread-out PHVETCs facilities in different parts of the country (El-Hawat, 1995). However, Tripoli in particular, had the significant share of the PHVETCs with more than 21 percent of the total colleges (Table 2).

Table 2: The distribution of population and PHVETCs' students in Libya, 2000

No	Mintaqah	No. of Colleges	Population (1995)		Students (2000)		Students per 1000/pop.*
			No.	Percent*	No.	Percent*	
01	Albatnan	1	151,240	13.4	1,249	1.93	8
02	J. Akhdar	8	381,165	7.92	4,246	6.56	11
03	S. Benghazi	8	665,615	13.83	8,927	13.80	13
04	Alowstah	4	240,574	5.00	1,517	2.35	6
05	Alwahat	3	62,056	1.29	540	0.83	9
06	Aljufrah	3	39,335	0.82	750	1.16	19
07	Sawfajjin	4	76,401	1.59	1,890	2.92	25
08	Misratah	6	488,553	10.15	3,837	5.93	8
09	Alnagaza	4	244,553	5.08	2,120	3.28	9
10	Tripoli	18	1,313,996	27.31	22,266	34.42	17
11	Azawiyah	9	517,395	10.75	8,995	13.90	17
12	J. Gharbi	10	316,970	6.59	3,953	6.11	12
13	Fazzan	7	314,029	6.53	4,580	7.08	15
Libya		85	4,811,902	100.0	64,690	100.0	13

Source: Computed by the author from data in GDHVECs (2000) and Secretariat of Planning (1999, p. 78). * Numbers and percentages are rounded to the nearest integer

Another aspect of the locational distribution of PHVETCs that has some bearing on opportunity in access to HEIs is the rural-urban differential. As can be observed from Figure 3, more than 61 percent of the PHVETCs are located in settlements of more than 50,000 inhabitants. Furthermore, according to available data (Appendix 1), 56.6 percent of the total PHVETCs are located either in the national capital or in district capitals. This pattern of distribution could be attributed to the heavy concentration of and hence access to HEIs opportunities in the more-developed areas (major cities and towns) at the expense of other disadvantaged areas.

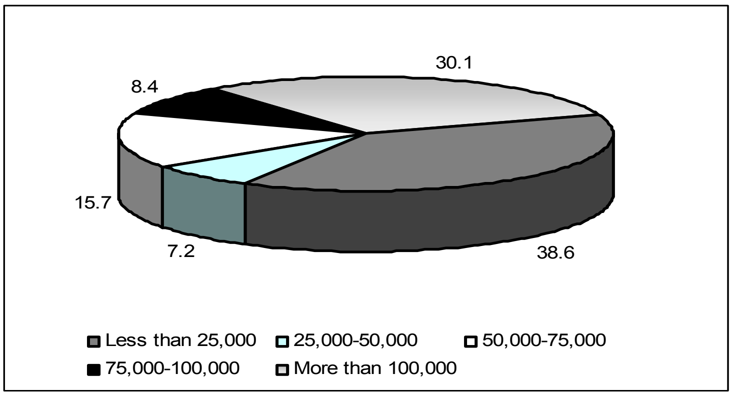

Figure 3: Percentage distribution of PHVETCs locations according to settlement size
Source: Computed by the author form data in Appendix 1.

4.2 Enrolment

The distribution of enrolments across the country's 13 Mintaqahs is shown in Table 2. As can be seen from Table 2, there is to some extent similarities in the percentage distribution according to each Mintaqah share of population and students.

Nevertheless, Tripoli in particular which is the largest Mintaqah in terms of population has proportionally more students than its population share. To measure the relationship between population and enrolments in the 13 Mintaqahs the Spearman Rank Order Correlation Coefficient has been administrated.

The formula for determining the Spearman Correlation Coefficient is (Rogerson, 2001, p. 94):

$$r_s = 1 - \frac{6(\sum D^2)}{N(N^2 - 1)}$$

Where 6: is a constant, D: refers to the difference between subjects ranks on the two variables, and N: is the number of cases.

The correlation coefficient has been computed between the two variables (enrolments and population) and found to be = 0.923. This result suggests a strong, positive and statistically significant relationship between the figures of population and enrolments in the 13 Mintaqahs of the country. Apparently this means that number of population in the Mintaqahs determines to a large extent the number of students enrolled in the PHVETCs.

Another way of examining the availability of education opportunities in any area either on national or local levels is the number of students per 1,000 inhabitants. As shown in Table 2, in the national level there were 13 students per 1,000 inhabitants with significant Mintaqahs differences. Taking the national average as a yardstick, there was only one Mintaqah that has similar national average (Sahel Benghazi). Whereas above the national average there were five Mintaqahs, four are located in the north and only one in the south. These Mintaqahs were ranged between 25 students as the case of Sawfajjin and 15 students as in Fazzan. On the other hand the rest seven Mintaqahs were below the average. These Mintaqahs ranged between as little as six students as the case of Alowstah and 11 students as in Jabal Akhdar.

4.3 Gender dimensions

One striking aspect of inequity of access to education in the developing societies is the female/male enrolments differential (Teferra and Altbach 2003; Akpan 1987). Clearly, gender inequity at national level has decreased enormously over the course of the past few years (El-Magouri, 2005; Al-Hawat, 2003; Bubtana and Sarakbi 1991). According to El-Magouri, (2005, p. 82) the proportion of female students to the total student enrolment has increased from 10 percent in 1970 to more than 50 percent in 2001. This also is true in the case PHVETCs provision. In 2000, the proportion of female enrolment at national level gave an impression that it was significant (approximately 48 percent). However, a closer look at Table 3 shows considerable variation on the Mintaqahs' level. Among the 13 Mintaqahs disparity in access to PHVETCs was smallest in Alnagaza (18.1 percent) and highest in Alwahat (75.7 percent).

This considerable variation between the Mintaqahs can be explained by socio-cultural characteristics on one hand and types of courses that are offered by the colleges on the other. Broadly speaking, until recent years Libyan society in general, and in rural areas in particular, there was bias towards female access to HEIs, (El-Magouri, 2005; Alshaikh 1972). However, there is a general trend in Libyan society that encouraging girls in particular to enrol in teachers training colleges if this type of HEIs is available in one area. Teaching is considered as the most favoured work for women among many other employment opportunities (El-Magouri, 2005; Keibah, 1998).

Table 3: The distribution of the Female/Male enrolment in Libya, 2000

No	Mintaqah	Males	Females	Female/Male %
01	Albatnan	387	862	69.0
02	Jabal Akhdar	2,196	2,050	48.3
03	Sahel Benghazi	4,686	4,241	47.5
04	Alowstah	585	932	61.4
05	Alwahat	131	409	75.7
06	Aljufrah	367	203	27.1
07	Sawffajjin	1,241	649	34.3
08	Misratah	2,293	1,544	40.2
09	Alnagaza	1,737	383	18.1
10	Tripoli	10,921	11,345	50.9
11	Azawiyah	4,386	4,609	51.2
12	Jabal Gharbi	2,338	1,615	40.8
13	Fazzan	2,430	2,150	46.9
Libya		33,698	30,992	47.9

Source: Computed by the author from data in GDHVECs (2000).

4.4 The Faculty

In 2000 the total number of academic staff at the PHVETCs was 4,845 (GDHVECs 2000). This number was distributed into three categories: Full-time national, full-time non-national, and part-time (Figure 4).

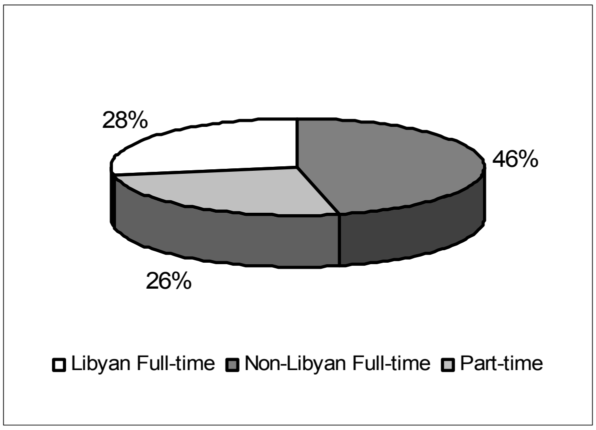

Figure 4: Distribution of faculty members in the PHVETCs in Libya, 2000
Source: Computed by the author from data in GDHVECs (2000).

It is clear from Figure (4) that PHVETCs rely noticeably on non-Libyan faculty as well as part-time faculty for the delivery of instruction. The full-time non-Libyan constituted almost 46 percent of the total faculty members in 2000. In this respect, there is sufficient evidence from the literature (Attir, 2005; EUN 2003; Bubtana and Sarakbi 1992; Muftah 1982) indicating that the lack of faculty members has long been problem that affected the system of higher education and will probably continue to affect it. Until now, Libyan higher education still depends to a large extent on expatriate for the delivery of instruction.

The problem of shortage of faculty staff is not only because Libyan higher education is incapable of producing sufficient number of academic staff but it can also be attributed to the impact of the phenomenon of brain drain, i.e. the loss of qualified and talented professionals to other countries (Attir, 2005; Teferra and Altbach, 2003).

Turning now to the distribution issues of PHVETCs, an important indicator for measuring equity in education system is the ratio of students to staff members. As can be seen from Figure 5 the overall ratio at national scale is 13 students per staff member, however, this ratio varies significantly at regional level. It ranged between 25 as in Albatnan and seven as is the case of Aljufrah and Misratah. While, there was only one Mintaqah that had the similar national average (Sahel Benghazi) there were five that exceeded the average and seven were below the average. This pattern of distribution can be attributed to: 1) the general distribution of population, 2) the rank and importance of city/town in the urban hierarchy system and 3) the above mentioned socioeconomic and political aspects.

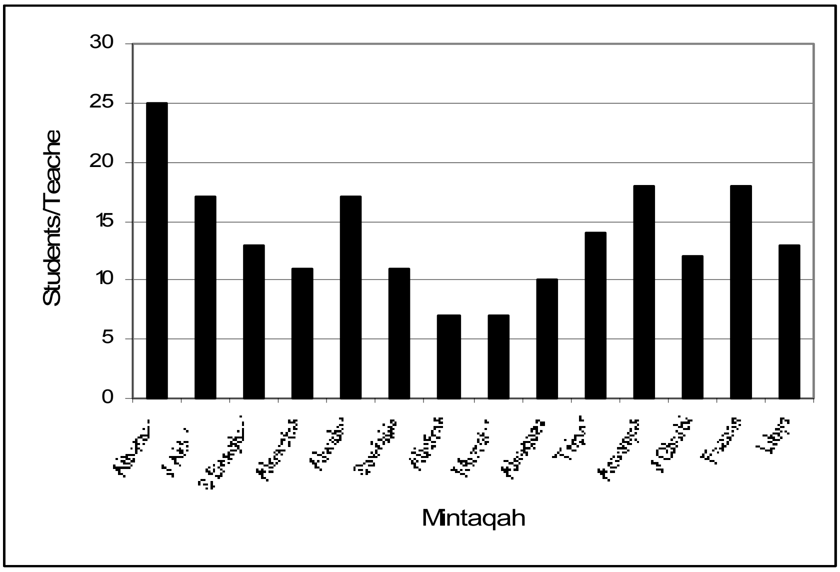

Figure 5: The distribution of students/staff in 2000
Source: computed by the author from data in GDHVECs (2000).

4.5 The Courses

According to GDHVECs (2000) the total number of courses provided by the PHVETCs for 1999/2000 was 368 courses. These courses are shown in Table 3 by Mintaqah and type. It is clear from the Table 4 that some Mintaqahs such as Tripoli and Jabal Gharbi were largely advantaged in terms of having more courses, followed by Azawiyah. These three Mintaqahs constituted 163 courses (more than 45 percent). Libya as a developing country needs more trained manpower in the areas of engineering and technology, however, PHVETCs continue to train and produce a significant number of graduates in education field. Table 4 shows, that there were 146 courses (39.7 percent) in the areas of engineering and technology whereas the area of education had 188 (39.7 percent). It is perhaps evident that the distribution colleges as well as courses have been carried out without an appropriate plan and/or done haphazardly.

Table 4: The distribution of PHVETCs' courses by type Mintaqahs in Libya, 2000

No	Mintaqah	Education	Fine Arts & Media	Management & Finance	Engineering	Architecture & Cons.	Computer Applications	A/C & Refrigeration	Hotel & Tourism	Agriculture Technology	Aquatic Technology	Medical Technology	Female's Occupations	Social Work	Vehicle Mechanics	Smithy & Welding	Tailoring	Applied Science	Vocational Training	Occupation Certification	Occupation Safety	Telecommunication Tech.	Total	
																							No	%
01	Albatnan	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	2.2
02	J. Akhdar	22	-	1	5	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	32	6.7
03	S. Benghazi	10	1	1	4	2	3	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	24	6.5
04	Alowstah	11	-	1	2	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	4.4
05	Alwahat	11	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	3.8
06	Aljufrah	3	-	-	3	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	2.4
07	Sawffajjin	9	-	-	5	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	4.3
08	Misratah	16	-	1	8	2	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	31	8.4
09	Alnagaza	-	-	2	9	1	2	-	-	-	1	1	-	-	-	-	-	-	1	1	-	-	18	4.9
10	Tripoli	32	4	2	14	4	8	3	2	-	2	-	-	-	1	1	2	-	-	-	1	1	76	20.7
11	Azawiyah	22	-	1	9	3	3	1	-	1	-	-	-	-	-	-	-	1	1	-	-	-	42	11.4
12	J. Gharbi	18	2	2	8	3	8	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	45	12.2
13	Fazzan	26	1	1	5	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37	10.1
Total		188	8	12	74	19	37	10	4	1	3	1	1	1	1	1	3	1	2	1	1	1	368	100.0

Source: Compiled by the author form data in GDHVECs (2000)

5. CONCLUSION

Notwithstanding that the PHVETCs sector has increased substantially during the last ten years or so, there are still some embedded problems in the system that affects its performance. As a result PHVETCs failed to attract required enrolments on one hand and unable to produce required graduates both in quality and quantity that the country needs on the other. As far as the equity of the PHVETCs distribution is concerned, a number of conclusions can be drawn from the above discussion. First, there is a strong correlation between population distribution and PHVETCs, it is clear that population size is a substantial determiner for locational distribution of the PHVETCs. Another feature of the distribution of the PHVETCs is that major cities and towns in general dominate in PHVETCs location.

Tripoli Mintaqah and Tripoli city (the national capital) in particular were the most dominate areas in Libya and comprised respectably about 21 percent and 13 percent of the total colleges in Libya. Secondly, despite the considerable improvement on the issue of gender disparities in more recent years at the national level, the situation was less promising at the Mintaqahs levels. There has been enormous variation between the Mintaqahs which can be to large degree explained by results of local socio-cultural characteristics. Thirdly, higher education system in Libya in general and the PHVETCs in particular, since its inception in late 1950s until present, was not able to fulfil its needs of faculty staff and still depends heavily on non-national and part-time faculty for the delivery of instruction. There is great variation among Mintaqahs in the ratio of students to staff. Finally, the distribution of subject courses by type and Mintaqah suggest unplanned nature of delivery of these courses among Libyan Mintaqahs. As a result, there has been concentration of these courses in specific Mintaqahs.

This study is part of an on-going PhD research entitled “Equity, Accessibility, and Efficiency of Public Higher Vocational Education and Training Colleges in Libya: An Empirical Investigation,” by Saad Elzalitni in cooperation with and supervision of Prof. Mel Less, School of Construction and Property Management, University of Salford, Salford, UK. This research intends to investigate critically the existing distribution of PHVETCs system in Libya. It focuses on three main aspects, namely spatial equity, locational accessibility and the internal efficiency of the system in relation to socioeconomic characteristics of the country.

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Appendix 1: The distribution of PHVETCs according to location in Libya, 2000

Mintaqah	College acronym	Location City/Town	The Pop. of location (1995)	Status of Location
1) Albatnan	A HCTT	Tubruq	88.750	District Capital
2) Jabal Akhdar	DHCTT	Darnah	74.358	Other Town
	DHCCO	,,	,,	,,
	QHCTT	Alqubba	15.627	Other Town
	QHCIT	,,	,,	,,
	BHCTT	Albayda	91.076	District Capital
	BHCCO	,,	,,	,,
	SHCHT	Susah	5.091	Other Town
	MHCTT	Almarj	47.805	Other Town
3) S. Benghazi	SBHCIT	Benghazi	495.418	District Capital
	SBHCMF	,,	,,	,,
	SBHCM	,,	,,	,,
	SBHCEL	,,	,,	,,
	SBHCEO	,,	,,	,,
	SBHCCT	,,	,,	,,
	SBHCSS	,,	,,	,,
	SBHCTT	,,	,,	,,
4) Alowstah	SHCCO	Surt	74.419	District Capital
	SHCTT	,,	,,	,,
	EJHCCO	Ejdabiya	81.121	Other Town
	EJHCTT	,,	,,	,,
5) Alwahat	JHCTT	Jalu	12.220	District Capital
	JHCCO	,,	,,	,,
	KHCTT	Alkufrah	23.339	Other Town
6) Aljufrah	HHCCO	Hun	10.097	District Capital
	WHCTT	Waddan	9.071	,,
	SHCCT	Suknah	8.029	Other Town
7) Sawfajjin	BWHCHI	Baniwalid	56.817	District Capital
	BWHCTT	,,	,,	,,
	BWHCCO	,,	,,	,,
	BWHCEL	,,	,,	,,

8) Misratah	MHCCO	Misratah	161.390	District Capital
	MHCIT	,,	,,	,,
	MHCTT	,,	,,	,,
	MHCHT	,,	,,	,,
	ZLHCIT	Zlitan	83.469	Other Town
	MAHCTT	Almaqulah	9.725	,,
9) Alnagaza	MIHCEO	Misalatah	38.394	Other Town
	MIHCCO	,,	,,	,,
	THCCO	Tarhuna	53.506	District Capital
	GHCCO	Algharabouli	34.584	Other Town
10) Tripoli	TRHCMO	Tripoli	1.054.845	National Capital
	TRHCMF	,,	,,	,,
	TRHCCT	,,	,,	,,
	TRHCEL	Tripoli	1.054.845	,,
	TRHCHT	,,	,,	,,
	TRHCMT	,,	,,	,,
	TRHCCO1	,,	,,	,,
	TRHCCO2	,,	,,	,,
	TRHCIT	,,	,,	,,
	TRHCTT1	,,	,,	,,
	TRHCTT2	,,	,,	,,
	BGHCTT	BinGhasher	13.529	Other Town
	BCHCCO	,,	,,	,,
	ISHCHO	Isbaiaah	17.042	,,
	JAHCTT	Janzour	53.203	,,
	ZHCCO	Azzahrah	17.520	,,
	ENHCIT	Enjailah	12.210	,,
	HHCAT	Alhashan	4.861	,,
11) Azawiyah	AZHCCO	Azzawiyah	109.864	District Capital
	AZHCTT	,,	,,	,,
	OJHCWI	Alojailat	73.367	Other Town
	ZUHCME	Zuwarah	26.833	,,
	ZOHCTT	Zoltun	8.654	,,
	ABHCTT	Aboissa	15.216	,,
	RHCIT	Ragdalin	20.907	,,
	TIHCTT	Tiji	4.306	,,
	SUHCCO	Surman	44.728	,,
12) Jabal Gharbi	GHCCO	Gharyan	23.339	District Capital
	GHCTT	,,	,,	,,
	GHCHI	,,	,,	,,
	YHCCO	Yafran	24.177	,,
	NHCCO	Nalut	13.282	Other Town
	AZHCTT	Azzintan	15.427	,,
	JDHCCO	Jadu	10.090	,,
	GDHCTT	Ghadamis	7.978	,,
	GDHCCO	,,	,,	,,
13) Fazzan	SBHCIT	Sabha	84.469	District Capital
	SBHCTT	,,	,,	,,
	SBHCCO	,,	,,	,,
	MAHCTT	Marzuq	13.679	Other Town
	BIHCTT	Birak	10.987	,,
	AGHCTT	Alghraifa	5.383	,,
	GAHCPHT	Ghat	3.560	Other Town

Source: Compiled by the author form data in GDHVECs (2000).

A CHOICE OF RESEARCH STRATEGY FOR IDENTIFYING COMMUNITY-BASED ACTION SKILL REQUIREMENTS IN THE PROCESS OF DELIVERING HOUSING MARKET RENEWAL

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ABSTRACT: This paper focuses on the choice of research strategy for investigating necessary skills and competencies that need to be acquired by the relevant participants involved in the process of delivering Housing Market Renewal in the East Lancashire Pathfinder area, England. It outlines the methodology adopted for the research and presents evidence for choosing the particular methodology during the development of research design. This paper reviews the differences and similarities among the common research strategies. The strengths and weaknesses of research paradigms with issues highlighted by reference to the research on skills for community-based action in the process of delivering Housing Market Renewal are discussed to provide valid reasons for the choice of the appropriate research strategy. From this study, it draws out lessons about research strategy, specifying from the research questions reaching closure and about the strengths and weaknesses of exploratory case study approach as a research tool.

Keywords - Exploratory Case Study; Housing Market Renewal; Research Paradigms

1. INTRODUCTION

This paper discusses methodology aspects of the PhD research work on investigating skills that need to be required by three key participants involved in the process of delivering Housing Market Renewal (HMR) in the East Lancashire Pathfinder, England. It describes and justifies the choice of methodology based on the epistemological and ontological assumptions made in the context of the nature of the research questions. The paper starts by defining the research paradigm and outlining the reasons for the selection of the particular paradigm and its phenomenological orientation in the context of the research work. This leads to the justification of case study approach as a research strategy.

2. THE NATURE OF THE RESEARCH AREA

HMR programme is a new opportunity to tackle the substantial problems of housing demand decline in some parts of North and Midlands, England. The programme was introduced shortly after the publication of the report on *Empty Homes* by the Transport, Local Government and the Regions Select Committee in March 2002. However, details of the HMR initiative were only first announced as part of the ODPM's Sustainable Communities Plan in February 2003. The broad objective for the programme was for Pathfinder strategic plans to *entail radical and sustained action to replace obsolete housing with modern sustainable accommodation, through demolition and new building or refurbishment. This will mean a better mix of homes and sometimes fewer homes* (ODPM, 2003).

However, housing market failure is not only central to the physical condition of housing but also about non-physical interventions factors such as social deprivation, economic and environmental issues that cause housing to be unpopular (CPRE, 2004 and Nevin et al., 2001). The aspirations of local community also need to be investigated as the latest protest by the local residents on the scale of clearances within the Pathfinder scheme in the North of

England (Clover, 2004 and Ungoed-Thomas, 2005) suggesting a gap between Pathfinder intentions and community expectations. The conflict between the aspirations of the local community and the objectives of the Pathfinder suggests that local residents are unclear about some of the terminology, options and possible outcomes that are being put forward by the Pathfinder in their areas. It highlighted the need for generic guidance or skills on how local community should be consulted and engaged in the process of delivering HMR.

The shortcomings of necessary skills to manage regeneration schemes were first noted in the *Urban Task Force* report in 1999. The report proposed the setting up of regional resource centre for addressing skills shortages and good practice in urban professionals. Five years later, the Uk government responded to the issue and appointed Sir John Egan to lead a task force into skills for sustainable communities. As a result of Egan's report and during the Sustainable Communities Summit 2005, the UK government announced the establishment of the Academy for Sustainable Communities in Leeds, England. This Academy will give priority to training in the broad range of skills and expertise that are required for delivering sustainable communities in the UK.

A review of the existing models of professional competences indicated that the professionals have recognised the important of the generic skills such as *working with others, communication, problem solving* incorporated into their professional practices. These models of professional development works and approaches can be found in: *The UK occupational standards models* (cited by Cheetham and Chivers, 1996); *The job competence model* (Mansfield and Mathews, 1985); *The reflective practitioner approach* (Schon, 1983); *Meta-competencies* (Reynolds and Snell, 1988 and Nordhaug, 1990); *Core skills* (Cheetham and Chivers, 1998); *Ethics and values* (Eraut et al, 1994); *Model for professional competence framework for RICS* (Kennie and Green, 2001) and *BIFM professional qualification* (BIFM, c1999). These models have their own strengths and weaknesses within the context of their own professions. However, the researchers seek to study the ability of the existing models to deal with the demand of skills in the process of delivering HMR. Understanding the existing models of professional competences also leads to the identification of shortcomings skills that need to be addressed by the participants involved in the process of delivering HMR. Furthermore, the community-based and people focus skills development have been recognised as the crucial education and training needs for the sustainable development programme in the UK (Hartley, 2002; Egan, 2004; Turner and Townsend, 2004; The Neighbourhood Renewal Unit, 2003; Martin & Hall, 2002; Sterling, 2001).

Meanwhile, an exploratory pilot case study at the East Lancashire Pathfinder was undertaken in February 2005 until August 2005. This particular Pathfinder comprises seven intervention areas known as Area of Development Frameworks (ADFs), containing approximately 85,000 properties across five local authorities of Blackburn with Darwen, Hyndburn, Burnley, Rossendale and Pendle Borough Councils (Elevate, 2004). The aim of this study was to seek insights of the participants involved in the 'real life' situations of HMR delivery process and draw attention to the issues and complexities of shortcomings skills necessary for community engagement. The study was conducted in three separate interview visits with three different participants in the process of delivering HMR. These three key participants are summarised as follows *(Figure 1*):

- *Participant 1(Skill Level 1): the representatives of the Elevate East Lancashire Pathfinder;*
- *Participant 2(Skill Level 2): the representatives of the Blackburn with Darwen HMR Teams and;*
- *Participant 3(Skill Level 3): the representatives of the Local Community Groups of Bank Top ADF.*

Figure 1 illustrates the delivery process of HMR that involves three key participants in three different levels of community-based action skills and competencies.

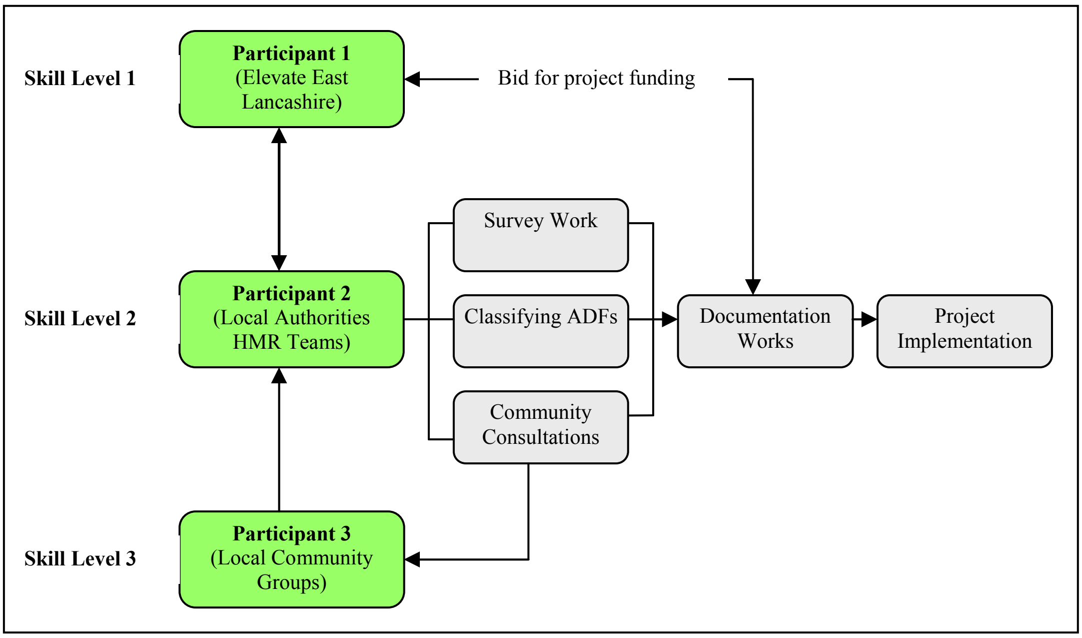

Figure1. The three major participants involved in the early process of delivering HMR in the East Lancashire Pathfinder

Findings from both literatures and exploratory pilot case study are necessary to formulate research questions (Booth, et al, 2003; Robson, 2002) for identifying necessary skills need to be acquired by those key participants involved in the process of delivering HMR. The main research focus that emerges from this work is centred on the following questions:

- *What are the additional skills and competencies that need to be acquired by the employees of Pathfinder organisations, relevant Local Authorities and Community groups necessary to deliver Housing Market Renewal?;*
- *Why do the employees of the Pathfinder organisations, relevant Local Authorities and Local Community groups need other skills and competencies in the process of delivering housing Market Renewal?* and
- *How significant are these additional skills and competencies in the process of delivering Housing Market Renewal?*

In answering these questions, the nature of research paradigm and methodology is defined to identify the appropriateness of the research strategy for this particular research work.

3. RESEARCH PARADIGM AND METHODOLOGY

Research methodology constitutes a process of how research questions are operationalised and measured to achieve the overall research aim and objectives (Brewerton and Milward, 2001). However, choosing the appropriate research methodology requires understanding of assumptions of each research paradigm and implications of the chosen methodology. This research work adopts a *nested methodology approach* (Kagioglou et. al., 1998) that is devised into three main interrelated themes: *research philosophy; research approach* and *research techniques*. However, this paper only discusses on the research philosophy and research approach as these themes provide theoretical background to justify the choice of the research strategy. This is taken to ensure that they are compatible to one another and suitable for the purpose of enquiry and the context of the study phenomenon. The themes will shape and guide the direction of research paradigm, which in turn drive to the selection of the research strategy.

3.1 Research Philosophy

The word *philosophy* is derived from the word of Greek, *the love of wisdom* (Cavalier, 1990). The wisdom encapsulates the essence of philosophy. It involves thinking about questions, making interpretations, trying out ideas and thinking of possible arguments for and against them and wondering how concepts really work (Ruona, 2000). It also offers a framework of thinking, helps develop capacities of thinking and improves the alignment between what we think and what we do (Paul, 1993 and Honderich, 1995). At the heart of it, philosophy is a systematic examination of the assumptions and common wisdoms (Root, 1993) that underlies thought and action.

In realising the potential utility of philosophy, a system of thought and action needs to be considered (Bohm, 1994). These philosophical knowledge claims represent a set of fundamental assumptions in relation to the world, the individual's place in it and the relationships between the world and the researcher. The assumptions that is relevant to the research philosophy: *being (ontology); knowing (epistemology)* and *acting (axiology)* (Denzin and Lincoln, 2000). Philosophically, Cresswell (1994) identifies five sets of assumptions that are related to *what is real/knowledge?* (a question of ontology); *how to know it is true?* (a question of epistemology); *what values go into it?* (a question of axiology); *how to write about it*? (a question of rhetoric) and *the process of studying it* (methodology) (Creswell, 1994; Gioia and Pitre, 1990 and Kuhn, 1970). It is important for researchers to recognise and understand the ontological and epistemological orientation within the research paradigm as it is able to determine the entire course of the researchers' project (Hussey and Hussey, 1997). Four schools of thought about knowledge claims are also discussed. They are *Idealism; Realism; Positivism and Interpretivism.*

The two main research paradigms propounded in the literature are the positivist/quantitative and interpretivist/qualitative paradigms (Cook and Reichardt, 1979; Easterby-Smith, 1991; Denzin and Lincoln, 2000 and Creswell; 1994). Even though, the term of interpretivsim has been referred interchangeably with the concept of phenomenological as a paradigm in the literature, the researchers opt to stick to the concept of interpretivism for this research work. It is also important to note that although positivism is associated with deductive reasoning and phenomenology with inductive reasoning, scientific and social inquiry, in practice these paradigms involve an *alternation between deduction and induction* (Babbie, 1998 and Creswell, 1994). During the deductive phase, one tends to reason towards observations. However, during the inductive phase, one tends to reasons from observations.

3.1.1 Strengths and weaknesses of the positivism paradigm

The term positivism was first introduced by the sociologist, Auguste Comte (Gliddens, 1974). Although quantitative investigation of the world has existed since people first began to record events or objects that had been counted, the modern idea of quantitative processes have their roots in Auguste Comte's Positivist framework. It is depicted as the traditional scientific approach to research for the philosophical paradigm for human inquiry. It is based on the numerical representation of observations for the purpose of describing and explaining the phenomena. Methodology approaches that avail themselves to this paradigm include cross-sectional studies, experimental studies, longitudinal studies and surveys.

The positivist paradigm that guides the quantitative mode of inquiry is based on the assumption that social reality has an objective ontological structure and that individuals are responding agents to this objective environment (Morgan & Smircich, 1980). Quantitative research involves counting and measuring of events and performing the statistical analysis of a body of numerical data (Smith, 1988). The assumption behind the positivist paradigm is that there is an objective truth existing in the world that can be measured and explained scientifically. The main concerns of the quantitative paradigm are that measurement is reliable, valid, and generalizable in its clear prediction of cause and effect (Cassell & Symon, 1994).

Being deductive and particularistic, quantitative research is based upon formulating the research hypotheses and verifying them empirically on a specific set of data (Frankfort-Nachmias & Nachmias, 1992). Scientific hypotheses are value-free. The researchers' own values, biases, and subjective preferences have no place in the quantitative approach. Researchers can view the communication process as concrete and tangible and can analyze it without contacting actual people involved in communication (Ting-Toomey, 1984).

The importance of positivism, particularly logical positivist explanation, is recognised as one of the most viable approach to explain a phenomenon. In the more recent evaluation research, logical positivism clearly forms the basis of *realistic evaluation* or *scientific realism* where programmes and policies demand realistic evaluation results (Pawson and Tilley, 1997). Babbie (1998) argues that place for positivism in social research and points out that the interacting links between positivism and phenomenology by noting that *ever observation is qualitative at the outset*. The author further argues that in social science, paradigms cannot be true or false; they can only be more or less useful.

However, there are weaknesses that undermine its usefulness to the subject matter of this research work: Community-based action skills in the process of delivering HMR. The positivist ontological position of reality exists independently therefore, it is not useful for this exploratory research as this research focuses to seek and understanding the participants' varying perception and meaning of the HMR delivery process. Objects, people, situations and events do not, in themselves, posses meaning; meaning is conferred on these elements by and via human interaction (Berg, 2001). Similarly, the positivist position on the epistemological question of *how do we obtain knowledge of reality?* is inappropriate because it postulates that the act of investigating such as reality would have no effect on that reality. It is also impossible to treat people as being separate from the social contexts and they cannot be understood without capturing their perceptions of their own activities. This approach is strictly structured design that imposes certain constraints on the results and may ignore the relevant findings. It cannot be objective as the researchers also bring their values and interests to this research work and be part of what they observe.

3.1.2 Strengths and weaknesses of the interpretivism paradigm

Qualitative research shares the theoretical assumptions of the interpretative paradigm, which is based on the notion that social reality is created and sustained through the subjective experience of people involved in communication (Morgan, 1980). Qualitative researchers are concerned in their research with attempting to accurately describe, decode, and interpret the meanings of phenomena occurring in their normal social contexts (Fryer, 1991). The researchers operating within the framework of the interpretative paradigm are focused on investigating the complexity, authenticity, contextualization, shared subjectivity of the researcher and the thing being researched and minimising of illusion (Fryer, 1991).

Qualitative research in general is more likely to take place in a natural setting (Denzin, 1971; Lincoln & Guba, 1985 and Marshall & Rossman, 1989). This means that topics for study focus on everyday activity are *defined, enacted, smoothed, and made problematic by persons going about their normal routines* (Van Maanen, 1983). Qualitative research is less likely to impose restrictive a priori classification on the collection of data. It is less driven by very specific hypotheses and categorical frameworks and more concerned with emergent themes and idiographic descriptions (Cassell & Symon, 1994). It is most useful for inductive and exploratory research as it can lead researchers to build hypothesis and explanation (Ghauri & Kjell, 2005).

Within the fundamental beliefs of the interpretative paradigm, there are three characteristics of qualitative inquiry (Ting-Toomey, 1984). *First,* qualitative research is the study of symbolic discourse that consists of the study of texts and conversations. *Second*, qualitative research is the study of the interpretive principles that people use to make sense of their symbolic activities. *Third*, qualitative research is the study of contextual principles such as the roles of the participants, the physical setting and a set of situational events that guide the interpretation of discourse.

The interpretivist paradigm is the social sciences that deal with action and behaviour (Giddens, 1974). There is a clear interrelationship between the investigator and what is being researched. Verifying what actually exists in the social and human world depends on the researcher's interpretation. Any interpretative analysis of subjective meanings depends upon *empirical rules* hence the development of the methodological tools, notably the typology of *rational action* and *ideal type* (Giddens, 1974). Methodology approaches most appropriate include action research, case studies, ethnography, grounded theory and participatory enquiry.

Interpretivism is the most relevant paradigm for this research work as it seeks to solve the research questions as stated in section two. The researchers seek to ascertain what the general trend is in term of the necessary skills that need to be required by the three participants involved in the process of delivering HMR. The process of delivering HMR involves three participants in three different levels of community-based actions skills. Seeking an understanding of the three different participants' perception levels in the process of delivering HMR undoubtedly have to be within the interpretive paradigm. The nature of the research focus that is a dynamic process and lived experience rather that a static reality. This further supported by the Strauss and Corbin (1990) that qualitative paradigm is useful for understanding what lies behind any phenomenon. It is useful for understanding meaning for participants in a study, the context within which the participants act, generating new theories and understanding the process by which the events and actions take place.

In addition, phenomenology is closely aligned to the interpretivism paradigm as it revolves around the meaning of the lived experiences for participants in the study about a phenomenon. This approach explores the structures of consciousness in human experiences (Creswell, 1998 and Patton, 1990). Phenomenology is important for this research as its method of approach is rooted in the notion of the lived-world. The researchers act in the social and human world rather than observe it as a disinterested scientist. The researchers deal not with the reality of the world but rather with human relationships within the world.

However, there are number of weaknesses in this paradigm. There are difficulties associated with time required and costs involved to undertake qualitative research. Problems may also emerge in the analysis and interpretation of data: there is often difficulty in achieving validity and reliability; there are ethical issues arising from the researchers' intrusion into the *personal sphere* of those being researched (Easterby-Smith, Thorpe and Lowe, 1991).

Figure 2 shows graphically positioning of this research paradigm in terms of three components of philosophical assumptions interact in a dynamic, multi-virtuous and systematic way, together forming a guiding framework for a congruent and coherent system of thought and action. These become a framework model that helps the researcher to make sense of it and outlines the philosophical basis for the chosen research paradigm and research strategy. Figure 2 illustrates the interactive and dynamic relationship among the key components integral to philo*sophical framework.* It elucidates the connections: demonstrating on how one *sees and* views the world and reality (ontology) and how one *thinks* about the world (epistemology); that how one *thinks* about the world and directs how one *acts* in the world (axiology). This reflects and influences how one *thinks* about and consequently *sees* the world that helps one to *act* in inquiry and practice within the ontological and epistemological orientations. In other words, axiology urges congruence between ontological and epistemological assumptions. It plays an important role in putting the standards and requirements of acceptable research approach and research techniques for the research in community-based action skill in HMR. Making the axiology explicit helps to set and clarify the guiding tone and rigour for action in the researchers' research work.

The position of research paradigm for this research work as illustrated in Figure 2 is summarised as follows:

- *Ontologically,* this study favours more towards idealism. The nature of this research is to seek understanding the participants' varying perceptions and meaning via human interactions. This means, this research does not treat phenomenon under study as an independent and single reality. Rather, it accepts the knowledge claims by understanding the participants' interpretations given to the reality.
- *Epistemologically*, this research favours more towards interpretivism. The nature of this research is rooted in the notion of lived-word experience. The researchers also acknowledge that the knowledge is socially constructed through interpretations of the major participants in the process of delivering HMR. This study intends to explore the explanations of the perceptions and actions of the major participants involved in the process of delivering HMR by understanding the way in which they comprehend their world.
- *Axiologically*, this research favours more towards value-laden and subjective nature of research. The phenomenon under study is interpreted within a context through direct interactions within organisational members. The appropriate research approach is chosen from the various alternatives of the research purpose and the questions it intends to answer (Yin, 2003). The research questions that being posed in this study are not only exploratory (*wha*t question) but also explanatory (*why* and *how* questions). It requires in depth insights of the interrelationships of the variables. A case study approach is appropriate to answering the research questions in this research (Yin, 2003).

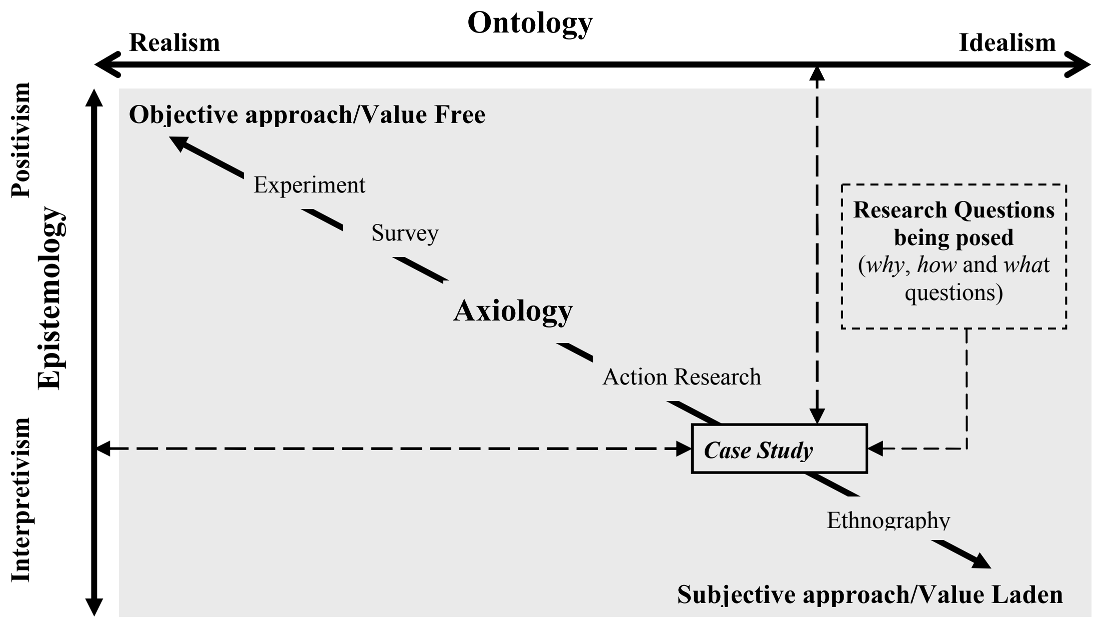

Figure 2. Positioning Research Paradigm (Source: Adapted from Sexton, 2003; Yin, 2003)

3.2 Research Approach

The justifications for choosing the case study approach for this research work derive from the interpretive paradigm, the broad phenomenological nature and its realistic underpinnings, the exploratory and explanatory nature of research questions formulated from the literature review and exploratory pilot case study (section two). The case study approach can be defined as a methodology in terms of process of actually carrying out the investigation, the unit of analysis (the case) or the end product. Yin (2003) defines case study approach as:

> *"an empirical inquiry that; Investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin 2003).*

Yin (2003) further believes that the reason for selecting one particular research strategy over another is determined by three conditions consisting of:

- *the type of research question posed,*
- *the extent of control an investigator has over actual behavioural event and*
- *the degree of focus on contemporary as apposed to historical event.*

Although the research strategies are not mutually exclusive, it is possible to identify situations where particular strategy is of particular usefulness. Yin (2003) suggests that case study approach is especially useful when a *how or why question is being asked about a contemporary set of events over which the investigator has little or no control*, which the researchers feel is relevant to the research work under investigations. Others focus on defining the unit of study, an entity around which there are boundaries that delimit what will be studied from what will not. Stake (1994) calls the case study an integrated systems, Smith (1978) uses the term bounded system and Miles and Huberman (1994) refer to the case as *a phenomenon of some sort occurring in a bounded context*. The last focus of definition is on the product of the investigation. Wolcott (1992) describes case study as an *end-product of field-oriented research* and Merriam (1998) defines characteristic is the delimitation of the unit study. If there is no actual or theoretical limit, the phenomenon is not bounded enough to be a case.

The strength of case study approach for this research work is its ability to deal with a full range of evidence: documentation, interviews and observations. A list of questions are set out to assist the researchers determine whether or not the case study approach is appropriate to identify necessary skill for community-based action in the process of delivering HMR.

- Can the phenomenon of interest be studied outside its natural setting?
  No, necessaryl skills that are needed for the participants involved in the process of delivering HMR can only be identified from within the organisations in question.
- Must the study focus on contemporary events?
  Yes, HMR is the new programme, at this time, only 3 years old.
- Is control or manipulation of subjects or events necessary?
  No, observation and recording will provide the clearest evidence of current events.
- Does the phenomenon of interest enjoy an established theoretical base?
  No, there is a very limited theoretical basis for the study in the HMR and community engagement in particular.

Case study approach has also been viewed as a useful tool for the *preliminary, exploratory stage* of research project as a basis for the development of the more structured tool that necessary in surveys and experiments (Rowley, 2002). Eisenhardt (1989) says that case study is: *Particularly well suited to new research areas or research areas for which existing theory seems inadequate. This type of work is highly complementary to incremental theory building from normal science research. The former is useful in early stages of research on a topic or when a fresh perspective is needed, whilst the latter is useful in later stages of knowledge*. This research work seeks to find out what is happening, to seek new insights, to ask questions and to assess phenomena in a new light, perhaps the most purely theory building form of case study. And consequently, an exploratory study normally focuses on current events and concerns and seeks to answer questions of *how* and *why* (Robson, 2002). A particular application of the exploratory case study is a diagnostic tool to develop a range of objective possibilities that could occurs. However, Yin (2003) only favours exploratory case study when the available literature or existing knowledge base is poor, that is, when there is some uncertainty about a major aspect of a *real* study. Once the uncertainty has been investigated and resolved, the exploratory phase is complete and the real study should be taken place.

A case study approach may either focus on a single case or use a number of cases (Yin, 2003). The differentiation between single case study approach and multiple case study approach needs to be clearly made for this particular research work. A single case study approach is akin to a single experiment and appropriate when the case provides a critical test to a well-established theory or where the case is extreme, unique, typical, critical or has something special to reveal. Single case study approach is also used as a preliminary or pilot in multiple case studies. Multiple case studies approach is also equivalent to multiple experiments, is used to achieve replication of a single type of incident in different settings or to compare and contrast different cases. Multiple case studies approach is useful if topics are too complex or involve too many actors to be addressed in a simple interview survey. The more cases that can be marshalled to establish or refute a theory, the more robust are the research outcomes.

Yin (2003) further distinguishes the design of single and multiple case studies approach as holistic or embedded, resulting in four possible combinations (*Figure 3*): holistic or embedded studies. Cases with a single source of information as *holistic* cases while, cases with multiple sources of information as *embedded* cases (Yin, 2003). Embedded studies identify a number of sub units such as meetings, roles or locations, each of which is explored individually. Result from these units are drawn together to yield an overall picture. However, the biggest challenge with embedded studies lies in achieving a holistic perspective from the analysis of the sub-units.

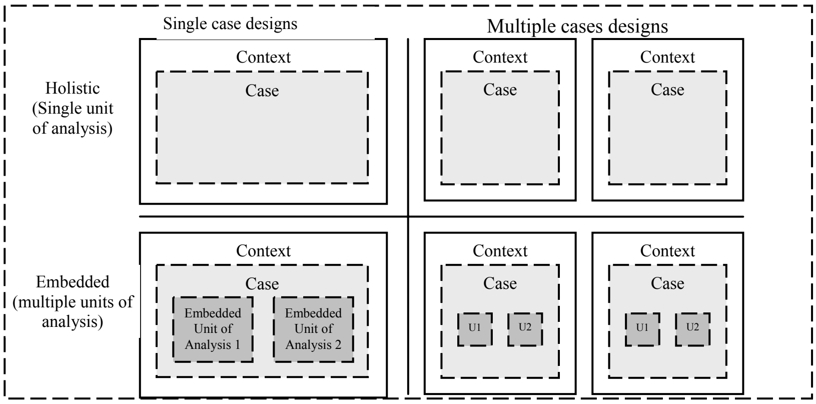

Figure 3. Basic types of design for case study designs (Source: Yin, 2003)

However, one of the frequently cited limitations of the case study approach is the difficulty in generalising the findings. The counter-argument is that generalising of case study findings is a legitimate outcome, based on an understanding of nature of that generalising. Yin (2003) strongly argues that case study approach involve only analytical generalising. Stake (1978) describes the generalisability of case study approach as *naturalistic* that is in context-specific and in harmony with a reader's experience and thus *a natural basis for generalisation*. It is considered legitimate to generalise based on the degree to which a case is representative of some larger population. It is not a question of how many units but rather what kind of unit is under study.

A benefit of multiple case studies approach is that they are generally considered to strengthen or broaden the analytic generalisations. This can be done through literal replication, in which cases are designed to replicate each other and produce corroborating evidence or through theoretical replication in which cases are designed to cover different theoretical conditions and produce contrasting results for predictable, theoretical reasons (Yin, 2003). The number of cases to be included in the positivist multiple case studies approach becomes a matter of the number of replications desired in turn depends on the certainty desired for the result. Greater certainty comes from larger numbers but if the rival theories are grossly different and the purpose of the study does not require excessive certainty, two or three cases are sufficient (Miles and Huberman, 1994).

In contrast, at least one interpretative researcher finds multiple case studies approach to be a drawback. Wolcott (1992) argues in practical terms that the study of multiple cases reduces the attention the researcher is able to give to any one of them and serves to weaken rather than strengthen the case study. The author prefers for single case designs especially when the researcher is inexperienced. Another criticism of the case study approach has to do with the *skills limitations* and *bias* on the part of the researcher. Case study approach is dependent on the sensitivity and integrity of the investigator. The researcher is the primary data-gathering instrument and not all researchers are equally skilled in observation and interviewing.

Based on the nature of the researchers' research work and the review of the relevant literature, the single and embedded case study approach has been chosen as an appropriate research strategy. This research approach is the most useful for the study of the necessary skills that need to be acquired by the three major participants involve in the process of HMR in the Bank Top, one of the Pathfinder ADFs in the Blackburn with Darwen Borough

Council, East Lancashire Pathfinder area. Identifying three separate ad different skill level for three participants involved in the process of delivering HMR constitute multiple unit of analysis embedded within a single case in the context of East Lancashire Pathfinder area. In addition, it is ontological and epistemological justifications that based upon idealism and interpretivism research paradigms has strongly supported the choice of case study approach as a research strategy for this research work.

4. CONCLUSION

Case study approach is chosen as a research approach for this research work as it is responsive to research questions of why and how, and it offers researchers a flexible yet integrated framework for embedded examination of a phenomenon in its natural stage of exploring the necessary skills that need to be required by the three participants involved in the process of delivering HMR in the East Lancashire Pathfinder area. Because case study approach is exceptionally useful for exploratory research and theory generation, it is particularly appropriate for the nature the researchers' research work that related to contemporary issues of people in the real world and when there is little theoretical knowledge or evidences on the research under study. The single case study approach is also appropriate for this research work as it is considered as a critical, unique and extreme case where the investigations on the necessary skills that are needed to delivery HMR are considered valuable and a revelatory case.

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THE ROLE OF VOCATIONAL EDUCATION AND TRAINING IN DEVELOPING HUMAN RESOURCES IN LIBYA

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ABSTRACT: Human resources (HR) can be developed at two stages: the first is the preparation stage, where the potential work force is provided with the necessary theoretical knowledge as well as practical application. The second stage is on-the-job training, where HR development is carried out through a group of technical operations on the job. Both the numerical (number of effective employees) and quality (effective employment) definitions of employment are related to the efforts exerted by the governments and different organisations to develop their HR This paper focuses on the education and training systems (ETS) in the Libyan labour market and the expansion of those systems.

Key words: Human resource, education and training system, labour market, Libya.

1. INTRODUCTION

This paper presents the findings of a literature review undertake as part of a large research project, which has title aim as; to explore the key factors affecting the quality of the output of the Libyan Building and Construction Training Centres (BCTC) and propose a framework that could be used to improve the quality of the centres' graduates to better fulfil the requirements of the labour market in Libya.

A chronological approach has been adopted to analyse related literature review to study the phenomenon under investigation in its historical dimension (Alvesson and Skoldberg 2000) . This is to fulfil the requirements of the research which is relevant to the above mentioned aims. The purpose of the literature review is to satisfy the objectives of the research which are:

- Review the literature on construction industry training with particular reference to the Middle East and Libya.
- Investigate and identify the key factors affecting the quality of the graduates from the (BCTC) in Libya.
- Obtain an in-depth understanding of the current training programmes in the Libyan (BCTC)
- Find an appropriate research methodology to achieve the research aims and hence to answer the research questions.
- Develop a framework of the main factors affecting the quality of these training centres graduates

The technical, social and economic progress in the workplace today has made it a necessity to develop, expand and improve technical education and training in Libya. It has also become essential to unify its goals and systems in order for the youth to gain the technical skills and professional knowledge necessary to enhance the level of economic development and achieve the goals of individuals in raising their standards of living to match the great and speedy progress in the field of modern technology.

Unless occupational tasks are a result of stable and continuous occupational training that bases its goals on the needs of the job market, it will be useless. The process of building and preparing scientific, occupational and technically professional human cadres that are capable of replacing foreign employees, must be carried out within a successful training programme that meets the needs of the Libyan job market; specially the need for a highly trained workforce (Al-Dweibi 2005), (Maatug 2004).

A chronological method has been adopted to analyse the related literature review to study the phenomenon under investigation in its historical dimension. This is to fulfil the requirement of the research which is relevant to the factors that affecting the quality of the output of the building and construction training centers in Libya.

2. HUMAN RESOURCES DEVELOPMENT (HRD) AND EDUCATION AND TRAINING

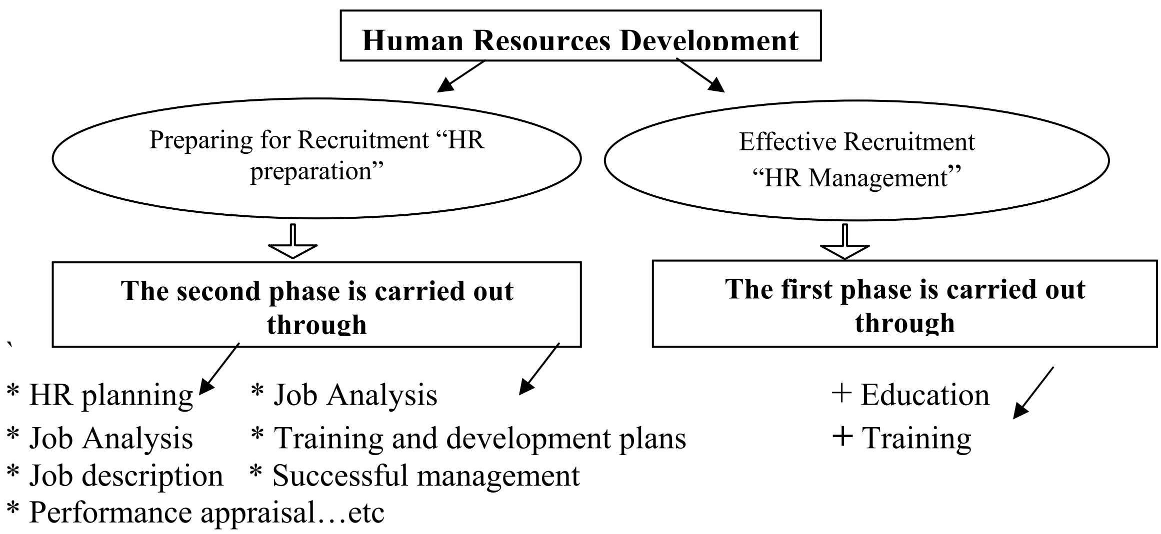
Development is defined as those efforts that are based on pre-studied plans to coordinate between human and financial resources, with the aim of achieving the maximum levels of national and individual incomes, as well as higher standards of living and better quality of life (Abusada, 2005).

Development and management theories use numerous expressions to notify similar meanings. For example, the twentieth century has witnessed the creation of expressions like: ‘workforce’ or ‘manpower’ and ‘personnel’, to define the group of technical processes that are specially designed for the human element.

The Behavioural School has searched for a more inclusive and precise expression to define the humane characteristics of the managerial process and finally came up with ‘Human Resources’ (HR). This was mainly because of the importance of the human role in both the production and services processes, as well as the supremacy of the human capital over natural and financial capitals in the development process. As (HR) include all those individuals in the manpower who are capable of and desire to work, at both the national and organisational levels, it still aims to provide this work force with the necessary knowledge and technical abilities to enable it to perform its tasks.(Al-Geryani,2005).

3. HUMAN RESOURCES DEVELOPMENT (HRD) AND ISSUES OF RECRUITMENT

The following model compares between HR development and recruitment:



The relation between HR development and recruitment can be summarised as follows:

3.1 First: Human Resources Development and Preparation for Recruitment:

This is the stage where the human workforce is put through an extensive and costly preparation process that includes educational and training programs. In general, the great part of this stage is paid for by the government, especially in Arab countries. It is nearly impossible to build a human capital; considered a basis for sustainable development, without special educational programmes and training programs for human resources (Al-Geryani, 2005).

3.1.1Education:

The education is the process through which a nation's human resources are provided with the necessary knowledge, in preparation for later recruitment. The education process is long and costly but essential at this primary stage for the decision of specialization in one branch of knowledge, or undertaking a certain venue of training. All these processes aim at building a qualified human capital that is capable through its participation in the production process, of creating the required and comprehensive development. The contemporary approach aims at raising the quality of education while reducing its costs, as well as, achieving the compliance between its outcomes with the demand of the job market.

3.1.2 Training

Is the parallel-to-education process of preparing and qualifying individuals within the limits of a defined period of time and technical preparation programs that are specially designed for those who nominated to join the job market according to its current and future needs and requirements? Training is one of the most important venues of human resources development, as both education and training are processes that can be performed by individuals throughout their lifetime, and if the training is strategic and perfect, the recruitment will be effective. (Al-Geryani, 2005).

3.2 Second: Human Resources Development for Effective Recruitment

At this stage, the main concern and focusing is about the organisational, psychological and social environments of the workforce. This through the analysis, of organisational and legislation of a suitable environment, which is allows human resources to perform its tasks and responsibilities within suitable and fitting work conditions that encourage creation, innovation and outstanding performance. Those efforts include:

3.2.1 Human Resource Planning:

The human resource planning (HRP) is the strategy of the country or the organisation to achieved sufficient numbers and qualified work force for invest and develop it. (HRP) is one of the most important planning activities in a country or an organisation, because it has a great effect through the role it plays in defining the training needs, as well a setting education and training policies o comply with the needs of the job market; a technically prepared and scientifically qualified workforce.

3.2.2 Comprehensive Organisational (CO)

CO is the long term organisational, including all organisational structures firms, and positions, as well as the firms' activities and the distribution of specialisations inside it. Structuring aims at the overall organisation of the firm and raising the levels organisational effectiveness.

3.2.3 Job Analysis and Job Description:

Job analyses are concerned with analyzing jobs, collecting, documenting and analyzing information on job content, their technical, physical and intellectual requirements, as well as data on the job's environment and surroundings. This process is carried out to set salary and wages plans, financial rewards, job evaluations and job positioning.
Job Descriptions, on the other hand, are concerned with listing a job's content, tasks, responsibilities and the minimum level of requirements necessary to occupy it. Job descriptions help achieve the 'effective recruitment' principle.

3.2.4 Recruitment:

The choice of employees is the direct result of educating and training efforts and the cumulative experience gained by employees. The recruitment process aims at choosing suitable members from the qualified workforce, who comply with the firm's activities and work. (Abusada, 2005), (Al-Geryani, 2005).

4. THE REALITY OF EDUCATION AND TRAINING IN LIBYA

Most students in Libya prefer to join the formal education process, which consists of high school and later university, rather than professional education and training, which is viewed as a lower venue of education. This is why high school drop-outs are the main source of students for professional education. Although the social situation in Libya and other Arab countries does not look favourably upon graduates of professional education and vocational training, the need for professional cadres in later years has led Arab societies including Libya to give more attention to professional education and training, to the extent of establishing specialised universities in this field. Nevertheless, it is still necessary to establish a strategy to further augment the attention given to professional education and attempt to remove the obstacles it faces and increase social awareness about it. (Al-rabieei.2004), El-hawat1995)

4.1. Development of Education and Training System (EDS) in Libya

Throughout the Ottoman period learning centres were religious institutions that were located in only a small number of cities. Education was only available to a few individuals whose families recognised the value of education or had economic conditions that allowed the children to be spared from working (El-Fathaly and Palmer, 1980:27). Additionally, the quality of education available, and the length of time one could spend as a student, was limited. During the Italian occupation, religious education continued to be the major type available and severe economic conditions prevented this already inadequate system of education from flourishing. There were also some secular schools opened in a few urban areas.

The policy of the colonial administration was to restrict the number of Libyans educated beyond the primary stage, and all teaching was conducted in Italian. The small number of Libyans who wanted to seek further education had to travel to Egypt, where they could continue mainly in Arabic literature and religious science, or to Italy to study in more secular fields. With the introduction of the British administration more emphasis was placed on secular education and vocational schools were established separate from religious educational institutions.

During the first decade of independence, severe economic problems, regional conflict of interests, and poor management of the available resources severely handicapped the development of a sound education system. The discovery of oil at the beginning of the l960s brought a radical change in the Libyan economy and eliminated the economic obstacles to education. Since then, educational facilities have greatly expanded; schools have been built in rural and remote areas.

Evidently Libyan education programmes concentrated on preparing a large number of people to work in administrative posts in the public enterprises (PEs), as there was a significant amount of financial support allocated for this purpose. Unfortunately there was no proper coordination between these programmes and many important issues such as manpower planning and the country's culture were ignored which influenced the degree of success in education development (Agnaia, 1997:34).

Another difficulty was related to the fact that the education system had paid more attention to the theoretical aspects of education than to the practical aspects (Deeb and Deeb, 1982:45). Moreover, the education system lacked adequate facilities, such as libraries and laboratories, especially in the middle level of education with regard to the science sections. According to Almdhie and Nyambegera, (2004:16) "even today the education system is designed according to the Western education system, and the source of curriculum techniques, facilities are mostly from western countries, especially in the oil industry,. Training is complementary to the education system in Libya as it is in most countries.

Generally speaking, the education system in Libya, however, has not been oriented to be more responsive to the needs of development, especially in technical and managerial fields. Additionally the education and training system in Libya as in many other developing countries is unable to supply at the right time and in sufficient number the qualified persons needed for industrial development.

However gaps remain. Economic difficulties affect some of the population who live outside the modern urban sector, especially in less developed parts of the country. The economy continues to depend significantly on foreign labour, although at the same time unemployment is high. As Libya's integration into the international economy continues, the need for improved labour competitiveness is certain to grow.
(Khalil, 2004)

4.2. The Structure of Education and Training System in Libya

The primary and secondary education system consists of nine years basic education, leading to the Basic Education Certificate, followed by four years of "intermediate" education. Intermediate level education extends from three to four years and comprises of a number types of secondary school. There are general secondary schools (Science and Arts sections); specialised secondary schools (in Economics, Biology, Arts and Media, Social Sciences and Engineering), teacher training institutes.

In specialised secondary schools studies last for four years. Secondary studies last for four years in technical education, three years in general secondary schools, and three to four years in Teacher Training institutions. Studies lead to the Secondary Education Certificate.

Higher education is offered in Universities, both general and specialised, and higher institutes. These include Teacher Training higher vocational institutes, polytechnic institutes; higher institutes for Technical, Industrial and Agricultural Sciences. Several higher institutes for Teacher Training were founded in 1997. New scientific institutions called Scientific Research Centres have been created in such fields as Health and Pharmacy, Education, the Environment and Basic Sciences. They are both educational and research institutions.

The National Authority for Scientific Research is responsible for higher education and research and the University People's Committee, chaired by a Secretary, manages university education. Each Faculty also has a People's Committee, chaired by the Dean and with heads of departments as members. Each university manages its administration and its budget. University-level education includes three major sections: university education (lasting four to seven years), university vocational and technical education (lasting three to five years), and advanced graduate studies.

Turning now to the training programmes in the country, during the nineteen sixties considerable attention was given to establishing occupational training programs in Libya. Students were assigned to workshops, production sites and factories to train on different trades. Later, 16 training centres were established in collaboration with the International Labour Organization, to train almost 2800 people in the years 1970-1971. In later years, the number of occupational training centres expanded to 69 in 1987. This encouraged the Libyan government to establish the Development and Occupational Training Association in 1988. By 1998-1999, the Association was supervising 558 training centres with 117,781 trainees. The Development and Occupational Training Program in Libya is composed of:

- *Basic Vocational Training Centres*

Primarily intended for those members of the population who left education early or failing to complete nine grades of primary education. The period of training for this stage is two years, for the five main professions: construction, mechanical engineering of cars, welding, services and maintenance jobs. Within these five professions there are up to 34 specialisations.

- *Intermediate Vocational Training Centres*

Intended primarily for students who have completed the intermediate education stage by completed and passed the ninth grade. The period of training for this stage is three years, and includes 40 specializations in the following professions: electricity and electronics, mechanics, administration and finance, engineering, public construction and tourism.

- *Advanced Occupational Training Centres*

Students at these centres include students who have graduated from senior (high) school. The period of training at this stage is two to three years and includes several specialisations. Centres are divided between those which specialise in training for certain specific professions; administration, finance, computing (software and hardware), electrical, mechanical, industrial safety engineering, the other centres provide general training.

- *Trainers' Centres*

These are divided into two levels: a) centres for intermediate trainers; those who specialize in teaching at the basic and intermediate stages of occupational training and,

b) centres for advanced trainers; those who specialize in teaching at the advanced stages of occupational training (Aki A.A. and Al-Bishti A., 1994); (Statistic Book;1999) ,(Libya (1969-1999),(El-Hawat 1995).

Despite, the ETS has expansion of even though development spending has decreased since the beginning of the 1980s. The share of education and training in Libya's national economy has increased noticeably; participation rates have increased from 30% of the total Libyan population in 1990 to 35.1% in 1999. The number of educational institutions has expanded and the educational and training infrastructure has developed on a large scale. The number of registered students has grown from 1,431,000 in the school year of 1990/91 to 1,719,000 in 1998/99, expressing an annual increase of 2.5% in this period.

The following table shows the number of students joining educational and training institutes, giving an idea on the number of new entrants into the job market:

Table 1: Number of students in the educational and training institutes

	Educational & Training Levels	**Numbers**	**percentage**
1	Universities & Higher Education Institution	164938	39.5
2	Teachers Training	23919	5.7
3	Secondary Education	80702	19.3
4	Intermediate Vocational Training Centres	109074	26.1
5	Basic Vocational Training Centres	22490	5.4
6	E & T Institution Under other Sectors supervision	16817	4
	Totals	**417940**	**100**

Source: (Sharif, 2000).

5. THE UTILISATION OF EDUCATIONAL OUTCOMES MODEL

The level of education and training outcomes can be judged from the level of their utility in covering the needs of different economic activities; including specialised elements like the technical, administrative, skilled and semi- skilled workforce. The high level of outcome also reflects the extent of correlation between financial and human resources planning and consequently, the level of coordination between the requirements of the labour market and the outcomes of both the education and training processes.

Numerous evidence assert that the massive investments and resources that were allocated for the Education and Training Sector in Libya throughout the past three decades, reached an average of 6.3% of total national output. Those resources are still not enough to improve quality as a major component the efforts exerted to expand the education and training processes. This denotes the inefficiency of the investment process, especially when comparing expenses to the expected revenues from education and training. The inefficiency is clearly demonstrated in the decreasing internal efficiency of education and training; denoted by rising rates of drop-out and failures, as well as low levels of epistemic realization and deteriorated creative and analytical skills (Human Development Report, 1999).

The National Report on Human Development in Libya points at two of the most negative effects on the education and training processes in Libya; deteriorating levels of teachers' training and outdated curriculum that do not match the new horizons of knowledge and information technology revolution. These factors contribute to the incompetent returns from education and training, which asserts the need for coordination between the quantitative expansion principle and quality control.

Consequences of maintaining the same pattern include more disparity between the outcomes of the education and training process on one side, and the requirements of the job market and level of development on the other, as well as, the reduction of the work productivity, and decrease economic and social returns from education and training, moreover increase in rates of unemployment among youth (Sharif, 2000).

6. ANALYSING THE STRUCTURE OF THE LABOUR MARKET

The inflexibility of the production system and the link between its processes and the foreign industries has helped weaken national abilities to adapt with the developing essential processes like research, innovation, training and education (Al-Rabieei F.K, 2004). The following table shows the nature of the transformation that took place in the structure of the workforce in the Libyan economy.

Table 2: The percentage distribution of the Libyan labour forces (1970 – 2000)

Sectors	1970	1980	1990	1995	2000
Agriculture	29.1	19.7	18.49	17.9	11.7
Industrial	7.9	7.43	12.24	13	11.5
Electrical	1.9	1.91	2.8	2.9	2.9
Construction	11.3	22.52	15.42	14	9.6
Trade	7	7.15	5.3	5.9	10.7
Transportation	8.1	7.88	8.1	8.5	5.2
Financial	1.4	1.14	1.55	1.8	1.8
Services	33.3	32.27	36.1	36	46.6
Total	100	100	100	100	100

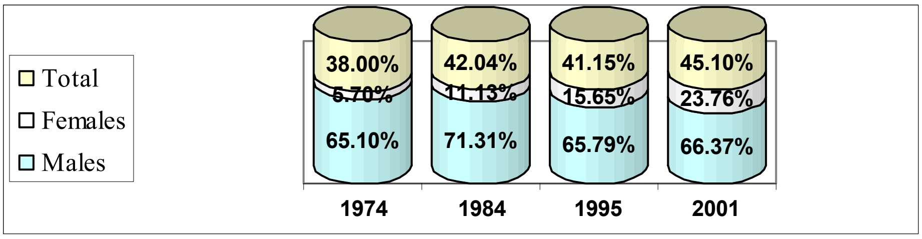
Source: Statistic Book, 1999.

From the table above it can be notice the amount and speed of conversion from the Agricultural Sector to the Service Sector. During the decade 1970-1980, the agricultural sector's contribution to the number of workers in the country decreased by 10% (from 29.1% in 1970 to 19.7% in 1980) to an increase in the Building and Construction Sector (11.3% in 1970 to 22.5% in 1980). But later, employment rates plummeted due to a decrease in investment in the Building and Construction Sector, which led to low rates of employment; 15.42% in 1990, 14% in 1995 and 9.6% in 2000. On the other hand, employment increased in the Services Sector from 32.27% in 1980 to 36.1% in 1990 to 46.6% in 2000.

The Libyan's economy has recently wetness a noticeable increase in the labour market particularly the females as shown in figure 1.

Figure one depicts the participation in the labour market from 1974 – 2001 by both males and females the percentage of males has been increased from 65.8 in year 1995 to 66.4 in year 2001 while the participation of the females increased from 15.7 in year 1995 to 23.8 in year 2001 and that has been reflected on the increase of the ratio of the total participation to the population from 41.2 to 45.4 in the same period

Figure 1: Percentage distribution of the manpower in the Libyan labour market 11974-2001



Source: Rhaith and El-mejbary 2005

We can therefore conclude that the large outputs of the education and training systems in Libya; especially those from social sciences faculties, teachers institutions and basic and middle professional training centres, have contributed to the escalation of a phenomenon of imbalance in the job market. As the growing numbers of graduates from administrative, financial and agricultural specializations helped expansion of the unproductive state, they aided in the transformation of disguised unemployment from the Agricultural Sector to the Services Sector which relatively assisted towards the deterioration of other production activities. **(**Wadiee2005**)**

7. STRUCTURE OF THE MANPOWER

The inflexibility of the production system and the link between its processes and the foreign industries has helped weaken national abilities to adapt with the developing essential processes like research, innovation, training and education (Al-Rabieei F.K, (2004). The following table shows the nature of the transformation that took place in the structure of the workforce in the Libyan economy.

Table 3: The percentage distribution of the Libyan labour forces (1970 – 2000)

Sectors	**1970**	**1980**	**1990**	**1995**	**2000**
Agriculture	29.1	19.7	18.49	17.9	11.7
Industrial	7.9	7.43	12.24	13	11.5
Electrical	1.9	1.91	2.8	2.9	2.9
Construction	11.3	22.52	15.42	14	9.6
Trade	7	7.15	5.3	5.9	10.7
Transportation	8.1	7.88	8.1	8.5	5.2
Financial	1.4	1.14	1.55	1.8	1.8
Services	33.3	32.27	36.1	36	46.6
Total	100	100	100	100	100

Source: AlRabei F.K, 2004 pp.8

Available education statistics for the years 92/1993 – 94/1995 indicate a fast growth in the number of high education graduates. This is shown in the following table:

Table 4: Development of the output of EDS in Libya from year 92/1993 to 94/1995

Educational & Training Levels	92/1993		93/1994		94/1995	
	Numbers	**%**	**Numbers**	**%**	**Numbers**	**%**
Higher Education Institution	6183	15.5	8273	17.7	10328	21.2
Teachers Training	8975	22.4	9214	19.7	7832	16
Intermediate E & V T Institution	17729	44.4	20556	44	21169	43.4
Basic Vocational Training Centres	7082	17.7	8712	18.6	9465	19.4
Totals	**39969**	**100**	**46755**	**100**	**48794**	**100**

Source: (Sharif, 2000).

Statistics show that the rate of joining educational and training institutions which prepare their graduates for direct entry into the job market, has grown with an annual rate of 10.5%, four times more than the growth rate of school participation. It is not the graduates only who act the demand for the employment, but there are the drop-outs from the educational and training system and the veterans from the army.

This fast development in the numbers of education and training graduates is a direct result of the numerical and quality expansions in the education and training systems. Several social and objective factors, such as the high growth in population throughout the past two decades, have also affected the rise in education participation, as it created a bias towards the younger categories. That is why the quality aspect of the education and training process should be made to match the expanding numerical aspect, in order to achieve social advancement and economic development.

8. CONCLUSION

Human resources can be developed at two stages: the first is the preparation stage, where the potential manpower is provided with the necessary theoretical knowledge as well as practical application. It is also necessary at this stage to identify job contents and gain enough skills for the job. The second stage is on-the-job training, where HR development is carried out through a group of technical operations on the job. On-the-job training mainly aims at increasing levels of performance, honing employee skills and talents, as well as creating a suitable psychological and humane environment for employees. Both the numerical (number of effective employees) and quality (effective employment) definitions of employment are related to the efforts exerted by the governments and different organisations to develop their HR. As the efforts to develop HR increase, they are reflected in employment rates; laying one of the most essential basis for sustainable development, building a strong human capital.

Nevertheless, theoretical and empirical studies pose a number of questions on the role of education and training in alleviating the employment and job market problem. The ‘Human Capital’ school supports the hypothesis: education and training should increase employability.

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ATTRACTING HIGH-EDUCATED PEOPLE BY USING LEISURE & RETAIL: WHY, WHO, AND HOW?

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ABSTRACT: Municipalities in the Netherlands are very interested in attracting high-educated people to their cities. By attracting these people they hope to improve their economic situation and to increase the involvement of citizens in society. Recently Dutch municipalities seem to pay more attention to the quality of life and to leisure facilities –for example, cinemas, theatres, cafes, restaurants, and galleries– and to retail facilities. This implies a positive relation between retail and leisure and city economics. In the paper the question will be addressed 'In what way municipalities can attract these high-educated people and how can they use retail and leisure facilities for that purpose?' This question will be addressed by desk-research. The conclusion of this paper is that leisure and retail functions are probably an important factor for attracting (certain groups of) high-educated people into a city, but that this must not be overestimated.

Keywords –Amenities, city, high-educated people, preferences, residential environment

1. MOTIVES FOR ATTRACTING HIGH-EDUCATED PEOPLE

At the moment, Dutch cities are very interested in attracting or keeping high-educated people within their boundaries. One of the often used arguments is that these people have on average a higher income. This is especially important, because in the four largest cities of the Netherlands a large fraction of the population depend on social welfare and only a small fraction of people has a high-income (see table 1). In Rotterdam the fraction of people living on welfare is the highest: one of six households in Rotterdam is depending on social welfare, against one on twenty-one households in the Netherlands as a whole.

Table 1. Population and unemployment in the Netherlands

	Amsterdam	**Rotterdam**	**The Hague**	**Utrecht**	***The Netherlands***
Population (1 Jan 2005)	742.783	596.407	472.096	275.258	*16.305.526*
Unemployment ratio (1 Jan 2005)*	8,0	10,6	6,3	6,4	*6,4*
Percentage of households depending on social welfare (2003)	10,8	13,9	9,5	6,5	*5,1*
Percentage of high-educated people (mean 2001-2003)	47,1	29,3	34,6	50,4	*27,9*
Percentage of households with more than 35.600 Euro (2002)	14,2	12,6	16,2	18,3	*20,0*

* The unemployment ratio is the percentage of people between 18 and 65 years that is unemployed and willing to work for at least 12 hours.

Source: CBS, 2005

There is indeed a relation between the level of education and the height of income. People with a finished higher education have a mean yearly income that is at least 3.000 Euro higher than people with a secondary education (second phase), when differences in household composition are taken into account. Especially households, in which both partners have a higher education, have on average a higher income (Selten & Rienstra, 2004).

In contrast with the high unemployment ratio in the four municipalities, a large number of high-educated people lives in these cities (see table 1). This is caused by the large number of students living in these cities. Many institutions of high-education are located inside these cities. Because of the high unemployment ratio, cities are especially interested in attracting high-educated people with a high income. When discussing the situation in Dutch cities it is important to mention that Dutch city municipalities have only a few or no suburban developments within their borders. However, in comparison with other cities abroad Dutch cities have small-scale morphology, with relatively few multi-family houses.

In his PhD thesis about urban ties of the new middle class - defined as high-educated people delivering mostly services - Van der Land mentions another reason for attracting the middle class: the middle class symbolizes solidarity and stability. 'The new middle class keeps the existing social structures in the city' (2003: 235). This high involvement could be an important condition for an economic successful city, because high-educated people are more often volunteering, although these differences have become smaller.

Furthermore, 'the presence of the new middle class in cities is an important pull-factor to attract knowledge-intensive industry in cities' (Van der Land, 2003: 235). A high-educated labour market can be an important agglomeration factor. His argument faces similarities with that of Richard Florida in his book 'The rise of the Creative Class' (2002). Florida argues that for cities it is good to attract people of the Creative Class, than to concentrate on companies. He says this, because nowadays companies seem to change more easily of location. People of the Creative Class are people who 'create meaningful new forms' (Florida, 2002: 68), such as scientists, engineers, designers, business managers and workers in the financial services. However, there seems to be a strong correlation between members of this Creative Class and high-educated people (Glaeser, 2005). The importance of creativity is not denied by Glaeser. 'Skilled people are the key to urban success. Sure, creativity matters. The people who have emphasized the connection between human capital and growth always argued that this effect reflected the importance of idea transmission in urban areas' (Glaeser 2004: 4-5). Because of this high-correlation, the emphasis in this paper will be on high-educated people and not creative people. As just said, the fraction of high-educated people is often related with a high economic growth (Glaeser, Scheinkman et al., 1995; Glaeser, Kolko et al., 2000; Florida, 2002). In the Netherlands there is also empirical evidence for the positive relation between the fraction of high-educated people -knowledge workers- and economic growth in the larger urban agglomerations (Van Oort & Raspe, 2005). The relation between a high-educated labour market and attracting knowledge-intensive firms is not conclusive in the Netherlands. For example, ICT companies say that they pay attention to the characteristics of their housing environment of their staff, but this relation seems not overwhelming strong (Van Oort, Weterings et al., 2003).

2. CHARACTERISTICS OF HIGH-EDUCATED PEOPLE

We already made a connection between the education level and the height of someone's income. In this paragraph the focus is on other characteristics of high-educated people in relation to retail and leisure. In the Netherlands, people spend a large part of there spare time and budget on leisure. Of the total national consumption of 225 billion Euros 3 percent is spent on recreation and culture in 2005. This percentage has been rising from 2.7 percent in 1995. Expenditures on dining and cafes have decreased in the Netherlands in the same period from 5.8 till 5.4 percent of the total national consumption (CBS, 2005). There are no data available about the size of expenditures in relation to education level. However, when income is rising, the percentage of expenditures in retail and leisure is also increasing, except for food (CBS, 2005). In the Netherlands the number of visits to traditional culture, such as museums, classical concerts, professional theatre, ballet, and monuments, has stabilized recently or rose slightly. The popular culture, such as popular music, cabaret, and movie theatre, has become more popular. When the education level is higher, people spend more time on popular and traditional culture (Broek, Huysmans et al., 2005).

*Table 2. Time budget of (working) Dutch people of twelve years and older (hours per week)***

	All Dutch people			**Working Dutch people**		
	1980	1990	2000	1980	1990	2000
Obligatory time*	40,8	42,0	43,9	47,2	50,0	51,7
Personal time	76,8	75,5	76,6	77,6	75,5	76,4
Spare time	47,0	47,2	44,8	43,3	42,5	39,9

* Work, care and education

** Obligatory time, personal time and spare time don't count exactly till 168 hours (24 * 7), this is because some activities fit in more than one category.

Source: Breedveld & Van den Broek, 2001; www.tijdbesteding.nl (9 December 2005)

From 1980 till 2000, the number of hours spare time had decreased from 47.0 to 44.8 hours (see table 1). Furthermore, people are not only busier, but they also feel more hurried (Breedveld & Van den Broek, 2002). This feeling of agitation is more prominent under people with a higher education and under people with children. In 2000 fifty-six percent of the people with a higher education against thirty-seven percent of the people with a lower education feel hurried. (Breedveld & Van den Broek, 2004). There is a positive relation between level of education and having a job (CBS,2005). Working people have less spare time per week (see table 1). In spite of the decreasing number of hours spare time, people want to experience more different activities. The consequence is that there is more recreational mobility, especially by an increased car use. There is a relation between the increased education, and the frequency and time of car travel (Harms, 2003). A higher average income can play a role in this.

3. ATTRACTING HIGH-EDUCATED PEOPLE BY RESIDENTIAL AMENITIES

When high-educated people can play such an important role, how can municipalities use the residential amenities -and especially leisure and retail real estate- to attract those people? The importance of high-quality amenities is stated for the American situation by Glaeser, Kolko and Saiz in their paper ‘Consumer City’ (2000).

Different conditions must be fulfilled before leisure and retail can influence residential behaviour (based on Drooglever Fortuijn, 2000). First, people should find leisure and retail facilities important; either because they frequently use them or because they appreciate the higher status of living in the vicinity of them. Secondly, people must be able to pay for such a residential environment. Frequently, this will not be a problem for high-educated people because of their higher income. Finally, there must be spatial differentiation in (the appreciation of) leisure and retail facilities. In the Netherlands nearly everybody has access to basic leisure and retail amenities (Van Dam, 2000). Only between the city and the country-side there seem real differences. In general a city has more leisure and retail facilities than a rural area. The focus of this section will be on the first condition: the importance the use of leisure and retail facilities or the higher status these facilities will give. Furthermore, a distinction between large-scale and small-scale leisure and retail facilities will be made. Examples of large-scale facilities are large cinemas, theatres, sport complexes, and shopping malls.

Gentrification and importance of lifestyle

The recent discussion about amenities is related with the autonomous –not particularly stimulated by the local government– process of gentrification. In the seventies in America and somewhat later in the Netherlands a process is started where young well-educated people without children (yuppies or young urban professionals) want to live in the inner city. In the Netherlands this trend of gentrification can only be identified in small numbers (Van Weesep & Musterd, 1991). But in combination with the suburbanisation of the merely white middle-class, it was probably a relief for cities that some people moved to the city.

In the eighties the Dutch housing market has shifted from supply-oriented towards demand-oriented. By this time the housing shortage, which had been caused by World War II, had been reduced. Welfare had increased and the overall quality of the housing had been improved. This all caused an increasing awareness in the Netherlands for the residential environment. In that period scientists and functionaries were trying to understand the relation between social and physical characteristics of the environment (Van Diepen & Arnoldus, 2002). This method has not been really successful in predicting those future needs. Recently, more attention is paid to differences in lifestyle as a way to predict future housing needs. Traditional variables, such as income and age, do not seem able to explain the different preferences of the residential environment completely. One definition of lifestyles is that lifestyles are manners people can use to show that they are a member of a specific group, that they have a specific identity. Another often used definition of lifestyle is that lifestyles are personal preferences that shape the activities people perform in a day. The residential environment can restrict the activities people want to perform or people choose a certain residential environment which fits their activity pattern most (Van Diepen & Arnoldus, 2002). In this paper both definitions of lifestyle and more traditional variables, when appropriated, are used to investigate the possible different needs of the residential environment of high-educated people.

Urban preferences and facilities

In what way is leisure and retail related to the residential preferences of high-educated people? The percentage of high-educated people living in the inner city seems higher than on the edge of cities (Vijgen & Van Engelsdorp Gastelaars, 1992: 40). This is remarkable, because many people in the Netherlands seem to prefer a rural or pseudo-rural environment (Heins & Van Dam, 2001). Florida (2002) says that besides a large labour market with many employment opportunities, creative people prefer places that are diverse, tolerant and open to new ideas. The quality and authenticity of a place are important aspects of a city to attract creative people (see figure 1 for an example of a restaurant in the Netherlands). In essence it is important for places to have a diverse, vibrant street live, a café culture, music, arts and outdoor possibilities. So Florida believes that '…a more organic and indigenous street-level culture' (2002: 182) is important for cities. This in contrast with what he calls canned experiences, chain themed restaurants, a multimedia-circus sports stadium or a pre-packaged entertainment-and-tourism district. The popularity of the vibrant street-level culture is linked with all-day-around availability, the possibility to communicate with other people and with the authenticity that people feel when using it. The large availability is especially important for people of the Creative Class, because they work long hours and have less time for organised events.

Figure 1. Restaurant 'De Bazar' in Rotterdam

There is empirical evidence about the positive relation between the quality of the urban residential environment and the size of the Creative Class in the Netherlands (Marlet & Van Woerkens, 2004). Marlet and Poort (2005) argue that Florida's bohemian index – the number of artists– and tolerance indexes have a positive relation with amenities and the accessibility of jobs in the thirty largest cities of the Netherlands. The amenities are culture, the number of monuments and old houses, restaurants and cafes, nature, and the quality of the houses. Housing prices seem to have a negative relation with the size of the Creative Class. They also find a relation between these amenities (except the number of monuments and old housed) and the growth of the Creative Class. Some other research (Van Aalst, Atzema et al., 2005) does not find the same relation between cultural amenities and the size of the Creative Class. Furthermore, Florida assumes that members and non-members of the Creative Class differ concerning their preference residential environment. In the Netherlands the current residential environment (stated preferences) of ICT employees, as members of the Creative Class, don't seem to differ from that of functionaries, as non-members of the Creative Class (Weterings & Hanny, 2003). Arnoldus (2003) examines the current living location and environmental characteristics as revealed preferences of four groups, namely artists, ICT-employees, architects and professors, in the Amsterdam region. He sees especially many differences in residential environment between the different groups. He concludes that not the whole Creative Class is simply oriented on urban residential areas. It is probably more reasonable, that in the Netherlands the division seems to be more among people with a cultural, creative profession and people with another kind of profession. Especially creative, cultural professions are interested in living in the inner city (De Wijs-Mulkens, 1999; Arnoldus, 2003; Karsten, 2003; Röling, 2004). The reasons are probably a combination of the higher status of an urban environment, the appreciation for urban amenities and work, and the fact that private life and work are more intertwined.

From the previous discussion can be concluded that there are probably connections between the activity pattern of high-educated people and the facilities in the neighbourhood. Vijgen and Van Engelsdorp Gastelaars (1992) relate the different activities and the residential environment. The different activity pattern is mainly caused by a difference in household composition and in working position, with dissimilar needs of facilities and residential environment. These different needs result in different spatial concentrations in specific environments. They argue that an urban environment –with good public transport, vicinity to work, cafes, restaurants, child care and shops– seems especially beneficial to singles and people with multiple obligations, such as work, care, study. Especially the education level of the women plays an important factor in the need for an urban environment and the willingness to pay a higher price for a good quality single-family home in an urban environment (see also Karsten, 2003). Therefore, for spatial sorting not only the (future) needs are important, but also the position on the housing market. In an urban environment a larger fraction of the people are actually using the existing facilities in the neighbourhood such as shops and restaurants, but it is hard to say if this is caused by spatial sorting of people –different personal characteristics are attracted by different facilities, housing characteristics, status, among others– or the larger number of facilities in the neighbourhood (Vijgen & Van Engelsdorp Gastelaars, 1992). However, the influence of the characteristics of the environment must not be overestimated. Karsten (2003) investigates the activity patterns of high-educated couples with children in the Former Port Area in Amsterdam. It appears that the environment –in this case the absence of sufficient child care and a not so child friendly environment– does not fit the wishes of the parents. However, it does not seem enough reason to move. The cultural facilities of Amsterdam, the modern architecture of the Former Port area, and the vicinity to work seem to be more important.

Figure 2. The dependence of the Hermitage in Amsterdam

Large-scale facilities

It can be concluded from the previous text, that small-scale leisure and retail facilities –certainly for some groups of high-educated people, such as working mothers, and people working in the creative, cultural profession–, are valued highly for the increased status or for using it. At this moment there are also new more large-scale retail developments on the edges of cities. In the Netherlands leisure and retail has always been clustered in the often historical inner cities. Retail is in these new projects often combined with leisure accommodations. After World War II there has been a restrictive policy in the Netherlands against large scale out of town (retail) developments (Evers, 2002). Recently a turnabout in national policy can be seen towards a policy in which such developments are somewhat more easily allowed. In combination with the idea that it is important for municipalities to compete with each other (Gold & Ward, 1994), real estate developments on the edge of cities are becoming more popular. Although real estate developments are also carried out in inner cities, it seems that more developments occur on edges of cities. Examples of these developments are Factory Outlet Centres as Bataviastad in Lelystad and Designer Outlet Centre in Roermond, but also ArenA Boulevard in Amsterdam. Bataviastad and the Designer Outlet Centre are the only two Factory Outlet Centres in the Netherlands at this moment. In these centres manufacturers of premium labels sell their unsold stocks with large discounts. The ArenA Boulevard is a large out-of-town leisure concentration of the soccer stadium of AJAX, a large cinema (multiplex), two pop podiums (Pepsi Stage and The Heineken Music Hall), a mall of furniture shops (Villa ArenA) and other large-scale shops. There are also plans for an urban entertainment centre (GETZ) with retail, a fitness centre, a hotel, a disco, a bowling centre, a theatre, and cafes and restaurants (see for more information www.arena-boulevard.nl). According to Florida, this kind of large-scale developments does not attract creative people (2002). Furthermore, high-educated people are more mobile, thus if they want to visit these facilities it is not necessary to live near these facilities. Most people do not visit these large-scale facilities often. This also applies to cultural facilities, such as museums and theatres. Of course, the addition of a museum or theatre can add status to (or improve the image of) the neighbourhood. An example is the location of a dependence of The Hermitage in Amsterdam (see figure 2). This effect seems limited for less high-standard facilities, such as an ordinary shopping mall or a pop podium.

Other important factors influencing residential behaviour

Because the conditions mentioned before –high priority, ability to pay, and spatial differentiation– seem to be fulfilled, leisure and retail facilities can influence the residential behaviour of (certain groups of) high-educated people. But fulfilling conditions differs from actually attracting high-educated people to a certain city. Moreover, amenities such as leisure and retail do not seem to be the most important reasons to move. Housing characteristics, such as space, quality, design, and cost, are by far more important reasons for people to move, when the move is of course not induced by employment change and change in the lifecycle, for example the size of the household (Pacine, 2005). So, the influence of retail and leisure facilities on the choice of a certain city should not be overestimated. The choice for a certain neighbourhood within a city will most likely be influenced by this kind of facilities.

Housing characteristics are very important for people. People with a high-income often own a private-owned, single home (CBS, 2005). Unfortunately, in cities most of the houses are social-sector rental, multi-tenant houses. At this moment city municipalities are building more houses for middle and high-income groups. Not only the characteristics of a house are important for these people, also the price/quality ratio is important. The higher house prices in a city are due to higher ground prices, and often higher public taxes. It is the hope that public amenities, such as a better public transport system, more cafes and restaurants, can compensate for that loss. Furthermore, cities are normally not considered to be the cleanest and safest places to live (Glaeser, Kolko et al., 2000). It is a significant problem for city municipalities all over the world to deal with (Clark, Lloyd et al., 2002). The quality of public schools does not yet seem to influence the choice of a certain neighbourhood in the Netherlands.

All available empirical evidence argues that proximity to multiple jobs stays important (Vijgen & Van Engelsdorp Gastelaars, 1992; Marlet & Van Woerkens, 2004; Pacine, 2005). On average high-educated people have a higher commuting tolerance than low-educated people (Van Oort, Weterings et al., 2003). In spite of the higher tolerance for commuting, high-educated people are more often forced to move to another location by a lower density of carrier opportunities (Hooimeijer & Nijstad, 1996). Because high-educated people are more often part of double-income households, they probably have to compromise more frequently between two working locations. It is useful for them to move to a place were the most jobs are accessible. The whole of the Randstad, the Dutch urban area in which Rotterdam, Amsterdam, Utrecht and The Hague are located, gives therefore the best opportunities. Amenities such as leisure and retail facilities could become more important, if this trend persists. For special categories of people the distance between the job and their home seems more important. Especially for women with children it is important that their work is in their proximity of their house (just like other facilities) due to their tight time-schedule (Vijgen & Van Engelsdorp Gastelaars, 1992; Karsten, 2003).

4. CONCLUSION

The main question of this paper is if it possible to attract high-educated people by using leisure & retail. These investments are often supported by public money. The main answer is that the quality of environment seems a condition for attracting high-educated people to cities, and that especially small-scale leisure –for example, cafes, restaurants, and galleries– and retail can make a positive contribution to the quality of the environment. This kind of facilities can be important for attracting high-educated people to a certain neighbourhood.

Why

One of the reasons why municipalities try to attract high-educated people is that there is a positive relation between economic growth and the fraction of high-educated people for urban agglomerations. A large number of high-educated people can make an interesting labour market for companies, although evidence for that is not overwhelming for the Dutch situation. Another reason is that because of their high social-involvement high-educated people are a condition for economic performance. High-educated people often have –after they finished their study– a higher income, which can increase the purchase power of the population. This is necessary, because the population of the four largest cities has a larger percentage op people living on social welfare.

Who

There is a positive relation between income and education. Because of their higher income, they are able to fulfil their housing needs more. High-educated people work more hours than people with a lower education. People who work and especially those who must take care of children are feeling busy and having less spare time. In the Netherlands it is often women that take care of the children and therefore especially they have a very tight time-budget. Furthermore, high-educated people often own a car, and they are often willing to travel more, especially for recreational purposes. Because of their income they spend a larger part of their income on goods (except food) and recreation.

How

As was previously discussed, cities want high-educated, high-income people to live within their boundaries. It must be said that in the Netherlands –also under high-educated people– not an urban, but more a rural environment seems to be appreciated. But in spite of this, still many high-educated people life in an urban area or/and prefer an urban environment to a rural environment. In the Netherlands not the whole Creative Class of Richard Florida is attracted to the inner city. Especially people with a cultural, creative profession seem to have an urban orientation in the Netherlands. The status of living in a (beautiful) house in a mixed urban area seems very important for these people. This does not mean that the diverse, vibrant street life, cafes, culture, music, arts, and outdoor possibilities, Richard Florida considers important, are not significant any more. The urban concentration of facilities is further very important for busy high-educated people to allow them to combine work, taking care and spare time. They are often using facilities such as child care, restaurants, and cafes. The availability of these facilities is important, but should not be overestimated. When a facility, for example child care, is not present, it does not mean that people immediately move to another neighbourhood. The relative importance of amenities is also noticeable when comparing the reasons people have for moving. Housing characteristics, such as space, quality, design, and cost, are by far more important reasons for people to move, when the move is of course not induced by employment change and change in the lifecycle, for example the size of the household. For high-educated people vicinity to work seems less important, because they often are a part of double-income household. They have to compromise more frequently between two working locations. Amenities such as leisure and retail facilities could become more important in the future. Next to small-scale facilities also large-scale leisure and retail facilities can influence the residential behaviour. The status of an area could increase if a museum or theatre is located. The conclusion of this paper is that leisure and retail functions are probably an important factor for attracting (certain groups of) high-educated people into a city, but that this effect should not be overestimated. The choice for a certain neighbourhood within a city will most likely be influenced by leisure and retail facilities.

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SOCIAL CLASSIFICATION OF CONSTRUCTION EMPLOYEES INFLUENCING MOTIVATION TO WORK

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ABSTRACT: The aim of this study is to investigate whether social class of employees is a factor to be considered by construction companies. Two objectives are established to determine: (i) if social class influences motivation to work, and (ii) if social class influences the impact of known motivational factors. The study uses the five-class self-completion version of National Statistics Socio-economic Classification (NS-SEC) to determine social class. An adaptation of the Michigan Organisational Assessment Rating Technique (MOART) developed by Gilbert and Walker (2001) is used to assess motivational levels. The research instrument is a questionnaire and the sample is construction staff and operatives. For objective (i), statistical analysis suggests that social class does not influence motivation. For objective (ii) relationships are found between social class and desire for money / job security. Company policy on the provision of financial incentives should be reviewed. This work is relevant to practising construction managers.

Keywords: incentives, job security, motivation, social class

1. INTRODUCTION AND THE PROBLEM

It is acknowledged that a highly motivated workforce can make the difference between success and failure (Ghoshal, 1995, quoted in Crainer and Dearlove, 2001). Walker and Smithers (1996) support this view adding that 'business performance is inextricably linked to attracting, retaining and developing motivated and committed individuals'.

There are many variables that will come into play during the lifetime of construction projects, a number of which could well be beyond the control of project teams. It is important therefore, for effective managers to understand what factors they can directly influence. Managers are responsible for obtaining results and consequently, they rely upon the basic principle of understanding the most important resource; people. Inefficient use of labour and waste of resources in construction is common place. In their respective reports, 'Constructing the Team' and 'Rethinking Construction', Latham (1994) and Egan (1999) identified adversarial attitudes, wastage and inefficient use of labour, as major characteristics of the modern day construction industry.

The Employers' Skills Need Survey undertaken by the CITB, surveyed nearly five hundred construction companies across Great Britain. These companies were asked about workload and recruitment difficulties in October 2003. Nearly 70% said that they were experiencing recruitment difficulties, with craft trades and managers representing the greatest difficulties (CITB 2003). Arguably then, there is a severe shortage of labour within the construction industry. Further evidence for this labour shortage is highlighted in the Built Environment Professional Skills Survey 2003 / 2004 (CIC 2004). Here, 68% of the 927 companies surveyed from within the construction professional services sector, had experienced difficulties in the past twelve months with the recruitment and retention of staff.

There is increasing expectation by both clients and industry for greater efficiency and predictability in time, cost and quality. Despite numerous improvements in construction technology and procurement routes, actual productivity is arguably below par, when compared with other industries. This is assertion is supported by Egan (1998), who states that 'there is deep concern that the industry as a whole is under-achieving. Coupled with the predominantly labour-intensive nature of the industry, this suggests that 'proper emphasis should be given to such matters as communications, participation and motivation' (Mansfield and Odeh, 1991). Understanding what motivates employees individually and moreover collectively, would enable managers to best allocate resources. Construction managers could be accused of marrying the concept of motivation with the use of incentives, and incentives with tangible rewards. The preconceived notion that motivation can be produced and sustained from the timely provision of tangible rewards is arguably short-sighted and highlights a lack of understanding and confused thinking in a complex area. Price (1992) acknowledges this point and argues that it is the transient nature of the construction industry that explains the trend towards financial incentives as the favoured method. Non-materialistic motivators such as interpersonal relationships or career development would be difficult to establish when short term relationships are the norm.

Although, many may argue that it is the nature and characteristics of the construction industry that have facilitated this practice for so long. The literature review provides a tantalising proposition that social class has a direct relationship with motivation and therefore, provides the catalyst for the study, that is, to see whether employees can be categorised into their social class and whether there are common trends and patterns in motivational needs or motivational levels across these groups. The ability of managers to make their workforce productive is fundamental to successful projects. Motivating employees to work in an efficient and productive manner is seen as one part of the 'traditional form' of management. The construction industry needs to concern itself with motivation at two different levels: to attract the best people to fill the positions and, once in these positions, to motivate the people to perform the duties associated with them.

2. THE LITERATURE

Motivation has been extensively reviewed in construction, therefore only some aspects of it are summarised here. Less interest has been taken in the concept of social class, and therefore a more extensive appraisal is presented.

2.1 Motivation

The word 'motivation' was derived from the Latin term *movere,* to move. Herzberg stated that motivation is a 'function of growth from getting intrinsic rewards out of interesting and challenging work'. Hollyforde and Whiddett (2002) define motivation as 'whatever the behaviour, the drive pushing or pulling a person to act in a particular way is motivation', and state that, 'most academics consider motivation to represent the drive behind human behaviour'. It has been suggested that effective management requires an understanding of what motivates a workforce. This understanding has changed substantially over the last century and is often believed to reflect the current labour situation. During the 1930's the threat of unemployment and the use of aggressive management achieved a form of 'productivity'. In later years there has been a reversal; financial rewards, over payments, incentive schemes etc, resulting in a more persuasive form of management (Seeds 1999).

This change in management thinking is exemplified by the work of Fredrick W Taylor, in the early part of the last century. Taylor's work on scientific management is often referred to as the traditional approach to motivation. Taylor's systems are based on employee pay; those who produced the best in quality and quantity received the best remuneration. It was believed these rewards would improve motivation and consequently, greater productivity and efficiency in the work place. However a number of researchers and academics argue that:

> 'bonus, payment by results, financial incentives (or any synonymous method for systematically encouraging productivity) has been the grumbling appendix to industrial relations in the building industry, with arguments for and against its use, thoroughly rehearsed over some seventy years' (Hague 1985).

Taylor's work was put into question when Elton Mayo conducted the Hawthorn studies. Mayo selected six women from a factory. Mayo continually changed the women's working conditions, sometimes for the better and sometimes for the worse; always discussing and explaining the changes in advance. To his surprise, there was a significant improvement in production, irrespective of the change to working conditions. These findings were partially at odds with Taylor, who based his approach on the premise that workers are purely motivated by economic self-interest. Mayo's findings illustrate a fundamental concept: 'workplaces are social environments and within them, people are motivated by much more than economic self-interest' (AJA, 2003). Mayo's understanding of the workplace as a social environment and of people, motivated by their role within this social environment is clearly sound and potentially, transferable to the construction industry.

Amongst others, Maslow and Herzberg regard 'motivation' as being a highly complex issue and would suggest that human motivation is based on a series of needs and wants. Maslow (1998) proposes that these needs can vary from the basic necessities for life, such as oxygen, food and water to love, belonging and esteem. Maslow, McClelland, Atkinson, and Herzberg could all be open to criticism, in that they lend insufficient consideration to the effect of job and work related variables. Price (1992) would say that 'a number of the early theories were primarily based on the individual's motivation, although job-related and work environments are not ignored. The main emphasis was placed on the individual's characteristic and the role played by personal needs in determining work behaviour'. Ruthankoon and Ogunlana (2003) would go further, in that Herzberg's theory, whilst widely known in management circles, has been criticised 'regarding its validity in work settings'.

Many authors such as Ruthankoon and Ogunlana (2003), Gilbert and Walker (2001), Price (1992) and Hague (1985) use the established and well known motivational theories of Maslow and Hertzberg amongst others, as the framework for their research. It is these theories that first recognised motivation as a series of needs and wants.

The characteristics of the construction industry (argued by some in Egan, 1998, to be different to other industries, particularly manufacturing) may well limit the viability of recognised research undertaken in other sectors, as a basis for comparison. Ruthankoon and Ogunlana (2003) emphasise that 'construction is an industry with unique characteristics which may have special effects on employee motivation', and Price (1992) highlighted that the transient nature of the construction industry with short term projects is a major factor. Arguably, there are many preconceived ideas about motivation, based on Fredrick W Taylor's systems, in the early part of the last century. Hague (1985) states 'it is tempting to conclude that managers are motivated while manual workers need bonus payments'. In contradiction, McFillen and Maloney (1988) believe that each worker is unique, which may consequently limit the potential to identify trends within the industry.

2.2 Social class

Davis and Moore (1945) link the two variables of social class and motivation. They believe that the inequalities created by social class in fact compel people to better themselves, ensuring that the most valued positions in society are filled by those most qualified and competent. In a modern society, some academics argue that it is no longer appropriate, justified or indeed, ethical, to categorise people into social class. Holt and Turner quoted in Crompton (1993) assert that 'class is an increasingly redundant issue'. The continuing debate on social class and its value or devalue to society is testimony to the need for further research into social classification.

At its most basic, social class is based on grouping people that have a similar social status. Liversey (2004) believes that social class is a widespread concept with many dimensions. The three primary dimensions are: (i) economic – i.e. wealth, income and occupation, (ii) political – i.e. status and power, and (iii) cultural – i.e. lifestyle, value beliefs, levels of education and so forth. The economic dimension is commonly accepted as the most important. This is largely due to the close relationship between economic position, social status and power. Liversey (2004) 'believes it is important to define social class because it is objectively linked to an individual's 'life chances'. Once defined, Liversey (2004) believes that it is then necessary to 'operationalise' social class; this is to find a method to gauge class, an indicator of class. This gauge could then be used as a basis for measurement and testing. Historically, this was done on the basis of occupation.

Rose (2004) states that the 'practice of officially classifying the British population according to occupation and industry began in 1851' and was undertaken for the purpose of mortality analysis. However, it was not until 1911 that a summary of occupations, designed to represent 'social grades' was introduced by the Registrar General's Annual Report. These were later referred to as 'social classes', originally named the Registrar General's Social Classes (RGSC) and then re-named social class based on occupation, in 1990. Therefore, the Registrar-General's class scheme was based on the premise that society is formed by a hierarchy of occupations. This hierarchy is divided into five basic social classes: professional, managerial, skilled occupations, partly-skilled occupations and unskilled occupations. These classes were recognised by the Office of Population Census and Surveys (OPCS) and were described, from 1921 to 1971, 'as an ordinal classification of occupations according to their reputed 'standing within the community' (Rose, 2004).

In the UK 'occupations were placed in social classes on the basis of judgements made by the Registrar General's staff and various other experts with whom they consulted, and not in accordance with any coherent body of social theory' (Rose, 2004). Maguire (2004) states that the Registrar General's scale contains absurdities 'like equating small tenant farmers and major land owners' and then argues that 'the level of skill at work may not be the best way of measuring access to social resources'.

It could be argued that the concept of social class is wide ranging. Liversey (2004) believes 'it is extremely difficult to operationalise since it involves a large number of variables such as the relationship between income, wealth, power, status, gender and age'. Modern attitudes and values may also limit the relevance of social classification in today's society. Crompton (1993) highlights a number of arguments to the effect that 'the idea of class is out of date and of declining significance' and that 'transformations of work and the structure of employment have blurred established class boundaries' whilst Breen and Rottman (1995) highlights the point that in Britain it is 'differences in consumption, rather than production, which are nowadays central to the formation of interest groups in society'. Liversey (2004) goes on to state that social class 'is not easy to define (although there may be certain observable indicators of a peoples' class, such as the way they talk, the way they dress and so forth)'.

Such criticism by academics and researchers may well have contributed to the National Statistics Socio-economic Classification (NS-SEC), introduced in 2001. NS-SEC replaces social classification based on occupation for official statistics and surveys. NS-SEC aims to assess employment relations and conditions; conceptually these are central to delineating the structure of socio-economic positions in modern societies and helping to explain variations in social behaviour and other social phenomena. The NS-SEC aims to differentiate positions within the labour markets and production units in terms of their typical 'employment relations' (NS-SEC, 2004).

Peoples' position in the labour market is determined by their level of income, security of income and prospects for improving level of income. Peoples' position in the work environment is determined by the systems of authority and control at work, autonomy being a secondary aspect. The NS-SEC categories thus distinguish different positions (not people) as defined by social relationships in the workplace – i.e. by how employees are regulated by employers through employment contracts (NS-SEC, 2004).

Stratification describes the different 'layers' that exist in society and is defined by Davis and Moore (1945) as 'unequal rights and prerequisites of different positions in society'. They propose that the 'stratification system provides for the appropriate motivations for the people to seek to fill certain role positions and desire to perform the appropriate tasks required of that position adequately'. Davis and Moore (1945) also support social stratification as an incentive for social betterment. They attribute more importance to particular jobs, for which they believe only a minority within society are able to perform. Tumin (1953) disagrees, on the basis that margins of society are not given the opportunity to discover their talent. The rewards used to motivate people and the hierarchical distribution of those awards are part of the social order and give rise to stratification. It could be argued that in addition to the motivational benefits of the rewards on the individual, the inequality created by stratification, also has a motivational effect on society.

Wrong (1999) states, that since the publication of the Davis-Moore theory, 'historical events and trends in social theory have increased the credibility of their work' whilst adding that 'their emphasis on rewards as incentives for individuals' self-recruitment to occupational roles was also right'. Wrong (1999) did however criticise their failure 'to mention that motives other than the desire for rewards may influence individual choice'.

Arising from the literature review the following hypotheses are established: (i) social class influences motivation to work; where social class is the independent variable (IV) and motivation to work is the dependent variable (DV1), and (ii) social class influences the impact of known motivational factors (where social class is the independent variable (IV) and the impact of known motivational factors is the dependent variable (DV2).

3. METHODOLOGY

The main research instrument was a group administered questionnaire. The population were operatives, administrative and secretarial staff, trades people, supervisors, managers, surveyors and engineers, working in a construction environment. The sample was one of convenience; those working for the employer of the lead author. It consisted of eighty-one construction personnel on partnering projects, throughout Yorkshire, Cheshire and Greater Manchester. Seventy-six of the respondents were male and five were female. The principle reasons for choosing this sample were to improve the response rate from the research questionnaire (95% response rate) and minimise cost.

The questionnaire uses the 'five-class self-completion' version of the National Statistics Socio-economic Classification (NS-SEC) to measure the independent variable 'social class'. There are three steps in deriving the classification of respondents. Firstly, the employment status has to be established. Secondly, a self-coded occupation variable has to be found and thirdly, a NS-SEC classification can be established. The NS-SEC classification is shown in table 1.

Table 1: The five-class NS-SEC classification

Class	Label
5	Managerial and professional occupations
4	Intermediate occupations
3	Small employers and own account workers
2	Lower supervisory and technical occupations
1	Semi-routine and routine occupations

The measures for the dependent variables DV1 and DV2 are taken from one data set; DV1 'motivation to work' is a multiple-item scale comprising eleven 'desires of people' identified from the literature, thus: peoples' desire for money, achievement, recognition, responsibility, professional advancement, job security, status, safe working environment, a good working relationship, client satisfaction, and working on interesting projects. The score for DV1 is expressed as a percentage. DV2 'impact of known motivational factors' is each of these eleven factors considered separately. An adaptation of the Michigan Organisational Assessment Rating Technique (MOART) developed by Gilbert and Walker (2001) has been employed as the method of data collection. Respondents were asked firstly to evaluate the degree of importance they attached to each variable on a four point scale: very low importance, just important, important, very important. Secondly, they were asked to evaluate the degree to which each variable was currently motivating them (presence) on a four point scale. A score for each variable was produced by multiplying the rating given to importance by the rating given for presence, as illustrated in table 2. The multiplied value provides a motivational rating for that variable. The sum of the motivational ratings for all the variables represents respondents' overall level of motivation to work (DV1) for respondents.

In addition, several sub-hypotheses were established based on demographic data collected from respondents in order to check for data homogeneity, thus: age, occupation, marital status, whether home owner, number of dependents, number of years worked in the construction industry, and gender. All these variables are termed 'subject variables'.

Table 2: Example of scoring technique used by respondents

Motivating Variable	Importance	Presence
Sense of achievement	1 2 3 4	A B C D
Recognition	1 2 3 4	A B C D

Validity of the data was improved by using established methods of measurement and by executing a pilot study. SPSS software was used to analyse the data. A variety of statistical tests are used; the main objectives are tested using Spearman's correlation coefficient and the Mann-Whitney test. In all the statistical tests the significance level at which point the null hypothesis is rejected is $p \leq 0.05$.

4. ANALYSIS, RESULTS AND FINDINGS

Analysis was undertaken to determine whether the data should be considered parametric or non-parametric. Three criteria were considered: whether (i) the data is of interval status, (ii) the distribution of responses mirrors a normal distribution, and (iii) the variance of the variables is homogeneous (Bryman and Cramer, 1997, p. 145). The independent variable and subject variables were all clearly non-parametric. Four of the eleven measures comprising the dependent variables were also non-parametric. Therefore throughout, non-parametric tests are used in the analysis.

To test the relationship between the IV (social class) and DV1 (motivation to work) a Spearman's correlation test was undertaken. The p value was 0.97, and the correlation coefficient -0.005. The null hypothesis could not be rejected. It was found that social class (IV) does not influence level of motivation to work (DV total). The scatter diagram for the data set is shown in figure 1.

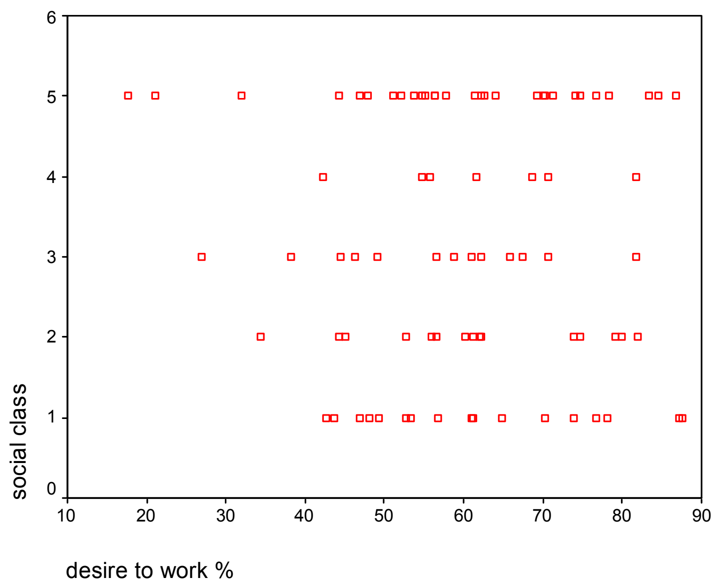

Figure 1: Scatter graph indicating social class (IV) v desire / motivation to work (DV1)

To test hypothesis (ii) 'social class influences the impact of known motivational factors', Spearman correlation tests were undertaken on each of the eleven separate variables. The results are displayed in table 3.

The hypotheses related to 'desire for money' and 'desire for job security' were both significant at $p \leq 0.05$levels. The null hypotheses were rejected. The correlation coefficients of -0.30 and -0.27 indicate that there is a 'fair degree' of relationship between the IV and the DVs. The findings are that the lower the social class the greater the desire for money and the greater the desire for job security.

Mann-Whitney and Kruskal-Wallis tests were used to test for significance between the mean scores for all the subject variables (age, occupation etc) and DV1. In all tests, p was > 0.05, therefore the null hypotheses could not be rejected; the data was found to be homogeneous. All the subject variables were also tested against the eleven separate measures of the dependent variable. Significant results were found in those cases presented in table 4.

The findings suggest that: (i) younger people have a higher desire for money, professional advancement and job security, and (ii) the greater the amount of time spent working in the construction industry the greater the reduction in respondents' desire for money.

The confidence interval was calculated for DV1 to measure how closely the data gained from the sample would be replicated in the total population. At the 95% level, with the mean at 60.20, the range was 59.05 to 61.35. It can be stated that there is a 95% probability that this range will include the true mean of the population. Such a narrow range supports assertions about validity of the study.

Table 3: Spearman's rho test results for hypothesis (ii)

Dependent variables DV2 - desires for:	**'P' value**	**Correlation coefficient**
Money	0.01	-0.30*
Achievement	0.46	-0.08
Recognition	0.22	0.14
Responsibility	0.50	0.08
Professional advancement	0.63	-0.06
Job security	0.01	-0.27*
Status	0.06	0.21
Safe working environment	0.21	-0.14
Good relationships with team members	0.92	-0.01
Client satisfaction	0.51	0.08
Working on interesting projects	0.29	0.12

* Correlation is significant at the .05 level (2-tailed).

Table 4: Significant results in Mann-Whitney tests for the subject variables age, occupation, marital status, whether home owner, number of dependents, number of years worked in the construction industry, and gender

Variables	**'P' value**	**Mean scores**
Age v Desire for money	0.00*	≤ 35 (N=36) 50.49 > 35 (N=45) 33.41
Age v Desire for professional advancement	0.00*	≤ 35 (N=36) 50.76 > 35 (N=45) 33.19
Age v Desire for job security	0.00*	≤ 35 (N=36) 50.06 > 35 (N=45) 33.76
Number of years worked in the construction industry v Desire for money	0.01*	≤ 13 (N=38) 48.00 > 13 (N=43) 34.81

** Significant at the 0.05 level (2-tailed).*

5. DISCUSSION AND CONCLUSIONS

The results for hypothesis (i) did not match the authors' expectations; it was found that social class does not influence level of motivation to work. The literature review had identified a number of academic theories on social class and motivation that had established a potential link between the two variables. Expectations were drawn from the concept of social stratification, as established by Davis and Moore (1945), recently supported by Wrong (1999) who states that historical events and trends in social theory have increased the credibility of Davis-Moore's work. Also the NS-SEC classification system is based on the principle that people need to be engaged in increasingly demanding job roles requiring additional effort and resources to fulfil and which also would require additional levels of motivation. However, the results obtained in this study can be compared to those of Gilbert and Walker (2001) who similarly found in the case of gender, that there was no statistically significant difference in total motivation levels between males and females.

Davis and Moore's (1945) work may be relevant to construction; it might be the case that people with higher social class are motivated by factors intrinsic to the job itself. People from lower social classes are elevated to the same motivational levels of higher class people by money. To the extent that higher class people are motivated by money, it is considered by them as a factor less frequently than by people of a lower social class. Support for this can be found in the results from objective (ii), the lower the social class the greater the desire for money and the greater the desire for job security. Current management practice in the use of motivational incentives already discriminates on the basis of occupation, with financial incentives directed towards operatives but senior staff motivational needs being satisfied by non-materialistic motivators such as professional advancement and challenging work. This approach is supported by Price (1992), who believes that it is the transient nature of construction operatives that explains the need to provide financial incentives; non-materialistic motivators such as interpersonal relationships or career development require longer term relationships to be established. Support can also be drawn from Hague (1985), who suggests 'it is tempting to conclude that managers are motivated while manual workers need bonus payments'.

Current practice places greater emphasis on monetary reward for the lower social class, and non-materialistic reward for the higher social class. The survey results have not been able to establish different motivation levels between the different social classes. It is therefore not unreasonable to recognise the success of current practice, in delivering its goal.

The results from analysis of subject variables suggest that younger people have a higher desire for money, professional advancement and job security than that of their older colleagues. Maslow briefly refers to age and the part that it might play in his theory. On considering the type of people who might be placed at the top of his hierarchy (within the self actualising group), Maslow acknowledges that 'older people are the right age to be self-actualizing'. Arguably, the desire for money and job security both fall towards the lower order needs within Malsow's theory, which states that lower-order needs must be satisfied, before higher-order needs will motivate people.

Younger people have the lowest disposable income, coupled with steadily increasing demands on their expenditure. Within many organisations money may well be limited and wage structures must be maintained, and there is much academic debate over the benefit of monetary rewards for the long term motivation of staff. With this in mind, resources could be directed to satisfying young peoples' desire for professional advancement and job security.

Motivational needs amongst categories of the workforce vary. The literature review has identified profession and gender, whilst this study has used social class. It is acknowledged that because the NS-SEC uses employment relations and conditions as a basis for classification, social class is inextricably linked to occupation. Policy in the lead authors's company on the provision of financial incentives as a catalyst for motivation should now be reviewed. Careful targeting can be undertaken to identify those with the greatest propensity to react to their timely provision.

Limitations of this study can be considered around the selection of the sample from just four partnering projects. It is recommended that a further study is undertaken to conclusively establish which employees (age, profession, gender, social class, marital status, etc) have the greatest propensity to benefit, in terms of improved motivational levels, from the provision of financial incentives. There is potential for such work to have broad application by using an industry-wide based sample.

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WOMEN IN CONSTRUCTION: A STUDY ON THE LEADERSHIP

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ABSTRACT: The women participation rate in construction sector both in academia and industry is very low, particularly at senior management level. The statistical analyses of western countries reveal that while the numbers of women entering management positions continues to increase, women remain under-represented in senior executive positions. It is important to attract and retain professional women with good leadership qualification and skills in the senior positions in order to maintain a good standard and professionalism within the construction sector. In this context, this paper will examine the literature relating to the educational and executive leadership in construction associated with Women. Focus will be given on the reasons behind the under-representation of women both at educational and executive leadership levels within the construction sector. The study also examines the barriers faced by women entering senior executive positions

Keywords – Construction, Educational Leadership, Executive Leadership, Women

1 BACKGROUND

The construction industry, in the UK in particular, is one of the UK's chief employers with over 2 million people, more than 1 in 14 of the total workforce (CITB, 2003). Currently there are over 11 million women employed in the UK, accounting for almost 50% of the work force. However, women only account for 9% of the construction workforce (CITB, 2003), making it one of the most male dominated of the major industrial sectors. Only when this figure is broken down do we see the true position of women in construction. A remarkable 84% of women in hold secretarial posts, whereas only 10% are employed in a professional capacity, in design and management areas. In the remaining breakdown women account for less than 1% of craft and trades people, 2% are sole traders and 4% are involved in micro enterprises, companies employing 1-10 people. The number of women entering into University education has continued to increase over recent years, and women now account for over 50% of students. However, it is found that despite this increase, women still only constitute 8% of construction students (Green, 2005).

There is a considerable evidence to indicate that the male dominated nature of the construction represents a significant barrier to female recruitment, career progression and retention. Though the number of women within the workforce and the education continue to rise the women participation rate in construction sector both in industry and academia is very low, particularly at senior management level.

The under-representation of women in positions of senior management within educational institutions continues to be a matter of some concern, particularly as the teaching force is largely dominated, nationally and internationally, by women (Cubillo and Brown, 2003). Studies on gender and leadership have revealed a number of barriers to women seeking educational leadership and management positions. Also the executive leadership is constituted as a predominantly male domain, placing women in an antithetical position to executive power (Olsson and Walker 2003).

The issue regarding the lack of women in construction has been a concern for many years, attracting government and industry wide attention. This issue has been made more prominent recently due to the potential skill shortage facing the industry. A healthy construction industry is vital for the physical regeneration of the region. The UK construction industry is busier now than it has ever been for a decade and is suffering from skill shortage in both craft and manual trades such as bricklaying, plumbing and painting, and at the professional level, in engineering, quantity surveying and estimating (Fox, 1998). Therefore it is not surprising that the UK government is again tapping into what Fox referred to as 'the talents of other half of the workforce', examining ways to encourage women into traditionally male-dominated jobs (Financial Times, 25 April, 2001; Women's Unit, 2000 cited in Whittock, 2002). The potential skills shortages are facing the construction industry, as Construction Industry Training Board Skills Forecast Report (2003) suggests: "*UK construction has delivered a sharp increase (8%) in output over the last year, growing faster than any other major sector. Approximately 83,000 new recruits will be required each year between 2003 and 2007*". The industry cannot rely on the traditional male workforce to meet these targets. The recruitment of women is imperative to achieving these objectives and prolonging the industry's growth. A study by Green (2005) highlights the current position: "*It's a pretty rare breed of woman that works in the industry*"; "*We need more women to fill the skills gaps and to make a change*". In her view traditional gender divisions in the construction sector are still evident and vertical segregation is still prevalent with women being under represented in senior positions. It is said that 'a major obstacle to the industry to recruit the best people is the fact that half of the population is largely ignored by the industry' (Green, 2005). The studies in these areas have been invaluable in pinpointing the factors militating against the participation of more women in the construction work place, and in particular, the recruitment into the construction professions (Agapiou, 2002).

Despite it being such a great concern there has been very little change in the number of women working in industry. Numerous initiatives promoting construction careers to women have been developed but none has had the desired effect. Therefore it is important to study how to attract and retain professional women with good leadership qualification and skills in the senior positions in order to fill the skill gaps at professional level and thus to maintain a good standard and professionalism within the construction sector.

2 AIM AND METHODOLOGY

This paper mainly focused on the reasons behind the under-representation of women in senior management levels in construction. The growing presence of women in the international workforce continues to motivate research on the leadership styles of women, particularly to determine if women have their own ways of leading. The real issue in leadership differences lies in the equity in selecting the right person with the appropriate skills and qualities to ensure the effectiveness and success of the organization (Bass and Avolio, 1994). The integration of women in leadership roles is not a matter of "fitting in" the traditional models, but "giving in" the opportunities for them to practice their own leadership styles. Since organizations have been mostly occupied by men, some women have chosen successful male leaders and their styles as their role models (Appelbaum and Shapiro, 1993). Some others dare break the mould and start with leadership styles that openly reveal feminine traits and behaviours as "silent cries" for social justice and a place of their own in organizations. The strategic value of these styles for organizations lies in the merging of both innate feminine characteristics and professional skills developed in the workplace that contributes to the attainability of organizational goals.

The presence of feminine or masculine characteristics in leadership styles is related to the construct of gender (Larson and Freeman, 1997). Gender, race, class, and other elements of social difference are acknowledged to play an important role in the development of leadership styles. Fitzgerald (2003) suggested that it is impossible to create conceptualisations of leading and managing without taking into account issues of gender and ethnicity.

In this context, this paper aimed to examine the literature relating to the educational and executive leadership in construction associated with Women. The study, while examining the reasons behind the under-representation of women at senior management level in construction, will also discuss the barriers faced by women entering senior executive positions. A critical literature review was carried on various book and journals that are related to gender, leadership and construction. Thus this paper primarily addresses the following questions.

1. What are the leadership styles that could be taken up by women in construction industry?
2. What are the reasons behind the under-representation of women at senior positions within construction sector?

3 LEADERSHIP IN CONSTRUCTION: GENDER PERSPECTVE

3.1 Introduction

The leadership is defined as 'the ability to influence – either directly or indirectly – the behaviour, thoughts, and actions of a significant number of individuals' (Gardner, 1995). Leadership is one of the least-understood concepts in business, despite the countless articles and books written about it. Many theories of leadership have been developed, yet no single approach adequately captures the essence of the concept. The intention of leadership theories is to explain relationship between leadership styles and the context in which leadership is evaluated. A review of management literature reveals that studies of leadership have focused mainly on finding the most appropriate or effective leadership style. Although many studies have been undertaken in the area of leadership styles, they have generally tended to be among manufacturing industries characterized by permanent organization structures. Few published work exists that is directly concerned with the construction industry (Giritli and Oraz, 2004). Langford et al. (1995) state that 'a lack understanding of knowledge of the industry on the part of social scientists and a lack of understanding of social science by those in the industry has been the cause of this dearth'. However, there seems to be few empirical studies related to the subject in project-based industries such as construction.

The construction sector can be researched into two discrete perspectives namely academic perspective and industry perspective. The academia may refer to the Universities and higher educational institutions where construction related courses are conducted. Construction as an industry is defined as one that employs workers in two main categories namely 'managers and professionals', who plan, organise, advise on specialist functions or field activities, direct and coordinate all activities and resources involved with construction operations; and 'construction trades', who construct, install, finish, maintain and repair internal and external structures of domestic, commercial and industrial buildings and civil constructions (Employment Service, 1990 *cited in* Fielden et al., 2000).

Educational leadership refers to "leadership influence through the generation and dissemination of educational knowledge and instructional information, development of teaching programs, and supervision of teaching performance" (Shum and Cheng, 1997) whereas executive leadership is defined as 'set of activities directed toward the development and management of the organization as a whole, including all of its subcomponents, to reflect long-range policies and purposes that have emerged from the senior leader's interactions within the organization and his or her interpretations of the organization's external environment' (Zaccaro, 2001).

3.2 Leadership in Construction

As per the forgoing discussions and definitions, the leaders within construction sector could be defined as below for the purpose of this study. In this context the managers and professionals of construction both in the industry and in the academia could be categorised into four types as follows (Bennett, 1999);

1. *Non management role*: includes assistant quantity surveyors, assistant engineers, trainers, designers etc. These positions are generally self-directed.
2. *Supervisory role*: includes engineers, management consultants, university lecturers etc. These positions typically fulfill a supporting role to middle management.
3. *Middle management role*: includes facilities manager, contract manager, senior quantity surveyor etc. These positions are mainly responsible for managing the whole process of a project and leading a project team
4. *Senior Management role*: includes company directors, company partners, project directors, academic directors, professors etc. These positions are often the ones of power where company-wide decisions are made

Among the above four categories the ones who play 'middle management role' and 'senior management role' perform a managerial role where the people and the associated activities are to be managed. In order to perform this role, they should have their influence towards their subordinates. But the extent of their influence will depend on the style of leadership that they use to get the work done. Since the leadership is defined as the ability to influence, those who fall under the categories 3 and 4 above could be considered as the leaders of construction. They cab be further divided as educational leaders and executive leaders based upon the type of organization (either educational or industrial) they are attached to.

Hey/ McBer categorises leadership styles into six distinct styles based on two major classes or styles: they are transactional and transformational (Goleman, 2000). Under transformational leadership, the most prominent behaviour used is inspirational motivation, followed by idealized attributes, intellectual stimulation, idealized behaviours, and individualized consideration. Under transactional leadership, the most prominent behaviour used is contingent reward, followed by management-by-exception active, and management-by-exception passive (Chan and Chan, 2005). In this regard corrective style ('do what I tell you) and authoritative style ('come with me') fall under transactional style whereas affiliative style ('people come first'), democratic style ('what do you think'), pacesetting style ('do as I do, now') and coaching style ('try this') fall under the transformational leadership styles (Goleman, 2000).

In construction academic environment the leadership styles hardly differ from that of other discipline academic. Because there are similarities in the nature of the educational institutes irrespective of under what type of disciplinary one falls. Also such institutes basically have a stable or permanent structure.

Unlike the construction academia the construction industry has its own characteristics. Because the construction industry is mainly project oriented where the project-based organization is disbanded upon the completion of the task. Thus the industry should be considered as a special case. In considering leadership styles, the unique characteristics of the construction industry such as project characteristics, contractual arrangements, project life-cycle and environmental factors can have an impact on leadership styles in construction.

This-project based nature of construction industry with its temporary multi-organizations, will almost certainly have an important influence on the managerial leadership styles of professionals working in the industry (Giritli and Oraz, 2004). Although, in most project environments, there is a strong preference for a democratic participative style, it may not be the most effective for all situations. Cleland (1995) argues that project leadership should be appropriate to the project situation because leadership is a continuous and flexible process. Naum (2001) states that large capital investment projects coupled with high complexity of decision issues can require different styles of leadership, and he admits that 'a participative style of leadership with bureaucratic organization is expected to be more appropriate than a directive style'. In contrast, Nicholas (1990 *cited in* Giritli and Oraz, 2004) suggests that a less participating, more directive style might be more appropriate when there is less time and high pressure to complete the work.

According to findings by Chan and Chan (2005) the transformational and transactional leadership are exhibited in the same individual building professionals, but to different degrees and intensities. Building professionals use transformational leadership more frequently than transactional leadership in their work. Transformational leadership and transactional leadership are complementary to each other. Transformational leadership can augment transactional leadership to produce greater synergistic effects on the employees' work outcomes than either transformational or transactional leadership in isolation. However, transactional leadership cannot augment transformational leadership to the same extent.

Another study by Pheng and Lee (1997) on construction project managers revealed that most of the respondents agreed that the project manager should possess firm and capable leadership qualities. The reasons given were that a project manager must be able to lead as he is regarded as the leader of the project team. Without firm leadership, he would not be able to gain respect from the other consultants. Furthermore, without good leadership qualities, he would not be able to motivate his team to work towards the common goals of the project. Strong leadership is therefore a very important criterion for the project manager. Also they mentioned the 'Team management leadership style' as the ideal style because such managers have great concern for people and production and work to motivate employees to reach the highest levels of accomplishment and are flexible and responsive to change, and understand the need to change.

The extensive use of sub-contracting is another factor that can have an impact on the leadership style of projects. The study by Bresnen *et al*. (1986) showed that task-oriented forms of leader behaviour are more appropriate where subcontract labour forms the bulk of the workplace. Furthermore, construction professionals need different leadership styles in different phases of the project life cycle. The style of leadership changes as the project progresses through its life cycle. During the different phases of the design process, styles may need to allow for more debates, fine-tuning and deliberation (Giritli and Oraz, 2004). It is also said that the environment in which leadership is exercised is also influential in shaping the leadership style of people who occupy managerial positions in construction settings. The leaders should be able to impose more authoritarian styles at times when there is a need to control the workers. In sum, it is difficult to determine the most appropriate leadership style to conform with each particular situation in the development of a project. Naum (2001) concludes that 'Leaders may thus have to switch from one style of leadership to another or combine elements of different styles until the right balance between concerns for tasks and concern for people is reached'. For this reason, individuals involved in the management process of construction should be able to enact a range of leadership behaviours.

3.3 Gender and Leadership

Although mainstream research on leadership generally continues to ignore gender relations, over recent years there has been major expansion of international research on gender relations in leadership, organizations and management (Hearn and Piekkari, 2005). Previous studies have found differences in leadership styles in terms of gender and managerial hierarchy. Discussions on the gendered differentiation of leadership have centered on the different qualities and styles of leadership of men and women; that is, the so-called masculine and feminine styles of leadership (Cubillo and Brown, 2003). Hofstede (2001) suggests that the masculinity / femininity dimension affects the meaning of work in people's lives (Giritli and Oraz, 2004). High masculinity may give rise to a fairly macho type of leadership, whereas high femininity may lead to a more empathetic consideration type of leadership. In masculine cultures, there is a higher emphasis on assertiveness and the acquisition of money and other material things. Feminine cultures stress relationships among people, concern for others, and interest in the quality of work environment (Giritli and Oraz, 2004).

The presence of feminine or masculine characteristics in leadership styles is related to the construct of gender (Larson and Freeman, 1997). Gender, race, class, and other elements of social difference are acknowledged to play an important role in the development of leadership styles. Studies such as those conducted by Martin Court (1995) in New Zealand, Margaret Grogan (1996) in the USA and Marianne Coleman (2001) in England and Wales have uncovered similarities in women's social, economic and educational backgrounds, career progression, family circumstances and leadership styles (Fitzgerald 2003). Fitzgerald also suggested that it is impossible to create conceptualisations of leading and managing without taking into account issues of gender and ethnicity.

As women have become a more prominent presence as managers and executives in organisations, more attention has been devoted to the possible differences between the leadership styles of women and men. Intuitive reasoning suggests that early socialisation patterns develop different qualities in women and men that would likely result in variations in leadership styles (Powell, 1993). The growing number of women in managerial positions created interest in the role of women as leaders (Klenke, 1996). In recent years, both mainstream management literature and organisational policy show evidence of a marked turn to leadership rather than management as the means to enhance organisational performance in contemporary organisations. This is matched by a growing trend in the UK to attribute ever-greater significance to leadership as a way of solving organisational problems not only within the private sector, but also within the public sector more generally, across education (in schools and in universities) as well as in health and local government organisations.(Ford, 2005). The belief that women are better than men at managing different activities simultaneously finds its origins in the role of women in various societies. Women are often carers of the family and of the household in addition to external employment. In a research done by Priola (2004) almost all of the participants interviewed referred to multitasking presenting it as a female quality and ability. Earlier thinking emphasized that women who had achieved leadership positions were imitators of male characteristics, but contemporary theories recognize feminine leadership styles (Stanford et al., 1995).

Research findings of Trinidad and Normore (2005) show that women adopt democratic and participative leadership styles in the corporate world and in education. Transformational leadership is the preferred leadership style used by women. The characteristics of transformational leadership relate to female values developed through socialization processes that include building relationships, communication, consensus building, power as influence, and working together for a common purpose. This is also supported by Shane et al (1995) saying that femininity was found to be positively correlated with transformational leadership. Further several studies focusing on transformational leadership indicated that women are perceived, and perceive themselves, as using transformational leadership styles more than men (Bass et al., 1996; Druskat, 1994; Rosener, 1990 *cited in* Kark, 2004). More specifically, many authors refer to transformational leadership as a feminine leadership style. However, research by Hackman et al, (1992) showed that transformational leadership is a stereotypically gender-balanced style. Also the transformational, empowering and collaborative style of leadership associated with women is compared with the more directive and authoritarian style traditionally associated with male leaders. The debate has progressed further to engage the concept of the androgynous leader which, rather than attributing the different qualities exclusively to any one gender, suggests that every good leader has available to them both sets of characteristics from which they are able to select the most appropriate for the situation (Singleton, 1993). Some other researches also indicate that the most successful leaders in any environment are those who can employ a range of styles depending on situational attributes.

From the forgoing discussions it is clearly seen that there are various styles of leadership available and a range of styles is needed in order to manage the construction sectors effectively. It is also discussed the concept of gender and leadership and certain styles are identified as the more suitable leadership styles for women. Hence, this chapter summarises the leadership styles in general, in construction and in associated with women. By taking the issues discussed here into account, the following chapter combines all these facts together and gives a review of the status of women in educational and executive leadership in construction.

4 CURRENT STATUS OF WOMEN LEADERS IN CONSTRUCTION

This chapter mainly focuses on the status of the women leaders in construction and thus could be discussed under three headings, namely (i) the under-representation of women in senior management levels, (ii) the barriers faced by women to reach educational and executive leadership positions, and (iii) a discussion on justifying the suitability of women leaders within construction sectors.

4.1 The under representation of women in senior management levels

As per the CITB (2003) it was revealed that women constitute only 9% of the construction workforce, making it one of the most male dominated of the major industrial sectors. When this figure is broken further we could see only 10% of women are employed in a professional capacity in design and management area. Similarly the number of women entering into construction related education still only constitutes 8%. Further, despite the introduction of Equal Opportunities policies by universities most academic staff continue to be male. Women hold only 35% of full time academic posts, and only 10% of professorships. The figures are even more revealing in the case of construction, where less than 0.5% of professors are women.

The teaching profession both in this country and internationally is, with few exceptions, predominated by women as it has traditionally been seen as a ‘suitable’ job for women. The fact that the teaching profession is relatively lower paid and does not enjoy the same high status as other male-dominated professions may partly account for the fact that there are more women than men in this profession. However, a look at the statistics reveals that despite the large numbers of women in the profession, they are greatly under-represented in positions of management (Cubillo and Brown, 2003). The sector of higher education is characterised by specific aspects which make it distinguishable from the business world. However, in higher education, as well as in business, men and masculine values are dominant (Whitehead, 2001).

Executive leadership is repeatedly constituted as a world dominated by corporate masculinity, a man's world, which accommodates women as 'other' or 'silence' (Marshall, 1995; Sinclair, 1994; Maier, 1999; Halford and Leonard, 2001 *cited in* Olsson and Walker 2003). The statistical analyses of western countries reveal that while the numbers of women entering management positions continues to increase, women remain under-represented in senior executive positions (Davidson and Bruke, 2000)

Like any new trend in traditional settings, it takes years to develop leadership styles until these styles are understood and accepted. Meanwhile, women face several barriers that prevent them from been considered leaders or leadership candidates (Still, 1994).Therefore it is appropriate to look into the barriers faced by women entering into educational and executive leadership positions in construction.

4.2 The barriers

Firstly in the context of academia, a number of writers have attempted to identify and categorise some of the barriers to the progress of women's careers in educational leadership (Brown and Ralph, 1996; Coleman, 2001; Hall, 1996 *cited in* Cubillo and Brown, 2003). One of the theories put forward the socialisation and stereotyping as the barriers for women seeking a senior position in education. Schmuck (1986 *cited in* Cubillo and Brown, 2003) warns of the dangers of subscribing to this "deficit" model where women are seen to need to be trained or educated up to the level of men, rather than be valued for what they might bring to the field of management. Some internal barriers such as one's lack of confidence, lack of competitiveness and fear of failure have also been identified for women entry into leadership position. Cubillo (1999) found in her study that women's so-called lack of confidence was more to do with unfamiliarity with the territory than a lack of faith in their abilities. The fear of failure, too, tended to be much reduced once women were aware of the "rules of the game". Women leaders in education need to find the leadership styles that, without denying its feminine origins, result in effectiveness. The redefinition of skills and characteristics of an effective school leader, following the current trends of organizational leadership, will help erase gender stereotypes and focus on desirable characteristics that candidates (men or women) bring to the position (Logan, 1998). Whatever the idealized view of educational leaders and despite calls for leaders who shape the fundamental culture, structure, and goals of educational organizations, stereotypes about leadership need to be challenged and addressed before educational training programs designed to promote women to the top will be successful.

Secondly in the context of industry, the components of invisible barriers that block women from the executive position are identified as failure to have their contribution recognized, not being taken seriously, isolated in their organization and seeing others promoted ahead of them (Mattis, 2000). Women's slow movement into senior management positions can be explained in three different ways (Gutek, 1993). They are structural barriers or discrimination, gender roles and stereotypes and individual differences or deficiencies. The structural barriers approach emphasizes that minority group members (basically women) encounter difficulties in adjusting to and fitting in with the majority culture (masculine culture). Gender role stereotypes have a major impact on selection and promotion procedures as well as on evaluation of managerial performance. The typical good manager is (still) described in traditionally masculine terms (Schein and Mueller, 1992). The individual differences as the main reason for the paucity of the advancement of women into management, looks into the question of whether the stereotypes illustrated above are for real. Further, the male dominated culture and environment displayed by the construction industry put the women into difficulties to fit in with male colleagues work and social activities. The construction industry has a tradition of working long hours, including routinely working through weekends. There is a strong culture within the industry that working long hours demonstrates employment commitment (Sutherland and Davidson, 1993) and a lack of compliance with such cultural norms can adversely impact promotion prospects and even future job security. Site based employees, both professional and manual workers, are usually subject to changing work locations. This can involve traveling substantial distances or periods away from home, a situation which can present serious difficulties in terms of transport and child-care (Greckol, 1987 *cited in* Fielden et al, 2000). The construction industry fails to appreciate some of the issues associated with combining work and family commitment (Gale, 1994), and organizations tend to treat family and work as completely separate. Evetts (1993 *cited in* Fielden et al, 2000) found that many women in construction did not feel that management was an appropriate career for them because of the conflict between family and work commitments.

4.3 Discussion

The issues related to the under-representation of women in educational and executive leadership in construction and the reasons for that are presented in this chapter. Also, the leadership styles that are used in construction and the relationship between gender and leadership are also discussed in the previous chapter. Now the discussion mainly focuses on the women into leadership in construction by combining all these issues together so that the appropriateness of women in leadership position could be identified within the construction sector.

It is said although democratic participative style is not be the most effective for all situations, in most project environments, there is a strong preference for that style. It is also highlighted in the finding from the study by Trinidad and Normore that women adopt democratic and participative leadership styles in the corporate world and in education. From this it could be said that the women have the capability to manage the construction environment both the industry as well as the academia.

This democratic participative style can fall under the major category of 'transformational' leadership style. According to findings by Chan and Chan the building professionals use transformational leadership more frequently than transactional leadership in their work. Transformational leadership can augment transactional leadership to produce greater synergistic effects on the employees' work outcomes than either transformational or transactional leadership in isolation. However, transactional leadership cannot augment transformational leadership to the same extent. It is also revealed that the transformational leadership is the preferred leadership style used by women. The characteristics of transformational leadership relate to female values developed through socialization processes that include building relationships, communication, consensus building, power as influence, and working together for a common purpose. More specifically, many authors refer to transformational leadership as a feminine leadership style. However the barriers pertaining to construction, industry in particular, may be a big challenge for women to use the transformational leadership style towards their workers.

5 CONCLUSION

This research paper reviewed various literatures on 'women in construction', 'educational and executive leadership' and 'gender and leadership' in order to examine the leadership styles in construction associated with women.

From the literature survey it is revealed that women adopt democratic and participative leadership styles in the corporate world and in education. From this it could be said that the women have the capability to manage the construction environment both the industry as well as the academia. This democratic participative style can fall under the major category of 'transformational' leadership style which is the preferred leadership style used by women. The characteristics of transformational leadership relate to female values developed through socialization processes that include building relationships, communication, consensus building, power as influence, and working together for a common purpose. More specifically, many authors refer to transformational leadership as a feminine leadership style. However the barriers pertaining to construction, industry in particular, may be a big challenge for women to use the transformational leadership style towards their workers. Such barriers are one of the reasons behind the under-representation of women in senior management positions. In this regard this paper also identified some barriers faced by women in capturing the top most position in both construction industry and academic organizations. In the academic context socialisation and stereotyping could be said as the barriers for women seeking a senior position in education. Also some internal barriers such as one's lack of confidence, lack of competitiveness and fear of failure have been identified for women entry into educational leadership position. On the other hand in the industry context, the components of invisible barriers that block women from the executive position are identified as failure to have their contribution recognized, not being taken seriously, isolated in their organization and seeing others promoted ahead of them. The structural barriers or discrimination, gender roles and stereotypes and individual differences or deficiencies are also said to be the causes for women's slow movement into senior management positions.

This study will be a supportive resource to any reader interested in identifying the women's leadership qualities to manage the construction sector and in finding out the ways to remove the barriers of women's entry into managerial positions. Further it provides a good guidance to continue the research work, in particular, in the area of gender and leadership which could be considered as an under-theorised area.

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LEARNING IN ORGANISATIONS: TOWARDS AN INTEGRATIVE FRAMEWORK

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ABSTRACT: Building up from the previous work done as part of the doctoral research, this paper presents several important aspects that need to be taken into account in the process of furthering the understanding of learning in organisational contexts. Following a presentation of holistic picture of the current streams of learning in organisations, the paper illustrates the significance of considering the paradigms shifts that are taking place in the areas of knowledge management and organisational change, within the context of this research.
Keywords - Change, Knowledge Management, Knowledge, Learning, Organisational Learning

1. INTRODUCTION

The concepts related to learning within organisational contexts have been presented in the management literature for decades. It became widely recognised in the 1990s in management contexts, especially within practitioner led scenarios. Easterby-Smith and Araujo (1999) quoting Crossan and Guatto's (1996) survey that indicates that as many academic contributions in this area were published in 1993 than in the whole of 1980s. Knowledge management has also developed into a popular phrase within the field of management. As such many researchers have used the current models of organisational learning and knowledge management as forms of representations of learning within organisations, while practitioners tend to use them as tools to promote and make effective use of learning in companies. However, a shift in thinking of how we visualise organisations may result in challenging some of the established thinking in organisational learning and knowledge management. This paper presents the impacts of such recent conceptual challenges presented in literature that informs the ongoing research into learning in organisations. This paper highlights some of the conceptual positions that have been considered as part of the ongoing doctoral study aimed at developing a framework of understanding with regard to learning in construction organisational contexts.

2. LEARNING IN ORGANISATIONS: POPULARITY AND PROBLEMS

Within most management literature, organisational learning is considered as one of the core underlying concepts. In this regard Wang and Ahmed (2003) through an extensive literature review identified organisational learning as having several focus areas namely *individual learning, process or system, culture or metaphor, knowledge management,* and *continuous improvement.* A similar position has been identified in relation to knowledge management. "…. a search of over 100 websites of knowledge management (Quintas et al, 1997) revealed the following heterogeneous range of interests, perspectives and issues: economics, intellectual capital, engineering approaches (flexible manufacturing systems), aspects of computing and knowledge media, organisation studies (informed by anthropology, sociology etc.), epistemology (including learning, situated cognition and cognitive psychology), other aspects of classification and definition informed by artificial intelligence, human resource issues etc." (McAdam and McCreedy, 1999, p91).

In tracking the developments in this field Easterby-Smith and Araujo (1999) identified two developments that have been significant in the growth of the field. First, it has attracted the attention of scholars from disparate disciplines. Business strategists have realised that the ability of one organisation to learn faster and better than its competitors may indeed carry the key to long-term success (Collis, 1994; Grant, 1996). Economists have taken a similar path, arguing that firms learn by doing as well as the formal training processes (Stiglitz, 1997). Sociologists too have become aware of the role that learning in organisational learning can play in the internal dynamics and politics of organisational life (Coopey, 1995). According to Easterby-Smith and Araujo (1999), the second major development in the field of organisational learning is the fact that many companies and consultants identifying and promoting its commercial significance. In this regard the works of Senge (1990) in the USA, Pedler et al (1989) in the UK and Field and Ford (1995) in Australia are significant due to the fact that they focused on making practical interventions in organisations to help them become learning organisations. Much of the efforts of these theorists have been identifying templates or ideal forms, which real organisations could emulate.

It is not difficult to find literature that suggests organisational learning as essential for the success and survival of organisations. De Geus (1997) stated that the only source of competitive advantage is an organisation's ability to learn. Baldwin et.al (1997) noted that what seems to distinguish surviving and adopting organisations from the rest is their ability to learn. Also Nonaka (1991) argued that competitive advantage, innovation and effectiveness are the primary products of nurturing a culture of learning within a company. Barrow (1993) and Hill (1996) highlight that organisational learning and continuous improvement principles are inextricably linked such that organisational learning should be the most compelling reason for undertaking any continuous improvement schemes. The Institute for Employment studies (IES) also identified fostering organisational learning as one of the challenges facing management in major UK employing organisations (Harish and Carter, 2002).

However, the study of organisation learning has also been subjected to criticism by observant researchers. Prange (1999) offers the following criticisms of the current state of knowledge in relation to organisational learning.

1. Organisational learning lacks theoretical integration, and research is being done on a non-cumulative way;

2. Organisational learning does not provide 'useful' knowledge for practitioners;

3. Organisational learning is mostly used in metaphorical and / or analogous sense.

Garrick and Rhodes (1998) in their discussion on the use of deconstruction as an approach to organisational learning research observes the focus of organisational learning in research and practice as "…..the ways organisational learning tends to be understood in contemporary contexts which are characterised by uncertainty, unpredictability and insatiable market appetite to develop 'knowledge workers' who will give an organisation a competitive edge" (Garrick and Rhodes, 1998, p1).They express scepticism about existing theoretical frameworks for promoting organisational learning, especially in terms the value of organisational learning in how it relates to the power structures that are being challenged and changed (Garrick and Rhodes, 1998).

3. A HOLISTIC VIEW OF ORGANISATIONAL LEARNING AS A RESEARCH AREA

In an attempt to trace back the development of the term and the meaning of the "learning", Dahlgaard (2004) points out that ancient Chinese ideograms may be one of the oldest conceptualisations of the term. According to ancient Chinese thinking learning contains the following two elements, namely

1. To study i.e. acquisition and accumulation of knowledge (cognitive and intellectual learning)
2. To practice repeatedly i.e. continuous / endless (physical) practice.

In tracking back the developments, for organisational learning, Argyris and Schon (1978); and for learning organisation Senge (1990), Pedler (1989) seemed to have lead the way in the massive growth of academic publications in the 1990s. However, the interest in the subject certainly did exist long before. Easterby-Smith and Lyles (2003), recognises the contributions made by Dewey (1916), Polanyi (1959), Penrose (1959) and Hayek (1945) as some of the significant early philosophical works. Dewey (1916) viewed organisational form the "individual learning" perspective, and hence expressed reservations regarding the ability to transfer what is learnt through social interaction, from one person to another. The distinction between tacit and explicit knowledge by Polanyi, paved the way for increased attention on the concept of organisational knowledge. It later on lead to the divergence of research themes namely explicit and tacit knowledge management. During the review of literature on organisational learning one of the main observations was the frequent use of the terms *organisational learning* and *learning organisation*. Whilst some authors use the two terms interchangeably, Burgoyne (1999) admits that confusion still exist about the clarity of the concept.

From the above explanation, four key terms, namely organisational learning, learning organisation, organisational knowledge and knowledge management, needs more elaboration. They are closely knitted but yet have established as distinct areas for both research and practice. Dahlgaard (2004) states that a deep understanding of the terminology and history of the theory and the philosophy is necessary to understand and advance practices for learning organisations. The following section will explain the terms with regard to their conceptual evolution. In this regard the authors specifically acknowledge the work of Easterby-Smith and Lyles (2003) and Dahlgaard (2004).

3.1 Organisational Learning and Learning Organisation

Cyert and March (1963) was instrumental in pioneering the notion that organisations are capable of learning in ways which are independent of the individuals within it. However, it must be noted that the works of March and Simon (1963), Cangelosi and Dill (1965) also echoed the same ideas. The notion of single and double loop learning of Argyris and Schon (1978) was responsible for the next significant development. Easterby-Smith and Lyles (2003) points out that whilst March and Simon (1958) argued based on neo-rationalist stance, Argyris and Schon (1978) challenged it with the view that human behaviour within organisations frequently does not follow lines of economic rationality. The year 1991 saw the emergence of another wave of significant contributions to the field of organisational learning through the works of Huber (1991), March (1991), and Simon (1991). By this time the theorist have made a significant change in the way organisational learning was viewed at. Although they still belonged to the neo-rationalist domain, emphasising that it is desirable to maximise the efficient use of knowledge in organisations, they also have begun to recognise the existence of substantial barriers and challenges, such as human / people issues, in pursing their objective.

The well publicised book “The fifth discipline” by Peter Senge (Senge, 1990) brought the term learning organisation into the limelight. However, Easterby-Smith and Lyles (2003) argues that work done in Europe in the late 1980s, including the work of UK authors such as Garratt (1988) and Pedler et al. (1989) made initial contributions in this regard. Senge (1990) provided the tool that the companies and consultants were interested in at that time, by presenting a model, merging the technical and social aspects associated with learning. Although made in US, the notion became more popular in Europe and lead to the later developments relating to action learning (Revans, 1980).

In this regard the observations made by Easterby-Smith and Araujo (1999) are noteworthy. They state that the two literatures (i.e. organisational learning and learning organisation) have developed in two divergent tracks. The literature on organisational learning concentrated on the detached observation and analysis of the process involved in individual and collective learning inside organisations, where as learning organisation literature has an action orientation, and is geared towards using specific diagnostic tools which can help to identify, promote and evaluate the quality of learning process inside organisations.

3.2 Organisational Knowledge and Knowledge Management

Organisational knowledge existed as a concept within the economics community for a long time, which is evident through the works of Hayek and Penrose (Easterby-Smith and Lyles, 2003). Also noted is the foundation contribution made by Nelson and Winter (1982), highlighting the importance of “tacit knowing” both in terms of individual and organisational levels. Nonaka and Takeuchi (1995) brought forward the most influential contribution work in this regard through the notion of knowledge creation through transformations of tacit and explicit knowledge.

Vera and Crossan (2003) states that knowledge management as defined by many suggests as “managed learning” and is assumed to have a positive impact on performance [‘explicit control and management of knowledge within an organisation aimed at achieving the company’s objectives (Van der Spek and Spijkervet, 1997, p 43), “the formal management of knowledge facilitating creation, access, and reuse of knowledge, typically using advanced technology” (O’Leary, 1998, p 43), “the process of creating, capturing, and using knowledge to enhance organisational performance” (Bassi, 1999, p 424)]. Although the term “knowledge management” is relatively new when compared with the previous topics, especially organisational learning and organisational knowledge, its has enjoyed a rapid rise to popularity and interest. The emergence of IT as a key strategic enabler for organisational excellence also heavily contributed to this. As such many early knowledge management research attempted to provide technical solutions. However, of late the importance social and other non-technical aspects have been recognised and attempts are being made for a more accommodating approach.

Easterby-Smith and Lyles (2003) observes the distinction between organisational knowledge and knowledge management. Organisational knowledge adopts a philosophical slant in trying to understand and conceptualise the nature of knowledge that is contained within organisations. Hence many of the discussions relate around distinctions between individual and organisational knowledge, or between tacit and explicit knowledge. Knowledge management is generally associated with using technological means as to disseminate and leverage knowledge to in order to enhance organisational performance. However, of late with the realisation of the limitations of pure technological solutions to tackle tacit knowledge in organisations, knowledge management practices are increasingly paying attention to non-technological means too.

Dahlgaard (2004) observes that Nonaka & Takeuchi (1995)'s knowledge creation model attempts to bring together individual, social, cognition and practice, of learning. They consider knowledge as dynamic and evolving, thereby giving more emphasis on interaction and situational aspects. Some theorists have recognised the concepts of learning and knowledge as multi-faceted phenomena (Blackler, 1995; Nonaka and Takeuchi, 1995), and as such they require a comprehensive approach rather than a narrow and one sided approach.

4. CONCEPTUALISING FOR AN INTERATIVE FRAMEWORK

In conceptualising the notions expressed so far, the following illustration (Table 1) by Vera and Crosaan (2003) indicating the relationship between knowledge, knowing and learning is noteworthy. They state that knowledge can be obtained through mind (learning by reflection, anticipatory learning) and through the body (learning by doing, experimental learning). Knowledge is accumulated in our minds (know what, declarative knowledge) and also in our bodies (know how, procedural knowledge). Knowing is practice and it is something that we do. Knowing is not knowledge used in action, but knowledge that is part of action (Cook and Brown, 1999). Learning is change in knowledge and change in knowing, which also is termed as changes in cognition and changes in behaviour.

Table 1: Knowldge - knowing - learning matrix (Source: Vera and Crossan (2003))

		KNOWLEDGE	
		Stable	**Change**
KNOWING	**Stable**	No Learning	Learning as the acquisition of new facts and /or skills
	Change	Learning as the practice of new facts and / or new skills	Learning as the acquisition and practice of new facts / or skills

Vera and Crossan (2003) has also made a significant contribution in terms of explaining the boundaries of each of the four key terms discussed above. They point out both organisational learning and organisational knowledge as two overlapping fields of research, but they also recognise that there are topics that are dealt exclusively within their domains. In the following diagram (Fig 1), which was adopted from Vera and Crossan (2003), the dotted indicate the common ground of research covered. The topics outside belong to the respective research areas as shown in the boxes.

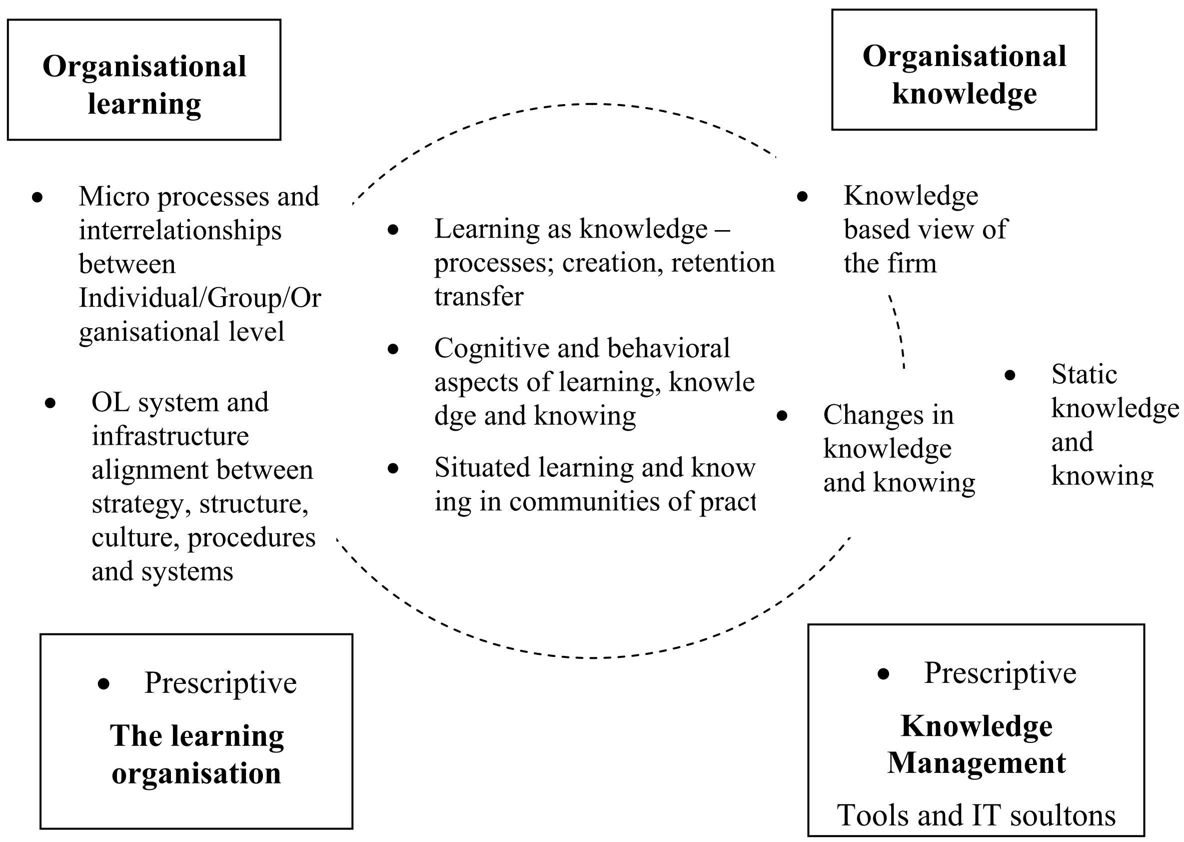

Fig 1: A Conceptual positioing of major focus streams related to learning in oragnisations (adopted and modiled from Vera and Crossan, 2003)

5. INDIVIDUAL VERSUS ORGANISATIONAL LEARNING

Surveying across the research efforts in the area of learning, Dahlgaard (2004) notes an attempt to separate individual, group/team, and organisational (firm) as different levels of learning. Nevertheless, it is common to observe that most leading researchers in organisational learning and learning organisation (Senge, 1990; Garvin, 1993; Hodgetts et al., 1994, Stata, 1989), seem to indicate that individuals play a pivotal role in fostering learning at an organisational level. If that is the position, how can we distinguish them as representative of organisational learning? The following is an attempt to seek clarification in this regard.

5.1 Individual Learning Theory within Organisational Learning

Elkjaer (2003) states that learning theory in much of the literature on organisational learning and the learning organisation has its roots in the individual oriented psychology. The theories which consider the "individual" as the key to learning, also posses the strong emphasis on the change in cognition as a vital part of organisational learning. The fact that organisations comprise of individuals seems to provide strong support in this respect. In this perspective, enhancing information processing and decision making in organisations is seen as something that is done by the individuals' learning and the processes that can be enhanced by individuals learning. Individuals' learning outcomes can then, by way of individuals acting on behalf of an organisation, be crystallized in organisational routines and values and hence become organisational learning. The notion that individuals possesses mental models that represent an abstracted form of their actions is a key element in this school of thought. Therefore the popular theories that emanates from this position enhancement of these mental models within individuals for better processing of information and to better decision-making in organisations. This focus brings leads to individual learning being strongly associated with the cognitive learning paradigm.

Cognitive learning theory privileges abstract and general verbal and conceptualized knowledge over and above the thinking that derives from practice (Lave, 1998; Nicolini and Menzar, 1995). The work of Senge (1990) stands testimony to this respect. He advocates the use of systems thinking to develop learning organisations. This means that Senge (1990) sees the organisation as an abstract entity or a *system,* which then the members of the organisation must learn, so that they can relate to it and understand it. As such the process of abstraction is considered as a necessary condition for learning in individual / cognitive learning paradigm.

Another striking feature of organisational learning concepts that are derived from individual learning theory, is the fact that learning being regarded as a specific activity, which needs to be initiated, motivated and stimulated. For example learning takes place when there is a problem to be solved (Argyris and Schon, 1978).

The immense focus on the relationships to / roots of individual learning, as the basis for formulating the concepts of the popular organisational learning and learning organisation has come under much criticism. (Cook and Yanow, 1993; Gherardi et al., 1998). Most of the organisational learning literature (Senge, 1990; Argyris and Schon, 1978), consider individuals as agents of the organisations acting on behalf of the organisation, which creates a separation between the organisation and the individual.

5.2 Social Learning Theory within Organisational Learning

Dahlgaard (2004) highlights the need to pay attention to a counterpart group of theorists who pay attention to "collective learning" as promoting organisational learning. Social learning theories can be considered as an alternative view to of conceptualization of organisational learning. It has emerged as a result of the criticism of the individual learning bias of organisational learning theory.

Lave (1998) summarises the following as issues of concern in the above respect.

- If learning is indicated by the change in cognitive structures (or mental models), how is it possible to learn on the basis of actions that may or may not be verbally representative as specific mental models, but instead may be emerging through taking action?
- If learning is a specific activity that is delimited to certain initiated events such as problem solving, how does one account for what is not learning?
- If it is possible to separate the individual from the organisation, how does one account for the fact that people can be knowledgeable in one situation, and not in another comparable situation?

The social context, relational, inter-actional, situational and historical perspectives (Lave and Wenger, 1991; Brown and Duguid, 1996, Strauss, 1993) are key components that the theorist have taken into account in this regard. Dahlgaard (2004) highlight concepts such as "communities of practice" (Brown and Duguid, 1991, 1996), "learning in practice", "participation" as some of the representative concepts. They promote the adaptation of "social learning" as a more suitable way of fostering learning as opposed to focusing purely on individual cognitive theory.

Cook and Brown (1998) presents the alternative view of the individual – organisation relationship by commenting that individuals at one and the same time should be regarded as products of their social and cultural history, and producing situations that mirror them. They state that individuals interact with selves, others, artefacts, and contexts, just as that products and producers of situations. As such this situated view of learning moves learning away from the individual mind to the social sphere of interaction, activity and practice. As such within the view of organisational learning from a social learning perspective, learning is not regarded as a specific, delimited and intentional activity. Learning is considered as part of natural human activity. This position is similar to the stance shown by Nicolini and Meznar (1995) and (Gherardi et al., 1998). Nicolini and Meznar (1995) state that learning cannot be avoided; it is not a choice for or against learning, but it is an integral part of normal day to day organisational life and work. Gherardi et al., (1998) takes the view that learning is a process that takes place among and through other people. In other words, learning is not restricted to taking place inside individuals minds, but as processes of participation and interaction.

Elkjaer (2003) points out that whilst individual learning theories aims the content of learning to help the learner get to know the organisational practices, the social learning theory aims the content of learning to help the learner to become a practitioner. Expressed in a different way, social learning theory is a way of being and becoming part of the social worlds that comprise an organisation, and in which the central issue of learning is to become a practitioner (Brown and Duguid, 1991; Richter, 1998).

6. DEVELOPMENTS IN KNOWLEDGE MANAGEMENT

The topic of knowledge management has also been subjected to a similar critique and as such different stages of its evolution can be observed. Snowden (2002) considers three stages of evolution in our understanding in relation to the topic of knowledge management. The first age, prior to 1995, sees knowledge being managed, where the focus is on the appropriate structuring and the flow of information to decision makers and the computerisation of major business applications leading to a technology enabled revolution dominated by the perceived efficiencies of process reengineering. However towards the mid-late 90s disillusionment crept in. Snowden considers the failure to recognise the value of knowledge gained through experience, through traditional forms of knowledge transfer such as apprentice schemes and the collective nature of knowledge as some of the reasons for it.

The work of Nonaka and Takeuchi (1995), who became popular with their SECI model was considered as the dominant view of knowledge management during the second stage (Snowden, 2002). The model focused on the movement of knowledge between tacit and explicit states thorough the four processes of socialisation, externalisation, combination and internalisation. In this regard he also notes "this concept is not totally new, and in fact its roots can be tracked to Polanyi (1974). However, were Polanyi saw tacit and explicit as different but inseparable aspects of knowledge, the *de facto* use of the SECI model was dualistic, rather than dialectical" (Snowden, 2002, p 101) .

Snowden (2002) states that Nonaka and Takeuchi were only seeking to contrast a claimed Japanese tradition of "Oneness'' with a rational, analytical and Cartesian western tradition. Their work derived in the main from the study of innovation in manufacturing processes where tacit knowledge is rendered explicit *to the degree necessary to enable that process to take place*; it did not follow that all of the knowledge in the designers' heads and conversations had, should or could have been made explicit. In partial contrast, early knowledge programmes attempted to disembody all knowledge from its possessors to make it an organisational asset. Nonaka attempted to restate his more holistic and dialectical view of tacit and explicit knowledge when he republished the model utilising the Japanese word *Ba*, which is a "shared space for emerging relationships'' (Nonaka and Konno, 1998), but by this time the simple two by two of the SECI model was too well established in business plans, software brochures and the structured methods of consultants to be restored to its original intent.

Some of the basic concepts underpinning knowledge management are now being challenged (Stacy, 2001; Snowden, 2002). Knowledge is not a "thing", or a system, but an ephemeral, active process of relating. If one takes this view then no one, let alone a corporation, can own knowledge. Knowledge itself cannot be stored, nor can intellectual capital be measured, and certainly neither of them can be managed (Stacy, 2001).

Snowden (2002) states that in the third generation the focus extends beyond managing knowledge as a thing to also managing knowledge as a flow. To do this it is needed to focus more on context and narrative, than on content. The question of the manageability of knowledge is not just an academic one. Organisations have increasingly discovered that the tacit and explicit distinction tends to focus on the container, rather than the thing contained (Snowden, 2000). Three heuristics illustrate the change in thinking required to manage knowledge:

(1) Knowledge can only be volunteered; it cannot be conscripted.

For the very simple reason that I can never truly know if someone is using his or her knowledge. I can know they have complied with a process or a quality standard. But, we have trained managers to manage conscripts not volunteers.

(2) We can always know more than we can tell, and we will always tell more than we can write down.

The nature of knowledge is such that we always know, or are capable of knowing more than we have the physical time or the conceptual ability to say. I can speak in five minutes what it will otherwise take me two weeks to get round to spending a couple of hours writing it down. The process of writing something down is reflective knowledge; it involves both adding and taking away from the actual experience or original thought. Reflective knowledge has high value, but is time consuming and involves loss of control over its subsequent use.

(3) We only know what we know when we need to know it.

Human knowledge is deeply contextual, it is triggered by circumstance. In understanding what people know we have to recreate the context of their knowing if we are to ask a meaningful question or enable knowledge use. To ask someone what he or she knows is to ask a meaningless question in a meaningless context, but such approaches are at the heart of mainstream consultancy method.

(Snowden, 2002, p 102)

The three heuristics partially support Stacy's view of knowledge as an ''active process of relating'' (Stacy, 2001). However Snowden (2002) notes that, it does not follow that we have to abandon second generation practice, but we must recognise its limitations. We can encompass both Stacy and Nonaka if we embrace paradox. He points out that philosophers have long seen paradox as a means of creating new knowledge and understanding. Physicists breaking out of the Newtonian era had to accept that electrons are paradoxically both waves and particles: if you look for waves you see waves, if you look for particles you see particles.

Properly understood knowledge is paradoxically both a *thing* and a *flow*; in the second age we looked for things and in consequence found things, in the third age we look for both in different ways and embrace the consequent paradox.

Snowden (2002) also highlights the importance of context and content within this discussion. With regard to context, the dimension of abstraction and the dimension of culture are of significance here. He also notes that the mechanisms of learning are very different to those for teaching. "In the case of teaching there is little ambiguity between teacher and taught, in learning such ambiguity is often a precondition of innovation" (Snowden, 2002, p103).

7. EMERGING VIEWS ON ORGANISATIONAL CHANGE

The debates and discussions about learning is also closely associated with the topic of change management, especially within organisational contexts. "If you pay more attention to how people learn, you will be capable of more effective change management. Learning and technology change management reinforce one another. "……… Learning is the keystone for dealing with the higher number of failed change efforts, the rapid rate of change in the information technology, and the need for new organisational constructs". (Levine, 1999, p1). Learning is also seen from two other perspectives, namely "cognitive" and "behavioural". Learning as a change of the content of the "known" forms the basis for cognitive perspective whilst learning as a process of change, transformation and development in the "outcomes", is the basis for behavioural perspective. (Fiol and Lyles, 1985; Weick, 1979; Huczynski and Buchanan, 1985, Dewey, 1925). However, Dahlgaard (2004) recognises need to consider the different perspectives as interacting and interrelated in the dynamic process of learning.

However, Tsoukas and Chia (2002) notes that the traditional approaches to organisational change have been dominated by the assumptions prevailing stability, routine, and order. As a result, organisational change has been reified and treated as exceptional rather than natural. Change, they argue, is the reweaving of actors' webs of beliefs and habits of action to accommodate new experiences obtained through interactions. Insofar as this is an ongoing process, that is to the extent the actors try to make sense of and act coherently in the world, change is inherent in human action, and organisations are sites of continuously involving human action. In this view organisation is a secondary accomplishment, in a double sense. Firstly, organisation is the attempt to order the intrinsic flux of human action, to channel it towards certain ends by generalising and institutionalising particular cognitive representations. Secondly, organisation is a pattern that is constituted, shaped and emerging from change. Organisation aims at stemming change, but, in the process of doing so, it is generated by it. (Tsoukas and Chia, 2002, p 567). From the perspective of *metaphysics of change*, it is change which is natural and primary and 'organization' is seen as secondary and an artificially-imposed attempt to arrest and stabilize what is essentially a ceaselessly fluxing reality indifferent to our causes. (Chia, 2001)

8. CONCLUSIONS AND WAY FORWARD

Having recognised its diversity and application, this paper presented a conceptual framework applicable to gain a broader view of the term "learning in organisations". The paper then paid attention to several observations made by recent developments with regard to the understanding of organisational dynamics, which the authors think has a profound impact towards conceptualising the nature of learning that takes place within organisational contexts. The paper also noted the role of individual learning theories within the overall discussion.

With regard to specific outcomes, the authors agree that there is a need to move beyond the de facto stance of tacit – explicit debate in knowledge management. It also recognises the necessity for broadening the understanding based on the paradoxical nature of knowledge as a "thing" and a "flow". Focusing on the sciences of complex adaptive systems may shed light in this regard. We also see the value of further exploring the challenging view presented by Snowden (2002) where he argued that "the dogma of scientific management, hypothesis-based consulting and the generalisation of best practices from multi client and multi project studies are inhibiting factors in progressing to the new levels of conceptual understandings required in the modern world.

The paper also suggests the consideration of new developments in the area of organisational change, as a key factor in the overall consideration of learning in organisations. In this regard, the view that change by default is part of organisational activity and, organisations themselves are in fact the resultants of such change, will assist in renewing our understanding on the topic being researched.

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RETHINKING LEADERSHIP IN CONSTRUCTION PARTNERING PROJECTS: RESEARCH METHODOLOGICAL PERSPECTIVE

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ABSTRACT: In recent years there has been a growing interest in the use of partnering in construction. Central to any successful partnering arrangement is the change in cultural and behavioural characteristics towards mutual trust and understanding. According to Schein, cultural and behavioural characteristics can be shaped and reflected by proper leadership. This research probes leadership as the response to address complex relationships of behaviour and culture in large scale partnering projects. This involves understanding, interpreting, explaining and mapping complex human behaviour. Therefore it is very important to comprehend and implement a suitable research methodology to carefully extract appropriate information. This paper justifies the social constructionism stance and case study approach for the leadership study as the response to address complex relationships challenges of behaviour and culture in construction partnering projects. For this purpose, the nested approach is used, highlighting the main facets of the arguments to justify the selection of appropriate research philosophy and research approach.

Keywords – Partnering, Leadership, Research Methodology

1 INTRODUCTION

Management research deals fundamentally with the production and legitimation of the various forms of knowledge associated with the practices of management. The approaches to management research and knowledge creation involve a varied combination of the key processes of observation, reflection, theory conjecturing and testing of theories and model developed to capture the essence of management realities. Therefore it is unwise to conduct research without an awareness of the philosophical issues that lie in the background. Research should be organised systematically to make the best use of the opportunities and available resources. In this regard, this paper attempts to outline available research philosophies and approaches, while logically justifying the use of appropriate research methodology to 'identify appropriate leadership styles and practices to address the cultural and behavioural challenges associated with partnering projects in construction'. For this purpose, the hierarchical model of research methodology by Kagioglou et al. (1998) is used, highlighting the main facets of the arguments to justify the selection of appropriate philosophical stance, research approach and research techniques.

2 BACKGROUND

The UK construction industry is one of the strongest in the world, with output ranked in the global top ten construction industries (DTI, 2004). It is considered as one of the pillars of the domestic economy, with its capability to deliver the most difficult and innovative projects, matches that of any other construction industry in the world (Egan, 1998). Nonetheless there is a deep concern that the industry as a whole is underachieving. Problems such as low and unreliable demand and profitability, lack of research and development, inadequate investment in training, its current approach to the usage of tender price evaluations, an adversarial culture and fragmented industry structure, are widely recognised. These problems must be addressed if the industry is to modernise and to improve performance (Latham, 1994; Egan, 1998; Santos and Powell 2001; NAO, 2001; Fairclough, 2002). Successive independent reviews of construction have emphasised the need to improve the culture, attitude and working practices of the industry.

As a follow up to recent industry commissioned reports, several support divisions and programmes were inaugurated to improve the performance to the world-class standards. According to Oakland (2001), excellence can be defined as 'Achieving world-class performance', thus much research in the construction industry in recent years has been focused on 'achieving construction excellence'. Study on evolution of business excellence revealed that the principles of 'business excellence models' and 'constructing excellence' shares the common objectives of 'delivering world-class products and services'(Thurairajah et al., 2005). A comparison of construction industry concepts with internationally recognised business excellence models was carried out to find resemblance and disparity in the application of excellence concepts. Results clearly indicated the significance of leadership element in excellence concepts (Thurairajah et al., 2005). In this regard, a leadership study in construction was selected as the primary area of research.

3 RESEARCH PROBLEM

In addition to the excellence concepts in recent industry commissioned reports, it has been found that there is a growing interest in the use of partnering in construction (Bresnen and Marshall, 2000a; Dainty et al, 2001; Wood and Ellis, 2005; Ingirige, 2004). Partnering and the related forms of collaboration have been seen as a way of dealing with the fragmentation and lack of integration that have bedevilled attempts to improve project performance over the years (Bresnen and Marshall, 2000a). This represents perhaps the most significant development to date as a means of improving project performance, whilst offering direct benefits to the whole supply chain (Larson and Drexler, 1997; Wood and Ellis, 2005). Many commentators argue that partnering can have a substantial positive impact on project performance, not only with regard to time, cost and quality objectives, but also with regard to more general outcomes such as greater innovation and improved user satisfaction (Latham, 1994; Bennett and Jayes, 1998; Bennett et al., 1996; Bresnen and Marshall, 2000c).

Partnering has been defined as 'a long term commitment between two or more organisations for the purpose of achieving specific business objectives by maximising the effects of each participant's resources (Bresnen and Marshall, 2000a). While there is an agreement about this overall philosophy of partnering, there are varying views on its features. This includes wide range of concepts capturing culture, behaviour, attitudes, values, practices, tools and techniques. Despite the fact that commentators place considerable emphasis upon the importance of changing attitudes, improving interpersonal relationships and transforming organisational cultures, very little of the research has explored in the social and psychological aspects associated with the successful integration of partnering (Bresnen and Marshall, 2000a; Wood and Ellis, 2005). Managing and leading such a complex supply chain towards its objective and shared benefits needs a better, appropriate leadership throughout the project. A lack of empirical evidence indicates the necessity of leadership research in construction partnering projects to achieve specific business objectives by maximising the effectiveness of each participant's resources and establishing ongoing business relationships. The requirement for a suitable leadership to lead the supply chain towards its objectives forms the basis of the research need of the study.

4 RESEARCH FOCUS

Central to any successful partnering arrangement is the change in attitudinal and behavioural characteristics towards mutual trust and understanding. Green and McDermott (1996: Bresnen and Marshall, 2000a) argue the attitudes and the behaviour evident in the construction industry are deeply ingrained and that it is difficult to engineer any rapid movement away from such an embedded culture. Much of the literature tends to presume that cultural alignment is a prerequisite for partnering. Since partnering is seen as changing behaviours and attitudes cultural transformation cannot be forgotten in the process. Bresnen and Marshall (2000a) stress the importance of decentralised, flexible structures, where the team is expected to operate with considerable autonomy and discretion to convert formal partnering arrangements into real differences in behaviour at operational levels.

The significance of cultural and behavioural challenges on partnering related collaborative methods, together with lack of empirical evidence of leadership literature in construction clearly indicates the need for leadership research in construction partnering projects. Furthermore, recent growth in the contribution of partnering projects to construction output justifies the selection of partnering projects. For example, total investment of £ 42.69 billion from public sector in 2004 on PFI projects (HM-Treasury, 2005) and £ 6.8 billion from BAA (2005) on partnering indicates the extent and the importance of partnering projects in UK construction. However for the purpose of this research, large scale partnering projects will be selected due to the significance in contribution to the total output of construction industry. Also large scale partnering projects may extend over several years with the involvement of various participants from the entire supply chain. This results in a short term natured organisation with shared benefits as the common objective. Research will focus on leading such partnering arrangements, to understand and address the complex nature of cultural and behavioural challenges.

According to Bresnen and Marshall (2000b), there are limitations to the use of contract incentives as a motivational tool in partnering projects and often broader organisational goals were more potent influences on behaviour. Therefore it is important to develop collaboration which does not rely simply upon devising appropriate incentive mechanisms, but instead embracing a wide range of supporting internal policies, systems and practices (Bresnen and Marshall 2000c). As discussed in research problems, leadership can be employed to devise supporting internal policies, systems and practices to address the challenges due to cultural and behavioural diversity in partnering projects. Also the existing research fails to concentrate adequately with the complex relationship between individual or group behaviour and organisational culture (Barlow and Cohen, 1996; Bresnen and Marshall, 2000c) which, nevertheless lies at the heart of many prescriptions for improving collaboration within the industry (Bennett and Jayes, 1998). This research probes leadership as the response to address complex relationships of behaviour and culture in large scale partnering projects.

5 RESEARCH AIMS AND OBJECTIVES

The aim of the research is to identify appropriate leadership styles and practices to address the cultural and behavioural challenges associated with partnering projects in construction. In this process, a comprehensive literature survey will be done to understand leadership concepts and challenges related to partnering projects. This ‘theory development’ towards leadership practices in addressing behavioural and cultural challenges of partnering projects will provide strong guidance in determining what data to collect and the strategies for analysing the data.

Following objectives are formulated to develop a framework of 'critical success factors of leadership' to improve performance by addressing cultural and behavioural challenges associated with construction partnering projects.

1. Identify the cultural and behavioural challenges in construction partnering projects
2. Explore the range of current leadership roles and practices adopted in construction partnering projects
3. Identify and evaluate leadership practices to address behavioural and cultural challenges of construction partnering projects
4. Develop a framework of 'critical success factors of leadership' to improve performance in construction partnering projects
5. Propose the leadership practices in construction partnering projects

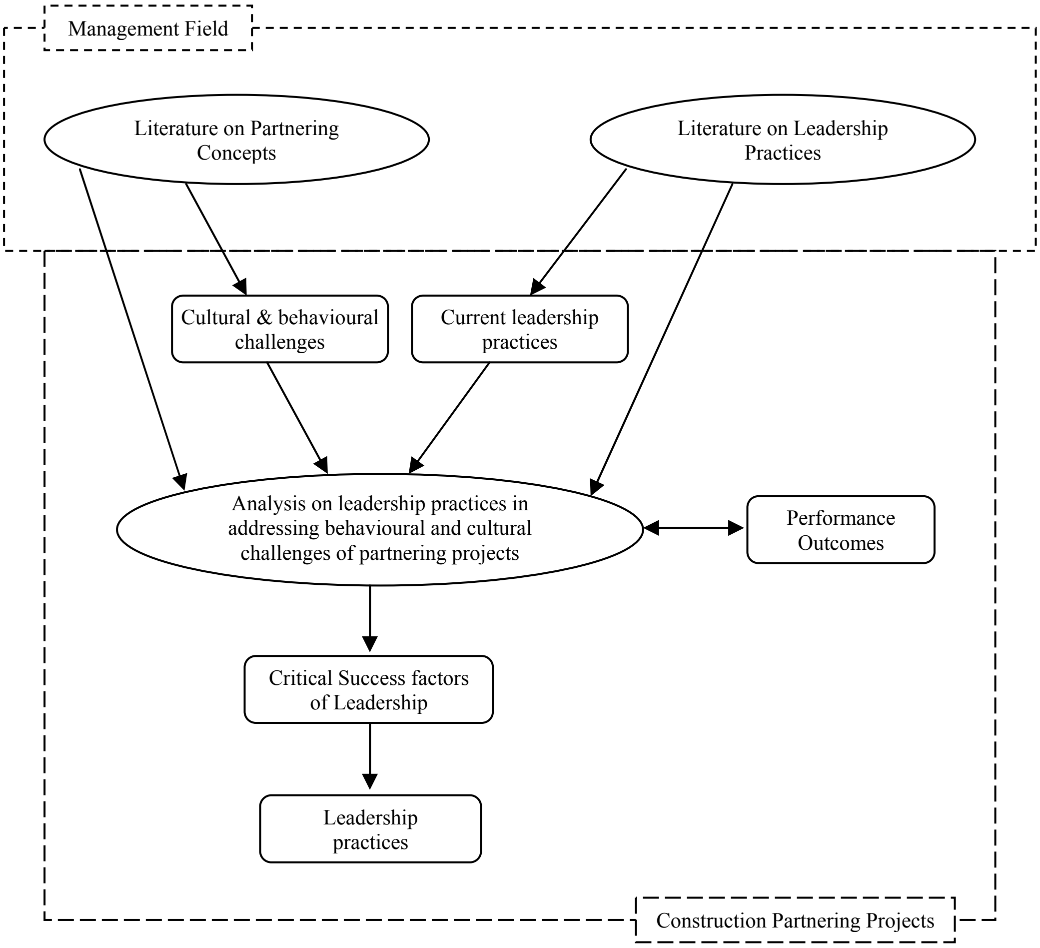

Figure 1: Research conceptual model

Figure 1 illustrates the research conceptual model devised on the literature review and synthesis. Cultural and behavioural challenges in partnering, current leadership practices and literature synthesis will be used for theory building and analysis to fulfil the research aims and objectives. Further to facilitate this process, research questions its propositions are identified in the following section.

5.1 Research Questions

Collis and Hussey (2003) suggest the choice of research questions instead of research hypothesis as the appropriate method of defining research propositions in a phenomenological study. The preference of research questions for this study is further justified by the exploratory nature of this research. Following principle research questions are formed based on the identified theoretical gaps, to fulfil the above stated aims and objectives. This takes the form of two 'grand tour questions' (Collis and Hussey, 2003), each with two 'sub questions', which will be further discussed in 'research methodology' section.

1. What are the current leadership roles and practices adopted in construction partnering projects in addressing major cultural and behavioural challenges in construction partnering projects?
   i. What are the root-causes of cultural and behavioural challenges?
   ii. How does current leadership tackle these root causes and challenges?
2. How can the leadership address these cultural and behavioural challenges in construction project partnering?
   i. What are the 'critical success factors of leadership' in addressing these challenges?
   ii. How these 'critical success factors of leadership' can be practiced in construction partnering projects?

6 RESEARCH METHODOLOGY

Research methodology refers to the overall approach to the design process from the theoretical underpinnings to the collection and analysis of the data (Collis & Hussey, 2003). There are many factors to be considered when choosing an appropriate research methodology; the topic to be researched and the specific research question are the primary drivers in the choice of methodology (Remenyi et al, 1998).

For this purpose, the hierarchical model of research methodology by Kagioglou et al. (1998) is used. This conceptual model (Figure 2) maintains the direction and cohesion of elements in representing a holistic research methodology. Within this nested approach, the research philosophy found at the outer ring "guides and energises the inner research approaches and research techniques" (Kagioglou et al, 1998)

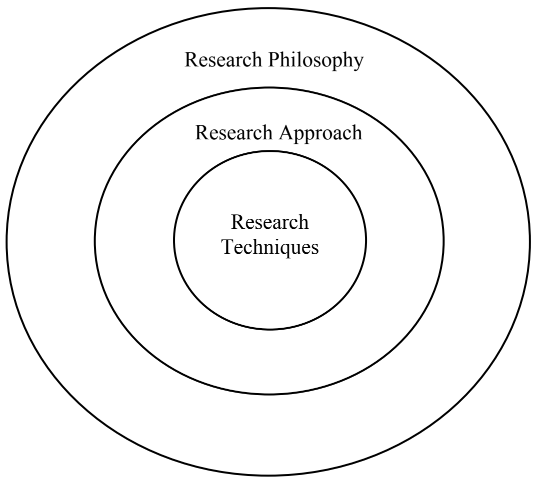

Figure 2: Research methodology 'nesting' (Kagioglou et al, 1998)

Nested approach first guides the researcher to understand the philosophical stance of the study, to define the background assumptions of the research approach. This leads to the selection of appropriate research techniques as the tools of research approach. With this integrated framework, the most suitable research methodology for the study is selected.

6.1 Research Philosophy

Partial and selective abstraction and interpretation are inevitable facts of the process of knowledge creation and thus, process of creating and legitimising knowledge requires proper understanding of philosophical underpinnings of research design. Philosophy is primarily concerned with rigorously establishing, regulating and improving the methods of knowledge creation in all fields of intellectual endeavour (Chia, 2002). According to Easterby-Smith et al (2003) there are at least three reasons for the importance of understanding the philosophical issues of a research. First, it can help to clarify research designs. Second, knowledge of philosophy can help the researcher to recognise which design will work and which will not. Third, knowledge of philosophy can help the researcher to identify and even to create designs that may be outside the researchers past experience.

The research philosophy is principally concerned with the assumptions that a researcher brings to an investigation. Although there is considerable blurring, the two main traditions of philosophies can be labelled as positivism and social constructionism/phenomenology (Collis & Hussey, 2003; Easterby-Smith et al, 2003). While positivist argue that the world exists externally and its properties should be measured through objective methods, social constructionist hold the view that the reality is not objective and exterior but is socially constructed and given meaning by people (Easterby-Smith et al, 2003). Table 1 outlines the contrasting implications of positivism and social constructionism.

Table 1: Contrasting implications of Positivism and Social Constructionism

	Positivism	Social Constructionism
The observer	Must be independent	Is part of what is being observed
Human Interest	Should be irrelevant	Are the main drivers of the science
Explanations	Must demonstrate causality	Aim to increase general understanding of the situation
Research progress through	Hypotheses and deduction	Gathering rich data from which ideas are induced
Concepts	Need to be operationalised so that they can be measured	Should incorporate stake holder perspectives
Units of analysis	Should be reduced to the simplest terms	May include the complexity of 'whole' situation
Generalisation through	Statistical probability	Theoretical abstraction
Sampling requires	Large numbers selected randomly	Small numbers of cases chosen for specific reasons
Methods used	Experiments, Surveys, Case study, Simulation, Modelling	Case study, Ethnography, Action research

Source: Adopted from Easterby-Smith et al, 2003

By considering the above listed characters social constructionism approach deemed to be more appropriate to this research than the traditional positivist philosophy. As set out in aims and objectives, this research is aimed to interpret and increase the understanding of leadership practices to address the cultural and behavioural challenges. This is largely a theory building attempt by inductive methods of data gathering and it focuses on in-depth study with in uncontrolled environment. Furthermore, research involves the investigation of complex interaction between leaders, followers, teams and processes in real life context. This leads to research the subjective aspects of human activity, focusing on the meaning rather than measurement of leadership phenomenon. Involvement of leadership phenomenon holds a very high degree of believe that the reality is dependant on the mind. As such, it disqualifies itself from embracing a strong positivist approach and takes social constructionism stance as the appropriate philosophical underpinning.

According to Creswell (1994, cited in Collis & Hussey, 2003) philosophical thinking revolves around ontological, epistemological, axiological, rhetorical and methodological assumptions. While ontological, epistemological and axiological assumptions positions the philosophical stance of a research, rhetorical and methodological assumptions are concerned with language and process of the research respectively. At this stage, for the purpose of positioning the research on the philosophical continuum, it is important to position the ontological, epistemological and axiological assumptions, before embarking on the research design.

In ontological positioning the researcher is to decide whether the reality is objective and external to the researcher, or socially constructed and only understood by examining the perceptions of the human actors (Collis & Hussey, 2003). These two ontological assumptions are known as realist (Johnson and Duberly, 2000) and idealist/relativism (Gummesson, 1991).

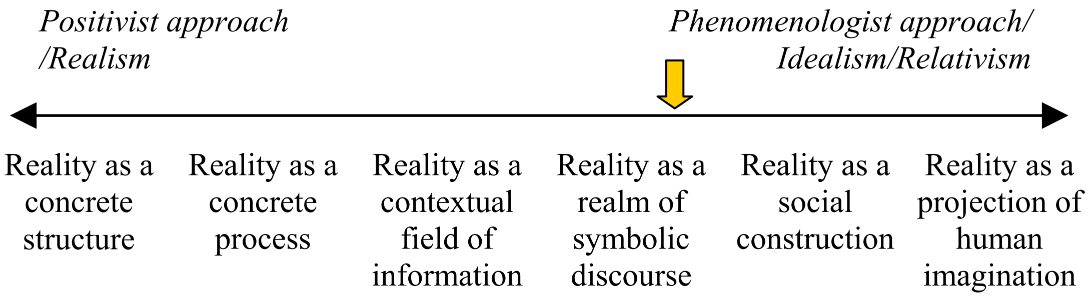

Figure 3: Continuum of core Ontological assumptions
Source: Morgan and Smircich (1980, cited in Collis & Hussey, 2003)

Literature synthesis clearly indicates the presence of cultural issues and leadership practices which are relationships and meanings sustained through a process of human action and interaction. This symbolic discourse (Collis & Hussey, 2003) and social construction together with explorative nature of study resembles with idealist assumptions. However, research doesn’t support the extreme reality of phenomenologist approach. Thus the ontological position of the research is indicated with vertical block arrow in Figure 3.

Epistemological positioning deals with questions about how and what is possible to know (Chia, 2002). At one side of the epistemological continuum positivist assumes that there is a reality which exists independently of the observer and hence the job of the researcher is merely to identify this pre-existing reality. In contrast, constructionist does not assume any pre-existing reality and the aims of the researcher are to understand how people invent structures to help them make sense of what is going on around them (Easterby-Smith et al, 2003). Similarly, this research does not assume any pre-existing reality and it aims to interpret and understand how leaders can address cultural and behavioural challenges with unstructured characteristics. It focuses on the collected construction of social phenomena and closely resembles the ideas of social constructionist. However research concentrates on leadership practices alone in addressing cultural and behavioural challenges rather than multiple realities thus an extreme social constructionism perspective of epistemological stance is avoided.

Axiological positioning is concerned with values. Positivists believe that science and process of research is value free. At the other extreme social constructionist consider that researchers have values, and these values help to determine what are recognised as facts and the interpretations which are drawn from them (Collis & Hussey, 2003). As the undertaken research is of interpretative nature and value laden, a social constructionist approach is more suitable.

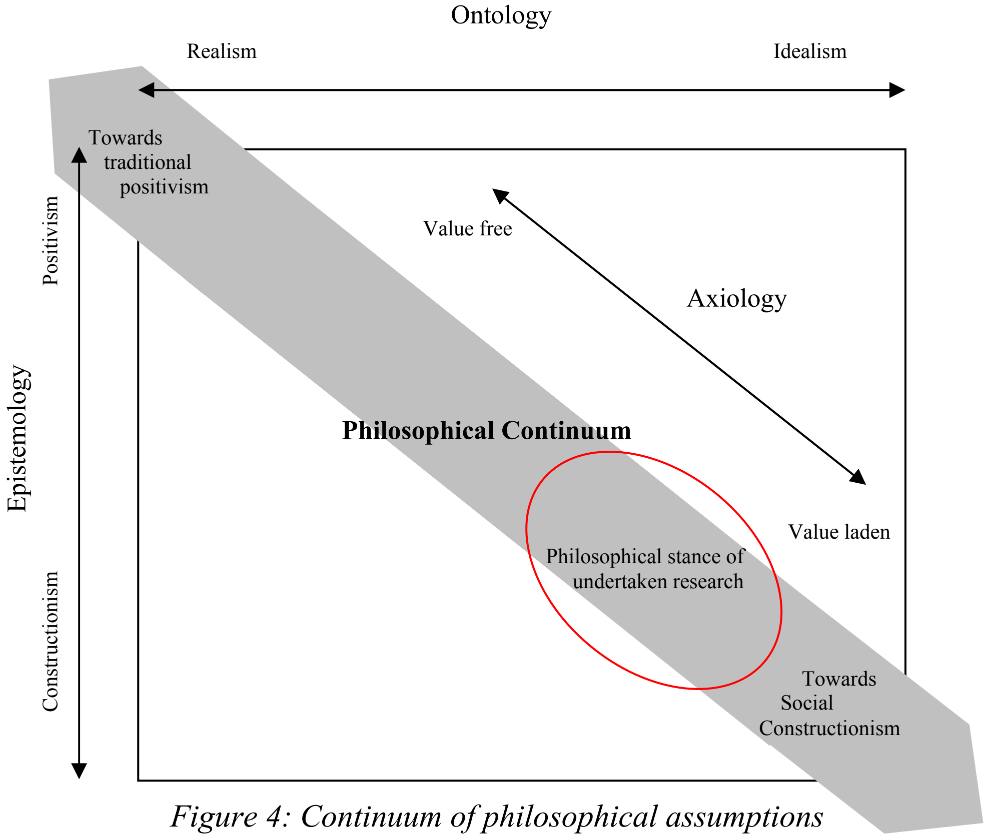

Figure 4: Continuum of philosophical assumptions

By analysing ontological, epistemological and axiological assumptions of the research, the philosophical positioning of the research is shown in Figure 4. While taking an idealist view in ontological assumptions it holds social constructionism stance in epistemological undertakings with value laden axiological position. As guided by nested approach this philosophical positioning influences the selection of appropriate research approach as described in the next section.

6.2 Research Approach

Research approaches are about organising research activity and embodying data collection, in ways that are most likely to achieve the research aims. They are guided by philosophical underpinning and energise the appropriate methods of research techniques. According to Easterby-Smith et al. (2002), five out of six key conditions in choosing appropriate research approach, closely relate to the basic dichotomy between the use of positivist and social constructionist approaches. As such Figure 5 is adopted to populate research approaches which are governed by research philosophies.

As per the selection by philosophical positioning, this research takes social constructionism stance. Since this research resides mainly with in positivist territory experiment and survey strategies are incompatible with this research. Ontological assumption of strong 'pre-existing reality' in experiments, require high extend of control over the environment by which investigator directly, precisely and systematically manipulates the reality (Yin, 2003). This can only occur in laboratory conditions and a pure experimental design cannot manipulate behaviour in real life context. Further the undertaken research entails fieldwork, as such experiment disqualifies from being a suitable research approach. In contrast, survey doesn't require high control over the environment. A survey can be readily designed to enumerate the 'what' type of exploratory questions and they can be easily applied in social science research. The major limitation of survey strategy is that it's hard to explain an observed pattern and it fails in adequately answering a 'why' type of question (Easterby-Smith et al., 2002). This research requires an in-depth analysis on leadership practices, with the combination of 'what' and 'why' type of questions in addressing cultural and behavioural challenges. Hence, experiment and survey approaches are inappropriate for this study.

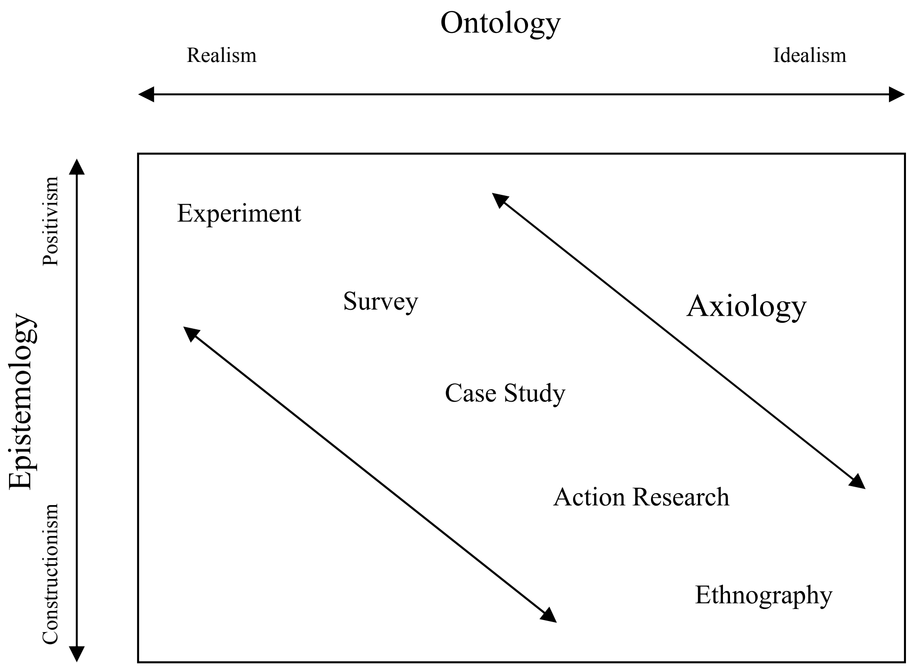

Figure 5: Continuum of research approaches
Source: Adapted from Sexton, 2004

This leaves case study, action research and ethnography strategies as suitable approaches, in which case study is been selected as the most suitable research approach for this research. In action research the researcher tries to solve the problem by being a part within the problem environment with the goal to change the status quo of the participants (Waser and Johns, 2003). This participative, partly controlled approach, concerns with the process of enquiry to form a cycle of planning, acting, observing and reflecting (Heller, 2004; Collis & Hussey, 2003). Conditions such as, partly controlled, participative observation and intervention disqualify action research from being the appropriate research approach. Similarly ethnography is defined as a study of people in fields to capture the social meaning, involving the researcher participating directly in the setting, if not also the activities to collect data in a systematic manner (Brewer, 2004). Even though ethnography does not operate in partly controlled environments, still it requires very high participative observation of the researcher.

In contrast, case study is defined as an empirical inquiry that investigates a contemporary phenomenon within real life context, especially when boundaries between phenomenon and context are not clearly evident (Yin, 2003). It covers both ‘what’ type of exploratory questions and ‘why’ type of explanatory questions. In this research both ‘grand tour’ questions and ‘sub questions’ are combinations of exploratory and exploratory nature about contemporary set of events, which is supported by case study methodology. Further the requirement to analyse leadership practices in real life context to address the cultural and behavioural challenges without controlling actual behavioural events clearly justifies the selection of case study as the appropriate research approach. Thereby, following section further examines into case study approach in defining the appropriate case study design.

6.2.1 Case Study Design

As discussed in section 5, the study questions require the ‘first case study stage’ of finding major cultural and behavioural challenges and current range of leadership practices. The solutions to the ‘first grand tour question’ will then stage the second phase of case study which is a theory building attempt by responding to ‘second grand tour question’. This will lead towards the theory modification approach in the third stage of this case study design. Third stage will mainly concentrate on proposing the roles and responsibilities of leadership to address the cultural and behavioural challenges in construction partnering projects.

Case study designs are categorised into four types according to 2X2 matrix concerned with choice between single or multiple units of analysis and holistic or embedded design situations (Yin, 2003). Selection of multiple case studies strengthens the foundation for the usage of replication logic by adding multiple sources of evidence and support the function of theory building and theory modification. As such, multiple case study approach is selected with minimum possible cases to satisfy the time constrains of this research. Possibilities of further supplementary cases will be examined after the first stage of the research, which will provide the proper understanding of the nature and required time scales for the defined unit of analysis.

The aim of the research is to identify appropriate leadership practices to address the cultural and behavioural challenges in construction partnering projects. The core analysis of this research is focused on cultural and behavioural challenges and the ways and means of addressing such challenges. This defines the ‘unit of analysis’ as ‘cultural and behavioural challenge’ cutting across various organisations which are contributing parties to ‘partnering charter’. In this regard, ‘cultural and behavioural challenge’ will be selected as the main unit of analysis, which may occur between different parties in the same project as well as in different projects. This requires the selection of embedded multiple case designs, for this research. Research will try to apply literal replication logic for the analytic generalisation. This is due to exploratory and explanatory needs with theory building attempt of this research. Therefore theoretical replication where cases are chosen to predict contrasting results is impossible.

Also the concern over lack of rigor and biasness in case study methodology requires greater validity and reliability. Yin (2003) proposes four design tests to overcome this criticism; construct validity, internal validity, external validity and reliability. Use of replication logic in multiple case studies satisfies the test of external validity, which deals with generalising study findings in the appropriate domain. The intended deployment of other design tests is discussed in the following section together with research techniques which are energised by the selection of appropriate research approach, case study.

6.3 Research Techniques

Research techniques include both data collection and data analysis, which belongs to the inner ring of nested research methodology. Data collection and analysis are developed together in an iterative process in a case study (Hartley, 2004). This section depicts these two issues with reference to case study approach adopted in this research.

6.3.1 Data Collection

Intended data collection techniques depict the ways and means to fulfil the 'aims and objectives' of this study by carefully addressing the research questions as defined in section 5.1. According to Yin (2003), evidence for case studies may come from six sources: documents, archival records, interviews, direct observation, participant observation and physical artefacts.

For the 'grand tour question one', data collection techniques such as documents, archival reports, interviews and direct observations will be used on relevant parties in construction partnering projects. In this context, cultural and behavioural challenges of every project participants will be collected together with the root causes of the challenges and the associated leadership practices. For the above mentioned objectives, 'survey technique' is considered as main source of case study information in gathering data. While the questionnaires are used to identify cultural and behavioural challenges, 'open ended interviews' will be preferred over other interview techniques in exploring leadership practices associated with the root causes. To assist this process a case study protocol techniques will be used in collecting relevant rich data for the analysis. To address 'grand tour question two' 'focused interviews' will be more appropriate as they are to corroborate certain facts, formed through the analysis. This will take place at the second stage where theory building will be the major aim of the research.

Further, Yin (2003) proposes three principles of data collection to maximise benefits from the evidence. They are; multiple source of evidence, creation of case study database and maintenance of chain of evidence. These concepts will be used to address construct validity and reliability design tests. Construct validity concerns with establishing correct operational measures. This research intends to use triangulation by multiple source of evidence, maintenance of chain of evidence and review of draft case study report by key informants which are considered as appropriate tactics in addressing construct validity (Yin 2003). Further the principle of case study protocol and developing case study database will be employed to address reliability design test.

6.3.2 Data Analysis

Data analysis consists of examining, categorising, tabulating, testing or otherwise recombining both quantitative and qualitative evidence to address the initial propositions of a study (Yin, 2003). In this research, to define the general analytic strategy, 'relying on theoretical proposition' is preferred over setting up a framework based on rival explanations and developing case descriptions (ibid, p111). Due to the explanatory nature, 'explanation building analytic technique' is more suitable for this research. However the potential problems with this technique will be reduced by the usage of case study protocol, case study database, and the following of a chain of evidence. This will improve the internal validity of the research (Yin, 2003).

In addressing the 'grand tour question one', sub question one, quantitative technique of factor analysis or mean score analysis would be used. Documents review, interviews and usage of repertory grids will be utilised to assist the quantitative analysis to identify the cultural and behavioural challenges and its root causes. These relevant data collected in the first phase will be analysed with content analysis, cognitive mapping and field force analysis techniques. By this process appropriate theory building will be carried out which will be modified in the next phase. Third phase will utilise group method analysis and theory building techniques to propose the roles and responsibilities of leadership to address the cultural and behavioural challenges in construction partnering projects.

7 CONCLUSION

Methodology provides sense of vision in fulfilling research objectives and it interplays between researcher and data (Strauss and Corbin, 1996). This paper discusses available research philosophies and approaches, while highlighting the appropriate methodology for the undertaken research. Epistemological undertakings and ontological assumptions of the research outlines the appropriate philosophical stance and further it guides towards the selection of research approach and research technique. This paper justifies the social constructionism stance and case study approach for the leadership study as the response to address complex relationships challenges of behaviour and culture in construction partnering projects.

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WHY DOES PRODUCTION MANAGEMENT FAIL IN CONSTRUCTION?

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ABSTRACT: Production Management in construction is blamed for project failures for a variety of different reasons. Thus, the goal of this paper is to analyze whether widespread failures have happened and in case, why. To start, evidence for a generic failure of production management is forwarded. Then, a number of relevant causes are discussed. Firstly, we discuss if construction lacks its own theory, or if it has enough theories but they are badly implemented. Secondly, the importance of a production system for each construction project is examined. Thirdly, some production management methods are presented, such as activity-based and location-based types of scheduling, as well as how the industry has been using them to manage its projects. Fourthly, the use of push and pull systems are also discussed. Fifthly, the human aspects are considered, especially the commitment of the workforce to the project. Learning capacity and opportunities for continuous improvement are also analyzed.

Keywords – Methods, Production Management, Production Systems, Project Failures, Theory.

1. INTRODUCTION

First of all we have to inquire if Production Management does really fail. Doing a rough search in the literature, it can be observed that Production Management is blamed for construction failures for a variety of reasons. Firstly, some authors point out the lack of specific theory for construction, or even a bad implementation of the few existent theories, as the cause of some project failures (Koskela & Howell, 2002). Secondly, others (Ballard & Howell, 1998, Bashford et al., 2005) argue that a construction project is a unique and temporary production system, and consequently needs a specific design in order to execute each project. Thus, non-existent or an unclear production system might be another reason for project failures. Thirdly, activity based methods, typically used in construction management, such as critical path and line of balance scheduling methods are also pinpointed as responsible for inefficient Production Management (Bashford et al., 2005). Fourthly, the construction industry usually employs a push type of production control for planning that has in itself been found to lead to unpredictability and loss of productivity. And fifthly, the lack of commitment within the project among the stakeholders, mainly at the lowest production level (direct laborers and sub-contractors), are also responsible for project delays and unreliable plans. Based on this background, the objective of this paper presents a brief literature review about each field presented above, and then discusses these themes. In all sections, findings from two case studies carried out in the UK are used to support the views presented.

2. CONSTRUCTION THEORIES AND IMPLEMENTATION

Theory-building is important because it provides a framework for analysis, facilitates efficiently development of the field, and is needed for the applicability to practical real world problems (Wacker, 1998). The procedure for a good theory-building research is justified as follow: it defines the variables, specifies the domain, builds internally consistent relationships, and makes specific predictions. Usually, theories are developed from observations and reflections taken in practice. Once they are built, theories should be returned to practice for their validation and applicability. Sometimes, comparisons based just on science are also used to support theory development.

A deficient or even inexistent theory of Production Management is justified by some authors by being the main cause for construction projects failures (Howell & Koskela, 2000, Koskela, 2000, Koskela & Howell, 2002). They argue that it is necessary a reform of Production Management driven by theories, improving then the management of workflows generated and delivered by each activity.

"It is the poverty of current theory that explains the other problems of project management, such as frequent project failures (Kharbanda & Pinto, 1996), lack of commitment towards project management methods (Forsberg & al., 1996) and slow rate of methodological renewal (Morris, 1994). Thus an explicit theory is the crucial and single most important issue for the future of the project management profession."(Koskela & Howell, 2002)

According to present understanding of the theory of production, there are three views to production, each providing for a number of principles for the production system: transformation, flow and value generation - TFV (Koskela, 2000). Although it is incomplete, the theory of management consists of particular theories for planning, execution, and control. Apart from Production Management theory has been evolved significantly, construction practices do not apply theory in a systematic and comprehensive manner. Thus, poor implementation of theory is often found in construction cases. Santos *et. al* (2002) argue that a lack of motivation and inadequate conditions for enabling "learning" are the central causes for the great mismatch between current Production Management theory and construction practice.

The case studies identified that one company had good implementation but poor theory, with its production based just on the transformation (T) view. On the other hand, the other company had almost nothing regarding theory implementation; if it had some theory behind the processes it was implicit.

3. PRODUCTION SYSTEMS - DESIGN OF PROCESSES

It is argued that each construction project is unique; consequently, for each project there should be developed a specific production system. It is understood that production system is what will define the production process by which materials are transformed into construction works through the use of resource capacities under certain conditions. After the product development, the following step is the design of a production system, where the production flow is defined and all activities that do not add value to the process or, to the end product, should be minimized. In this phase, possible wastes in the process are also identified, with aim of: avoid, eliminate, or at least mitigate them.

Observing the gains of Toyota through applying ‘lean production’ techniques, some researchers in construction (Ballard, Howell, Koskela) founded the ‘International Group for Lean Construction’ in 1993, aiming to try obtaining similar gains to manufacturing industry by transporting this philosophy to construction. Thus, ‘lean’ is a way to design, control and improve production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value. Thus, production has three kinds of goal: getting intended products produced in general; cost minimization and optimising levels of utilization (internal goals); and needs of the customer, such as quality, dependability and flexibility (external goals) (Koskela et al., 2002).

Toyota has identified seven major types of non-value-adding waste in business or manufacturing processes, which are described below. They can be applied to product development, process, materials requirement, and in the office. One more kind of waste has been identified by Koskela (2004) increasing to eight types of waste that can be found in the construction industry:

- Overproduction;
- Waiting;
- Unnecessary transport or conveyance;
- Over-processing or incorrect processing;
- Excess inventory;
- Unnecessary movement;
- Defects/reworks.
- Making-do (Tasks are started without all their standard inputs (materials, machinery, tools, personnel, external conditions, instructions, etc.)

Activities have to be executed in a logical sequence and without disruptions, whenever it is possible. Thus, a production system design takes into account all production requirements for the execution of the activities (sequence, external conditions, and resources). Production systems also provide standard forms for information flows and consequently data for decision-making at all hierarchical levels of the company. They should transmit the companies’ best practices and being constantly up to date. They also should transmit all experience and learning accumulated by the companies during their life, and they might have some variations from project to project (according with the typology of construction). A lack of a production system leads to waste. It occurs because there is no knowledge transferring based on the best practice of the company, continuous improvement, and learning process. Finally, production systems have to represent the whole project process, be transparent, and provide self-learning for who will read it.

The case studies revealed confirmed these issues. One company had its production system described in three booklets, supplying the managers with all information necessary for decision-making and execution of the production processes. What was noticed in this case is that the company was inflexible because its hierarchical structure and the managers were confined because the bureaucracy contented in the booklets. Thus, the company was not ready for a fast response to problems that emerged in the day-by-day on site. On the other hand, the second company does not rely on written documentation regarding its own production system. As result, what could be noticed in practice was more flexible and agile management but, a less transparent process that was cause of waste.

4. PRODUCTION MANAGEMENT METHODS

Nowadays there are two main methodologies for scheduling work in construction: activity-based scheduling and location-based scheduling. The first one leads with a network of activities dependencies and their respective durations. Among the main methods of activity-based scheduling are Gantt Charts, CPM, PERT, Critical Chain, etc. On the other hand, location-based scheduling assumes that successive activities use the same and consistent resources from unit to unit in multiple locations. As example among many methods we have Line-of-Balance, Vertical Production Method, Time-Location Matrix Model, etc (Kenley, 2004). Both methodologies have their strong points and their weakness which many times could be complemented by the other methodology. As example, to have a satisfactory Production Management, the method utilized must transmit a minimum amount of information to decision-makers as: WHAT, WHERE, and WHEN something have to be processed. These are the three premises to production management and here it is where the methods fail. They are not able to treat these three key pieces of information at the same time, in a clear optimal information display aiding decision-making. The activity-based scheduling does not involve the variable WHERE. The location-based scheduling usually does involve three of them, but it is poorly usable in complex and no repetitive projects.

A common problem in both methodologies is that they are not able to manage resources. Identify, measure, and allocate resources are fundamental for a reliable production control and consequently for a sound project. Kim and Garza (2005) proposed the Resource-Constrained Critical Path Method where they introduced resource-dependent activity relationship based on the original CPM schedule. It is not so different from other previous methods presented by other researchers, and its complexity makes manage more difficult. It is clear that better tools have to be developed for construction practitioners to manage workflow and production. The challenge is create a tool that is able to stepwise production control rates and buffer sizes by even labour crews, materials supply rates, equipment, and work hours, while random variations affect the outcome of each step.

There is also a framework deficiency for design production systems in construction. A lack of theory to support production system designs, prior to a job's start, is responsible for future wastes in the process. Schedulers try to reduce complexity, but the management tools available for construction are not efficient.

Materials management is usually planned separately in construction and its integration with the other schedules is necessary. The buyer department is general isolated into the company and work under materials requirements coming from the site. These orders often do not arrive early enough to delivery the material in time.

Task-based methods turn production management complex because a unique task can involve several resources (materials, equipments, and crew). If these variables could be simplified, unified or isolated production management would become easier. For this, a defocus in the task concept is necessary.

What could be noticed in the case studies is that construction industry has been using bygone production methods or, using them in a wrong context. It generated great amounts of waste because the methods used to planning and control were not the most appropriated tool to lead with that determined production situation. Some difficult were observed in the use of the methods, such as: up to date, logical task sequence, and easy visualization and interpretation to anticipate possible problems in the production processes. This leads projects planning and control to failures as well.

5. MANAGEMENT-AS-PLANNING AND MANAGEMENT-AS-ORGANIZING

Conventional production management is essentially about planning, i.e. manipulation of that representation (management-as-planning)(Johnston & Brennan, 1996). Here, management at the operations level is seen as consisting of creation, revision and implementation of plans. A criticism about this type of management is that the plans 'push' tasks to execution without taking the status of the production system into account. It leaves the tasks of management essentially uncoupled from everyday activity. The construction industry demands another approach, where human activity is core and production is responsive to the situation in question (management-as-organizing). Here 'pull-systems' take this situation into account, authorizing the release of work on the basis of system status.

However, in construction, it is normal to create a conceptual plan using a push-system type of scheduling in order to determine the logical sequence of works and identify the interdependence among the activities. In this phase, adoption of a 'diverging/converging' planning process (Laufer, 1997) is useful to analyze a company' resources and supply data for the decision-makers to choose the best way for the project be carried-out. At this time, the project is in its conceptual and definition phase and the activities are of a 'push' nature, in order to create the logical sequence of process mentioned before. Here critical activities, bottlenecks, milestones, and project buffers are defined. Push-systems assume that all resources required to execute an activity that is about to start will indeed be available at that activity's start time, i.e. each activity passively waits for its ingredients (instructions, labour, materials, equipment, and space) to become available (Tommelein, 1998).

At some stage within the project process it is necessary for the management method to migrate from a push-system to a pull-system. It is suggested that the optimal time for this transition is when the execution phase starts, because feedback then becomes more frequent. Push-systems control the release of jobs by controlling a Master Production Schedule. Projects which focus too much on the Master Plan, rather than on the milestones lead to 'making-do' type of waste. A pull technique is based on working from a target completion date backwards, which causes tasks to be defined and sequenced so that their completion releases work. Working backwards from a target completion date eliminates work but does not add value (Ballard, 2000). For implementation of pull-systems, improvements are needed in the areas of: work flow reliability in the site assembly process, and a reduction of the time required from order to delivery of materials at the site. The benefits of pulling are: shorter projects and reduced working capital tied up with inventories of materials; less labour time spent handling materials; and less loss, damage or misplacement of materials (Ballard, 1998). For a pull-system to be successful, it is important to achieve synergy among all organizations that do the work within the phase. Thus, teamwork techniques need to be implemented for planning and controlling the execution phase, e.g. the Last Planner System technique. Table 1 shows some relevant differences between push and pull-systems.

Table 1. Push vs. pull systems comparison

Push Systems	Pull Systems
Schedule work releases	Authorize work releases
Based on market focus	Based on client focus
Stock piling	JIT deliveries
Inflexible	More flexible
Value is implicit	Pressure for higher value

‘Management-as-planning’ is understood to be a recurrent formulation of management at the operations level in terms of the creation, revision and implementation of plans. It assumes that everyday activity itself is mediated by representations of the world and affected by the implementation of plans. On the other hand, there is ‘management-as-organizing’ where "attention is paid to structuring the physical, political and cultural setting of action, in recognition that purposeful action is an interaction between intelligent agents and structured environments, rather than just an information process. In short, management is seen as organizing things (we assumed here that the authors meant by ‘organizing things’, the resources’ organization, e.g. labour, materials, equipment, space, etc. It is a different view to ‘substance metaphysics’) rather than planning or scheduling them” (Johnston & Brennan, 1996).

Based on these descriptions we can assume that the ‘management-as-organizing’ approach is strongly linked with pull-systems. This way of management takes into consideration the organizational environment structure and not just a probabilistic scheduling of the activities as it is done in ‘management-as-planning’.

The two companies, where the case studies were carried out, have used push techniques for planning. Thus, works were released according to planned in the schedule. This assumption that all resources will be available before the work starts leads to waste, mainly in an uncertain environment like construction. These findings reinforce that changes in the practice philosophy are needed as well.

6. PROJECT COMMITMENT – HUMAN ASPECTS

A lack of commitment with the project is often observed in construction projects. A reason for this is that the majority of the workforce comes from subcontractors. As they are an independent company interest in profit, subcontractors tend to press project managers to release their jobs as soon and fast as possible. Doing this, they have in mind that can avoid idleness quickly moving their gangs for next contract (project) to increase profit. Operating the production system the manager might confront with variability. Sometimes is better select a reliable and capable subcontractor ready to handle with it, even if he/she has not the lowest bid (Koskela & Ballard, 2003).

In the Last Planner System technique there is a phase scheduling that involves integration and coordination of various specialists’ operations (subcontractors). The purpose of the phase scheduling is to produce a plan for completing a phase of work that maximizes value generation and one that everyone involved understands and supports; to produce a plan from which scheduled activities are drawn into the lookahead process to be exploded into operational detail and made ready for assignment in weekly work plans. The level of detail in the phase schedule is determined by the requirement that the phase schedule specify the handoffs between the specialists involved in doing the work in that phase. In this context, “specialist” is equivalent to “work group type” (Ballard & Howell, 2003). Participants in the phase scheduling process are representatives of those with work to do in the phase. For example, a team working to schedule a construction phase would typically involve the general contractor and subcontractors, and perhaps stakeholders such as designers, client, and regulatory agencies. Participants should bring relevant schedules and drawings including the master schedule and perhaps even the contract.

This team work that Last Planner assumes is very difficult to identify in construction sites. It occurs because nowadays companies are more interest in subcontracting work force, what generate less commitment with the project among stakeholders. Subcontractors usually are interested in their own profit trying to finish their job as soon as possible to relocate their gangs to another job (contract). Usually subcontractors press the managers to release their jobs. It leads, again, to making-do type of waste where activities are started without all resources available. On the other hand, contractors do not care too much with sub-contractors' man hour losses by idleness, because it is not a direct cost for them.

Studies (Ballard, 1998) point that the use of pull techniques and team planning to develop schedules for each phase of work, from design to turnover, contributes to achieving continuous improvement. In the case studies, some managers did not believe in skills and knowledge transfer from one site to the next. A cause of this may be that the main workforce comes from subcontractors and it is assumed that the subcontractors should know how to do their jobs in the best way and improvements should therefore be their concern.

7. CONCLUSIONS

This paper presented just few relevant causes to failures happening in construction projects. The authors are aware that there are many other reasons that could be treated, such as: materials management, changes in the scope, uncertainty, complexity, etc. We have chosen these five topics because they are among the most significant reasons for failures in Production Management, as well as they are closely linked with the author's research area. It is on the authors' plans develop further research on theory based in production management, where contribution and implementation to the existent theory are the main focus. We are also not completely satisfied with the actual production management methods that the construction industry has been used. We expect that specific theory of construction would be useful to support generation of new methods and tool specific for production management in construction. Another important issue demonstrated in this paper is that construction fits to use a mix of push and pull techniques to management production. And finally, human aspects have to be taken in consideration, preferably bringing all stakeholders on board to be part of the scheduling phase, increasing then commitment to the project.

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DEVELOPMENT OF A CONCEPTUAL FRAMEWORK FOR THE CONTROL OF HEALTHCARE ASSOCIATED INFECTIONS IN FACILITIES MANAGEMENT SERVICES

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ABSTRACT: This paper articulates some of the work carried out during the mid-stages of an on-going PhD research study. The idea of this paper is to present a four-step approach in the development of a conceptual framework for the control of Healthcare Associated Infections (HAI). Facilities Management - FM (i.e. availability of facilities, their utilisation and suitability) can greatly influence the healthcare setting as a whole, especially with regard to the development and transmission of HAI. However, a thorough review of literature suggests that, thus far, very little consideration has been given to FM services in the control of HAI. Resolving this requires a climate of awareness of the importance of FM services in the control of HAI. It demands an understanding of the relative importance of FM as a fundamental part of the control of HAI. Therefore, the conceptual framework developed for the control of HAI attempts to take an FM view. The conceptual framework aims to identify the key issues to be considered in the control of HAI in FM services. These key issues are mainly derived from the findings of a thorough review of literature and the informal interviews carried out as part of the research. Finally it is concluded that strategies adopted, involvement and integration of parties, performance management and knowledge management are all vital in the control of HAI in FM services.

Keywords: Conceptual framework, Facilities Management, Integration, Knowledge Management, Performance Management.

1. INTRODUCTION

The research study on which the paper is based focuses on Healthcare Associated Infection (HAI) in Facilities Management (FM) services (specifically on domestic services). HAI by definition means “infection which was neither present nor incubating at the time of admission but has developed during the course of a stay in hospital or other healthcare facility” (Scottish Executive Health Department, 2002). One of the main objectives of this research study was to develop a conceptual framework in order to explore the issues related to control of HAI in FM services. A thorough review of literature and informal interviews were therefore carried out during the first stages of the research study in order to achieve this. The idea of this paper is to explicate the process of development of the aforementioned conceptual framework in-detail.

2. THE RESEARCH METHODS

As previously mentioned, a thorough review of literature and informal interviews were carried out to develop the conceptual framework. During the literature search, the topics examined were broadly categorised into three, i.e. literature on HAI, literature on FM and literature on HAI and FM, mainly to identify the following:

- literature search on HAI: what is HAI, its impact and severity, how can it be controlled, history of HAI, and areas associated with the control of HAI, etc.

- literature search on FM: what is FM in general and FM related to healthcare; its importance and the components of FM, etc.
- literature search on HAI and FM: association between HAI and FM, how can HAI be controlled through FM, what are the main components to be considered under FM in the control of HAI and what should be given due consideration in terms of components of FM in the control of HAI.

The dearth of literature written on FM relating to control of HAI was one of the difficulties faced by the researcher during the literature review. Hence, twenty-five (25) informal interviews were carried out, concurrently with the review of literature, to identify in-detail the FM's involvement in the control of HAI. Interviews were carried out with experts from the NHS (particularly in the NHS in Scotland) who are actively involved in the areas of control of HAI and FM. The variety of experts selected for this stage of the study ranged from healthcare managers, microbiologists, infection control nurses, facilities managers to construction professionals. These discussions offered useful insights in identifying the areas associated with the control of HAI and FM's relation to HAI. The data gleaned from the interviews were tabulated according to professional categories mainly to exploit the following:

- the importance FM in the control of HAI
- areas of FM which are associated with the control of HAI
- challenges/ issues of control of HAI in FM services

3. DEVELOPMENT OF THE CONCEPTUAL FRAMEWORK

The development of the conceptual framework involved four main steps (refer to figure 1).

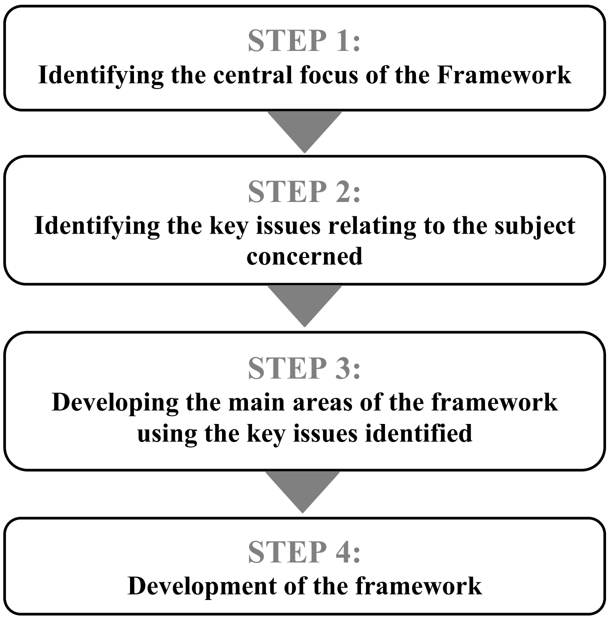

Figure 1: Steps adopted to develop the conceptual framework

All research needs an adequate conceptual framework (York University Research Partnership, 2000). A framework is defined (Miriam-Webster dictionary, 1994) as a 'basic conceptual structure' which would ordinarily contain two or more domains (groups) as well as one or more dimensions (sub-groups). According to Millennium Ecosystem Assessment (2003) a conceptual framework is designed to address a set of core questions developed through an extensive literature search and/ or through extensive interaction with users (i.e. users of the particular area concerned). As they further explain, a conceptual framework lists the issues to be addressed and illustrates their interrelationships. The conceptual framework developed in this study, therefore, assisted in identifying the issues to be considered in the area under investigation and was also used to generate research questions for the next stage of the study. In the conceptual framework developed, as figure 1 depicts, the first step defines the central focus of the framework. The second step continues to identify the key issues relating to the subject concerned. Step three then attempts to develop the main areas of the framework (for the purpose of this study, the main areas are identified as significant areas of the subject concerned). These main areas were devised using the key issues identified in the second step. Finally, the aim of step 4 is to develop the framework using the main areas and key issues identified. The following sub-sections discuss the aforementioned steps in-detail.

3.1 Step 1: central focus of the framework

There is a growing recognition that FM services have a dominant role in the control of HAI. However, a thorough review of literature suggests that, thus far, very little consideration has been given to FM services in the control of HAI. Resolving this requires a climate of awareness of the importance of FM services in the control of HAI; it demands an understanding of the relative importance of FM as a fundamental part of the control of HAI. Therefore, the conceptual framework developed for control of HAI attempted to take an FM view, i.e. the central focus of the conceptual framework is the control of HAI in FM services.

3.2 Step 2: identifying the key issues

This step is aimed at identifying the key issues to be considered under control of HAI in FM services. As aforementioned findings of the thorough review of literature revealed that FM is not yet fully exploited in the control of HAI. It is the case in clinical services. This was also asserted by many interviewees participated in the informal interviews.

The experts participated in the informal interviews presented different views on issues related to the control of HAI in FM services. The key issues derived from these findings are as follows. The discussions related to the issues are also substantiated with the findings of the review of literature:

- Issue of roles and responsibilities of FM in the control of HAI: Many books and reports on infection control have regarded HAI solely as a clinical issue (Bennet and Brachman, 1998). The Medical Research Council (1944) has considered the control of HAI as a nursing issue. Nevertheless, a recent publication entitled ‘Winning Ways’, a report of the Department of Health (DoH, 2003), has proposed seven action areas in the control of HAI and has averred that it should not be left to clinical staff alone. The ‘Winning Ways’ report, however, has not given particular emphasis to the area of FM. It appears from the discussions laid out in the said report that it has overlooked the remit of FM in the control of HAI. The organisational structure developed by the Comptroller and Auditor General (2000) specifically for control of HAI also appears not to have given any responsibilities to facilities managers. This was also evident from the informal interviews. As one of the facilities managers who participated in the informal interviews claimed, although many government documents have averred the significance of FM services in the control of HAI, it would seem that they have not accorded a prominent role to FM services in doing so. As he further states, to tackle HAI, FM has to be given due priority. It has been put forward in a conference held in 2003 in NHS in Scotland that (the conference was organised by the Property and Environment Forum Executive, Scotland), controlling HAI is everybody's business; meaning that the 'process of the control of HAI is a collective effort'. 'Everybody' in this respect includes the government, policy makers, healthcare management, participants from both clinical and non-clinical staff services, and the general public. Therefore, if there is to be any major and positive impact on controlling the risks of HAI, there has to be a fundamental change in the thinking of management and staff. There has to be a climate of awareness of the importance of FM services in the control of HAI. Thus, improvements in the process of the control of HAI demand an understanding of the relative importance of FM as a fundamental aspect of the control of HAI. Furthermore, steps should be taken to define the roles and responsibilities of FM in the control of HAI.

- Issue of involvement of infection control teams: Various parties are involved in the process of control of HAI in FM services (both during design & construction stages and the building occupancy stage). These include facilities managers, healthcare managers, design & construction professionals, etc. These parties should ensure that patients, especially immunocompromised patients, are at no greater risk of infection within the hospital than outside. Therefore, Noskin and Peterson (2001) assert that infection control teams too play a major role in this process. In one of the Department of Health reports (2002) it was put forward that the NHS trusts have to fully involve infection control teams throughout the design process of a hospital and during FM operations. However, the National Audit Office (2004; as cited in Comptroller and Auditor General, 2004) reported that only half of infection control teams are usually consulted on the control of HAI issues in FM services. As the National Audit Office report recommended, the FM services should ensure that they comply with the newly published control of HAI standards by consulting infection control teams when purchasing equipment, planning, etc. The National Audit Office strengthened this recommendation to propose that NHS trusts should require consultation with infection control teams to be a mandatory step in contract tendering procedures for new build projects, and for cleaning, laundry and catering services. However, many infection control team members who participated in the informal interviews claimed that 'they are often ignored or their advice is given lip service by facilities managers'. One of the infection control nurses stated that:

  "It is very frustrating when our advice is ignored or overridden"

  Therefore, it is perceptible that the importance of infection control team's involvement in FM services in hospitals (both during design and construction stages and the building occupancy stage) remains unclear. As Bartley (2000) informs us, guidelines are needed to highlight that FM services require consultation from infection control teams. As he also states, early involvement of infection control teams in FM services helps to ascertain the risks for susceptible patients and disruption of essential patient services.

- Issue of integration among the parties involved: Integration for the purpose of this research study implies that 'the parties involved in the control of HAI communicate and coordinate their work together to deliver safe patient care'. Findings of the thorough review of literature suggest that the infection control teams and other medical team representatives must be allowed to routinely address the issues associated with the control of HAI in FM operations (Bartley and Bjerke, 2001). Barkley and Bjerke further assert that collaborative tam skills and appropriate communication techniques are integral throughout FM operations. However, it was identified from the informal interviews that there is lack of communication and coordination among the parties involved in the control of HAI in FM services.

- Lack of knowledge in the control of HAI: The lack of knowledge in the control of HAI was another issue uncovered during the informal interviews and review of literature. The Canada Communicable Disease Report (1998) highlights that: "although FM services are considered to be important in the control of HAI, studies have repeatedly shown poor compliance with control of HAI protocols by FM personnel". As the report further claims, the failure to comply is a complex problem that includes an element of lack of knowledge about the importance of control of HAI. Designers, construction professionals and facilities managers often lack knowledge in the control of HAI and lack awareness of the severity of HAI. This can increase the chances of avoiding their adherence to control of HAI standards during design and construction of hospitals and during FM operations. In contrast, infection control teams lack knowledge on FM aspects (design and construction, cleaning, catering, etc.). With this, managers and staff tend to be, or often become, pigeon-holed within their own specialities, and only when necessary are they backed up by ad-hoc teamwork (Horton and Parker, 2002). Newton (2003) avers that the sharing of knowledge is definitely advantageous in such types of situations. As he recommends, having representatives from all the teams involved is certainly beneficial to assist each other in their particular areas of expertise.
- Training and education: Wolfe (2003) states that it is essential for the non-clinical staff (i.e. construction and FM staff, in this study point of view) to understand the issues associated with the control of HAI during construction of a hospital and during FM operations (e.g. how to construct a negative pressure enclosure, how to implement work practices that reduce or eliminate the transmission of infections). However, from the discussions with the experts (during the informal interviews) it was apparent that many construction and FM staff have limited up-to-date training and background knowledge in the principles of control of HAI, including the proper use of personal protective equipment. As most of the infection control nurses revealed, in the NHS, there is a severe shortage of formal training and education programmes associated with the control of HAI.
- Issues related to policies, guidelines and standards: It was also apparent from the interviews that there is a lack of mandatory and evidence-based policies, guidelines and standards (identified as guidance documents for the purpose of this study) in NHS for the control of HAI in terms of healthcare facilities. That is not to say that there are no guidance documents to draw from. The NHS has provided some guidance on appropriate healthcare facilities management to ensure effective control of HAI; for example, 'infection control in the built environment – Health Building Note 30' (NHS Estates, 2001). However, as one of the infection control nurses who participated in the interviews highlighted, such documents only contain general guidelines and standards. What is needed, as she perceives, is far more comprehensive documents on healthcare facilities management, particularly with respect to the type of healthcare facilities, e.g. operation theatres, emergency departments, wards, etc.
- Lack of performance management in the control of HAI: Bartley (2000) has recommended the need for 'performance management' to assess the level of adoption of control of HAI standards in FM services. In his recommendations, he suggests defining outcome measures (e.g. surgical site infection rates) and/or process measures (e.g. measuring compliance), for measuring and managing performance. From the discussions with the experts it was revealed that performance measurement and management are less

developed areas in the control of HAI in FM services. For example, hitherto, there are no performance measures in-place to ensure that the control of HAI standards are adequately met during FM operations.

3.3 Step 3: devising the main areas of the framework

As Berwick (as cited in Woods et al, 2001) asserts, great health professionals do not make great healthcare. Great health professionals interacting well with all of the other elements of the healthcare system make great healthcare. Therefore, the Department of Human Services (1998) states that, the control of HAI requires the commitment of adequate resources and clear lines of communication between the major players. As mentioned in the previous section, the NHS organisation structures specifically designed for the control of HAI (by the Comptroller and Auditor General, 2000 and Scottish Centre for Infection and Environmental Health, 2002a and 2002b) have not considered FM as a major player in the process of control of HAI. Neither have they given any clear lines of responsibilities for FM personnel nor clear lines of communications for FM services to interact with the major players in the control of HAI (e.g. infection control teams). This has created a perception that HAI is predominantly a clinical issue, and has resulted in the lack of 'integration' between clinical and FM services staff.

From the discussions laid out in the previous section, it was also identified that there are key shortfalls in areas such as guidance documents with regard to the control of HAI in FM services and the involvement of infection control teams. It was also apparent that there are issues related to the lack of knowledge in the control of HAI. This is partly due to lack of training and education programmes associated with the control of HAI.

Considering such issues, a few of the key documents have offered recommendations for successful control of HAI. The dearth of literature on control of HAI in FM services (especially journal papers and books) was one of the challenges of this study. Therefore, the key documents considered for the development of the conceptual framework are mostly reports published by healthcare organisations/ healthcare related organisations (UK and worldwide). The said documents are identified as 'key' considering three main factors, i.e. the title, the author (i.e. organisation) and year of publication:

- Relevance of the title (title): the documents chosen are specifically related to the control of HAI in FM services. Most of the documents, inter alia, discuss about the problems/ issues related to HAI. The documents have provided key recommendations to improve control of HAI in FM services.
- Prominence of the organisation (author): the author should be/ should be related to a leading healthcare organisation, e.g. World Health Organisation (WHO). This is to ensure reliability of the information gleaned.
- Currency of publication (year of publication): the conceptual framework for this study was developed in mid 2004. Therefore the documents used for devising the main areas to be considered for the conceptual framework were chosen considering the date of publication as well. The date of publication of most of the key documents is between 2000 and 2004.

Taking all the recommendations of the aforementioned key reports and the key issues described in step 2 in the previous section into consideration, the significant areas to be considered in the process of successful control of HAI in FM services can be encapsulated as depicted in table 1. The information given in table 1 reveals that, at present, the strategies adopted in the control of HAI in FM services, involvement and integration of different parties involved in the control of HAI in FM services, performance management and knowledge management stand as significant areas in the control of HAI in FM services.

Strategy herein implies a 'framework within which to plan/ work in order to achieve the goals of an organisation'. According to the NHS Estates (2003), for an FM service to be effective, formulating a 'strategy' is an essential criterion in order to address key issues in the particular FM service. As they further explain the development and review of policies, guidelines, standards and specifications, defining accountabilities, roles and responsibilities are all essential in formulating a strategy.

The lack of involvement and integration among the parties involved are also major issues in the control of HAI in FM services. According to the report published by the HAI Task Force Secretariat – Scotland (2005), clear mechanisms should be established in NHS boards for the infection control teams to coordinate and communicate with the clinical and non-clinical (FM) services in all prevention and control of HAI programmes. As the report suggests this is a critical success factor in achieving stated goals in infection control and prevention.

Table 1: Significant areas to be considered in the process of successful control of HAI in FM services

KEY ISSUES	KEY RECOMMENDATIONS	SIGNIFICANT AREAS
▪ Issues related to roles and responsibilities ▪ Issues related to guidance documents (policies, guidelines and standards) ▪ Issues related to priority given to FM in the control of HAI ▪ Lack of resources (availability of staff, cost implications)	▪ Define accountability ▪ Define roles and responsibilities ▪ Develop and review control of HAI policies, guidelines and standards ▪ Ensure compliance with policies and guidelines ▪ Develop and review service specifications ▪ Ensure FM is stressed as a vitally important part of the control of HAI ▪ Give infection control the importance and priority it deserves ▪ Identify resource deployment	**Strategies**
▪ Lack of involvement of infection control teams ▪ Lack of integration among the parties involved in the control of HAI	▪ Involve infection control teams ▪ Work with the infection control teams, matrons and nurses ▪ Improve communication and coordination	**Involvement and integration of different parties**
▪ Lack of performance management	▪ Develop key performance indicators/ measures ▪ Identify performance requirements ▪ Develop monitoring and supervision arrangements ▪ Measuring performance ▪ Audit and feedback to staff	**Performance Management (PM)**
▪ Lack of training and education ▪ Lack of knowledge in the control of HAI	▪ Set up training and education programmes ▪ Review training and education programmes ▪ Develop knowledge and skills appropriate to control of HAI in FM services ▪ Apply knowledge and skills appropriately in the control of HAI in FM services ▪ Knowledge dissemination	**Knowledge Management (KM)**

As Sumlin (1997) noted, successful organisations are already discovering Performance Management (PM) as a critical business tool, one that plays an important role in translating business strategy in to results. Performance Management (PM) can be seen as a significant area in the control of HAI in FM services since it can be used to improve and develop the performance of the said field (control of HAI). However, it has seldom been recognised as a main component in the control of HAI. PM can be used as an effective tool to detect pros and cons of the control of HAI system in-use and can then support strategic decision making. It can be used as a point of reference to compare the past performance levels with the present. It can also be utilised to identify mistakes and to assist in deciding remedies to be taken. Alternatively, it can enable an organisation to manage performance by measuring performance.

The report ‘NHS Performance Indicators: A Consultation (2001)’ asserts that around 15% of HAI could be avoided through strengthened arrangements for prevention and control, and better application of existing knowledge and good practice. As a knowledge intensive sector healthcare needs to adopt the latest medical and relevant support service practices. It also has to rely on the skills and expertise (knowledge) of the staff to provide a quality service (Knowledge Management Strategic Advisory Committee, 2002). KM is specifically vital in achieving this due to the fact that it requires prompt attention or quick response on customer needs, i.e. patient care, with the aid of prompt and appropriate knowledge, skills and expertise of staff for excellent delivery of services. It needs the employment of the right sets of knowledge at the right time.

3.4 Step 4: development of the framework

Even though FM is a support service, its integration with core services (i.e. clinical care), as a whole, can enhance the overall healthcare experience of patients. As the Health Facilities Notes 17 (NHS Estates, 1998) states, patient’s perception of quality is based not only on clinical treatments but also on a range of other factors relating to the overall healthcare experience. Support functions, such as catering, cleaning, administration and reception services, can create first and lasting impressions – good and bad. Hence there is a need to consider support services as an integral part of healthcare services (NHS Estates, 1998). According to Kincaid (1994) integration of FM as an effective function for an organisation is a must and can be achieved through:

- FM must link strategically, tactically and operationally to other support activities and primary activities to create value; and
- Within FM, managers must be equipped with knowledge of facilities and management to carry out their integrated support role.

FM can be made integral to the healthcare services when there is improved co-ordination and communication among the clinical and FM services staff. Also the involvement of all the relevant parties in the concerned processes (e.g. involving both infection control teams, nurses and FM teams in the control of HAI in FM services) allows key functions to be performed as and when required. Nevertheless, this has to be done in such a way that there is less confusion among the parties involved regarding their roles and responsibilities. It is the remit of healthcare management to adopt appropriate strategies to properly define roles and responsibilities of all staff.

Knowledge Management (KM) is also vital in the process of improving the involvement and integration of parties in the control of HAI in FM services. The involvement and integration of relevant parties require an open culture where FM and clinical staff can blend with one another without any barriers. KM can be used to create this through encouraging employees to share their knowledge, which will provide an opportunity to achieve:

- mutual recognition and information exchange regarding objectives and planned outcomes
- improvement of skills and competences which could ultimately lead to effectiveness and efficiency of practices of employees of the organisation
- avoiding duplication of mistakes through sharing of experiences
- avoiding gaps or repetition of work through effective communication

The strategies adopted by healthcare management/ facilities management also become vital in the aforementioned process. Taking appropriate steps to boost the profile of FM in the control of HAI and also to increase the awareness of FM staff in the control of HAI is vital in avoiding 'superiority/ inferiority' attitudes of the staff. This could create a culture where FM and clinical staff can blend with one another without any barriers. Developing appropriate policies, guidelines and standards in order to encourage staff to develop, improve and share knowledge and skills is significant for effective KM and better integration.

As repeatedly discussed in the previous sections, PM is also important in the control of HAI in FM services. PM is mainly about assessing the achievement of planned targets. In doing so, the selection of suitable performance measures is significant to reflect the actual levels of performance of FM services. However, this is always challenging due to the difficulty in choosing what is to be measured appropriately, rather than picking what is easy to measure. An appropriate benchmarking system is also a prerequisite of a proper PM approach. Benchmarking is a structured and focused approach which can be used to compare current performance with past performance levels or to compare performance with other services/hospitals. The purpose of the comparisons is to enable the facilities managers to identify where and how they can do better. Most importantly, PM can also assist in developing and/ or reviewing strategies adopted in FM services. It can also provide the opportunity to assess/ evaluate the degree of application of KM in FM services. Besides, it can also be used to evaluate the extent of involvement and integration of different parties in particular processes. All of the above can subsequently result in improving the processes of control of HAI in FM services. The inclusion of PM into the conceptual framework, therefore, provides an opportunity to achieve the following in the control of HAI in FM services:

- measure progress towards achieving objectives
- promote benchmarking practices in order to compare performance with past levels of performance and among other hospitals
- promote service improvement through corrective actions

Overall, as previously mentioned, KM is significant in the process of involvement and integration of different parties in the control of HAI in FM services. Involvement and integration requires an open culture and KM can be used to create this open culture through encouraging staff to share their knowledge. KM enhances knowledge sharing which can eventually result in integration. On the other hand, PM can be used to assess the performance of control of HAI in FM services. PM is also essential for KM. Knowing what you have done and what has gone wrong can assist in avoiding repetition of the same mistake. Also knowing where you are, what you are doing, and what to do will help to generate knowledge at the right time. This is particularly important to share information or knowledge at the right time to the right person. Adopting appropriate strategies in the process of successful control of HAI in FM services is also essential, inter alia, in setting up and reviewing requirements in terms of KM, PM and issues to do with the involvement and integration.

Taking all the above into consideration a conceptual framework was developed and is depicted in figure 2. The significant areas, i.e. strategies, involvement and integration of parties, PM and KM, are highlighted in the conceptual framework. The aforementioned discussions revealed that these are not stand-alone areas, thus, the areas are linked to show their interrelationships. The recommendations highlighted in table 1 are also noted in the conceptual framework to further elaborate the significant areas. The framework was developed for the purpose of the next stages of the study. Therefore, the research questions to be explored in the next stages of the study are also depicted in the conceptual framework.

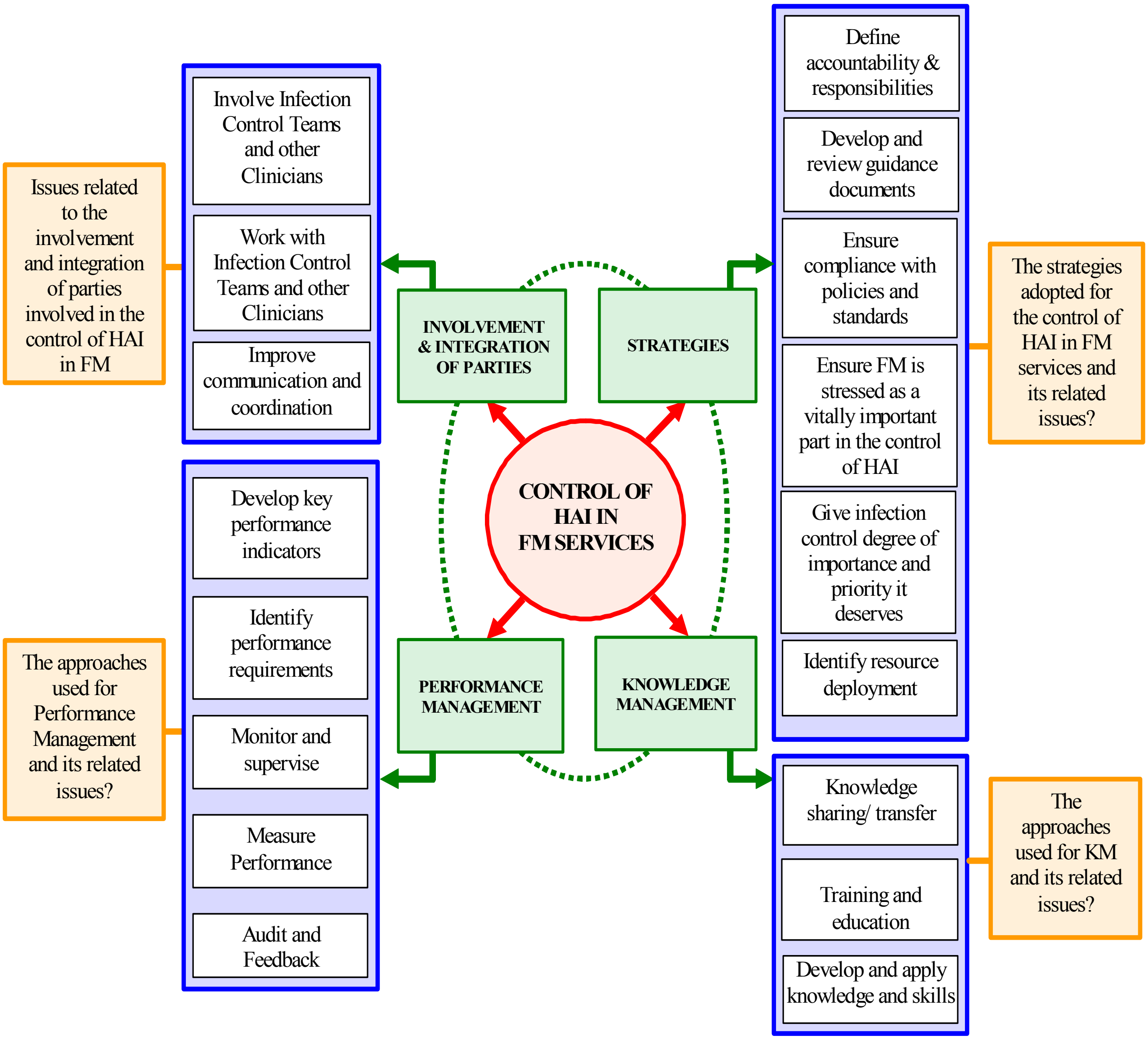

Figure 2: The conceptual framework for the control of HAI in FM services

4. SUMMARY AND CONCLUSIONS

A thorough review of literature and informal interviews suggest that appropriate strategies, involvement and integration of parties, performance management and knowledge management are significant in the control of HAI in FM services. Herein, a 'strategy' implies a 'framework within which to plan/ work in order to achieve the goals of an organisation'. The development and review of policies, guidelines, standards and specifications, defining accountabilities, roles and responsibilities are all essential in the process of strategy formulation. It was perceived that there should be a greater level of involvement and integration of relevant parties in the control of HAI in FM services. This is to eliminate discrepancies of work practices in terms of the control of HAI. Performance Management (PM) is essential to assess whether staff have successfully achieved the stated targets in the control of HAI. Since Performance Management (PM) is mostly about assessment and management of the achievement of planned targets, it could enable the facilities managers to identify where and how they can do better in terms of control of HAI. Knowledge Management is vital in the control of HAI to develop, share, apply and improve knowledge and skills of FM staff who are unaware of the issues associated with the control of HAI. Some can misinterpret KM as an approach which has a high association with information technology (IT). However, if studied carefully, KM is not all about technology; it is about identifying and linking groups and individuals around knowledge. In terms of HAI, it would appear that there is a necessity for all teams and individuals of clinical and non-clinical (FM) teams to work together to achieve the targets associated with successful practices of the control of HAI. Therefore, KM can encourage learning through mistakes and thus can increase efficiency in practices associated with the control of HAI. Overall, it can be concluded that the review of literature and the informal interviews carried out as part of this research study highlighted four themes in the control of HAI in FM services, which point to the need for further investigation:

- the strategies adopted
- the need for involvement and integration of different parties
- the need for managing performance
- the need for managing knowledge

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AGILE CONSTRUCTION PROJECT MANAGEMENT

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ABSTRACT: Project management in the information systems industry has had a poor record of delivering value and has consequently seized upon the recent evolutional of agile project management. What is meant by agile project management, from whence it originated and whether it has further applicability are not widely understood. The construction industry also has a less than perfect project management record and might benefit from the adoption of agile project management. An extended literature review has established that agile project management does indeed offer significant improvements and that the construction industry might also potentially benefit. In order to resolve to an agile theory, the underlying rationales for agile have been explored, leading to the identification of further promising research

Keywords – Agile Construction, Information Systems, Project Management.

1 INTRODUCTION

Agile thinking, production and project management has evolved since 1990 as a response to the gains made in Japanese industries since their restructuring after the Second World War. It has made significant headway in the information systems industry; however, impartial academic studies as to its advantages are sparse. In order to investigate the potential for an underlying theory of 'agile', it is first necessary to understand its underlying rationale, and to then assess the possibility of engaging any strengths in other domains.

This paper describes initial research into 'agile' and identifies promising areas for further research.

2 THE EVOLUTION OF AGILE PROJECT MANAGEMENT

Agile project management has its foundations in the management science of Deming but perhaps harks back to pre-industrial revolution times, before decomposition and management-as-planning took a hold. The real progress today lies in the domain of information systems; however, it may be possible to migrate the core attributes to other domains, including construction.

2.1 Agile Manufacturing

Iterative and incremental development methodologies were first defined by Shewart in the 1930s and then expanded upon by Deming in Japan (1982), focusing on causes of deviation and acting on those causes. Indeed, the Plan-Do-Check-Act (PDCA) cycle is still being used in Toyota product development (Liker, 2004) and conforms to the scientific experimentation model of control. However, in the field of information systems, anarchic ad-hoc code and fix developments of the 1960s led on to the welcome embrace of Royce's sequential (or waterfall) development method in

1970 (Royce, 1970). Unfortunately, the iterative aspects of Royce's paper were largely ignored or misapplied; rigid adherence to early definition and fixing of system and software requirements resulted in errors being propagated and compounded throughout projects, leading to widespread failures in delivered value. Several voices (notably Gilb's and Boehm's) were raised against such an approach to information systems development in the 80s and early 90s. (Futrell et al., 2002)
The work of Imai, Nonaka and Takeuchi (1986) was a catalyst to the establishment in 1990 of a US Department of Defense and National Science Foundation funded study at Lehigh University to investigate the competitive environment of 2005 and beyond. This study was a response to greater efficiencies achieved by Japanese industries, and led on to the development of an Agile Forum for manufacturing in 1992.

2.2 Agile Project Management

Coincidentally, in 1990 DeGrace and Stahl analysed the Waterfall model used in information systems development and found it wanting (DeGrace and Stahl, 1990); in Japan the Waterfall model was reduced to four overlapping phases (as in Sashimi).

Sutherland (2001) merged Scrum reactive methodology with his earlier work with other agile processes in 1993 and spread its use to a number of corporations. In 2001 the term 'Agile' was adopted as an umbrella term for advanced software development methodologies which were largely rooted in the early 1990's. The Agile Movement became particularly active within the information systems industry from early 2003. The use of Scrum for software development project management was then popularised through Schwaber and Beedle's book (Schwaber and Beedle, 2002).

2.3 What is Agile?

Whilst some continued to eschew the information systems waterfall method, it was not until 2001 that a 'Manifesto for Agile Software Development' (Beck and et al, 2001a) evolved through the efforts of leaders in the field and the term Agile became synonymous with a variety of existing information systems development methodologies, under the auspices of the Agile Alliance. The 'Manifesto' (which must be reproduced in full) states:

> *'We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:*
>
> - *Individuals and interactions over processes and tools*
> - *Working software over comprehensive documentation*
> - *Customer collaboration over contract negotiation*
> - *Responding to change over following a plan*
>
> *That is, while there is value in the items on the right, we value the items on the left more.'*

The Manifesto, together with its underlying 'Principles' (Beck and et al, 2001b) depict a substantial concentration on the early and regular delivery of value, and the use of changes as opportunities to enhance that value. Working practices focus on frequent, sustainable iterative deliveries by facilitated multi-functional, self-organising intercommunicative teams. Scrum and other agile methodologies add to those overall foci by prescribing numbers for the optimum team size (typically 5 to 20) and iteration periods (typically around 30 days, although varying widely).

The Agile Project Leadership Network (APLN) has a wider focus than just software and focuses on: value, customer, teams, individuals, context and uncertainty. The APLN Declaration of Interdependence (Anderson and et al, 2005) for agile and adaptive management states that, based on the experience of the authors, the following interrelated strategies deliver highly successful results:

- *'We increase return on investment by making continuous flow of value our focus.*
- *We deliver reliable results by engaging customers in frequent interactions and shared ownership.*
- *We expect uncertainty and manage for it through iterations, anticipation, and adaptation.*
- *We unleash creativity and innovation by recognizing that individuals are the ultimate source of value, and creating an environment where they can make a difference.*
- *We boost performance through group accountability for results and shared responsibility for team effectiveness.*
- *We improve effectiveness and reliability through situationally specific strategies, processes and practices.'*

Whilst not unique, the functional engagement of customers is more explicit here. The value of individuals in value generation remains a common theme. Agility itself is defined by one of its originators (Dove), as follows:

'The Ability of an Organization to Adapt Proficiently (Thrive) in a Continuously Changing, Unpredictable Business Environment. (Dove, 1996)

Agile systems are ones that can respond to both reactive needs and proactive opportunities - when these are unpredictable, uncertain, and likely to change.' (Dove, 2005)

Dove considers that agility consists of practices and processes for knowledge management, value propositioning and response ability and sees these practices and processes as positioning an enterprise to cope with change. Indeed, dictionary definitions of agility generally include words such as quick, quick-witted and nimble.

Whilst some see agility as a state of mind, others focus on methodologies; those who implement 'agile' frequently confuse it with 'lean'. In terms of manufacturing, lean and agile are different, as pointed out below (Sanchez and Nagi, 2001):

'Lean manufacturing' developed as *'a response to competitive pressures with limited resources. Agile manufacturing, on the other hand, is a response to complexity brought about by constant change. Lean is a collection of operational techniques focused on productive use of resources. Agility is an overall strategy focused on thriving in an unpredictable environment. …… Flexible manufacturing systems* (offer) *reactive adaptation, while'* agile manufacturing systems offer *'proactive adaptation'*.

To amalgamate the common themes of the various individuals, teams and initiatives set out above; to be agile an enterprise or project must be structured appropriately to proactively and quickly adapt to change, seizing such opportunities to enhance value outcomes.

In terms of methodologies, these should depend upon the specifics of the project but common themes should include the use of empowered, multi-disciplinary, small teams to iteratively, incrementally and continuously develop value through the transformation of emergent and evolving requirements, products or processes which involve, and provide early enhanced value for stakeholder(s). Excessive discrete planning or documentation should be seen as waste, indeed it is the recombining of ‘thinking’ (planning) and ‘doing’ (following the plan) which leads to agility.

3 AGILE BENEFITS

It is important to verify that agile processes do actually lead to worthwhile improvements, compared with traditional processes. Seven sets of comparative studies consolidated by Boehm and Turner (2004) illustrate the trend for a reduction in the effort required to fulfil a project, averaging around 50%. Further data concerning the impact of agile development practices is shown in Table 1. These figures were obtained from an EC-funded pan-European initiative to identify methods for process improvements. The improvement in organizational skills of 79% resulting from the adoption of DSDM agile practices is particularly noteworthy.

Table 1. DSDM in Process Improvement - Outcomes

Objective	Target Improvement	Actual Improvement
Improve on-time delivery and customer satisfaction	20%	23%
Increase process predictability; higher maturity level	10%	40%
Improve organisational skills of both management and development personnel	20%	79%

(Source: (Stapleton and Consortium, 2003), p.191)

The final evidence offered, in Table 2, is the result of an online survey of 131 companies and their perceptions of the improvements which agile processes offer. A large majority of respondents reported improvements or significant improvements in productivity, quality and business satisfaction. Just under half of respondents reported reductions in costs (cost reduction is a secondary effect of agility as the primary focus is on value or, in this context, quality-improvement).

Table 2. Agile Survey Results

Did Agile Processes Result In:	Positive	Neutral	Negative
Reduction or significant reduction in **cost**	49%	46%	5%
Better or significantly better **productivity**	93%	5%	2%
Better or significantly better **quality**	88%	11%	1%
Better or significantly better **business satisfaction**	83%	16%	1%

(Source: (Shine, 2003))

Having established that agile techniques offer significant improvements in the delivery of projects, we then have to establish why such improvements occur. The evidence in Table 2 of significant improvements in organisational skills provides a starting point. DSDM, Scrum and other agile processes and methods all emphasise the advantages of communication flows within small teams. Communication is improved through the use of simultaneous broadband paths instead of discrete cascaded messaging; information is consequently rendered more immediate and better targeted. Teams are facilitated to achieve their goal(s) by their manager but otherwise left to organise their own work. It could therefore be argued that the organisational skills improvements have been realised through the decomposition of organisation from command and control to consensus management.

4 UNDERLYING RATIONALES FOR AGILE

In order to examine why agile project management offers such an advantage, it is necessary to examine the core aspects of its nature. Whilst further research is essential, an initial appraisal shows the key questions to be:

Emergent requirements – to what degree do they occur and how can they be dealt with?

Motivational aspects – how do individuals respond to agile methodologies?

Complex systems, network theory & human dynamics – how does the structure of work affect outcomes?

Feedback & organizational learning – how can this be maximised within the temporary organizational structures of the West?

Metaphysical underpinnings – how would a theory of agile fit within current theories of production and management, and their metaphysical underpinnings?

4.1 Coping With Emergent Requirements

Most projects are, to some extent, volatile and subject to unforeseeable chaotic inputs and emergent requirements. Project managers are expected to do their best to ensure that these changes can be mitigated and that the project can 'run to plan'. Where agile thinking differs, is that change is recognised as inevitable and therefore embraced as an opportunity for enhancing customer-perceived value. This is particularly important in the case of information systems as they are so difficult to visualise:

'We can not completely specify an interactive system.' - Wegner's Lemma (Wegner, 1995)

'For a new software system, the requirements will not be completely known until after the users have used it.' - Humphrey's Requirements Uncertainty Principle (Humphrey, 1995)

'Uncertainty is inherent and inevitable in software development processes and products.' - Ziv's Uncertainty Principle (Ziv and Richardson, 1997)

In the case of construction, research shows that, as late as the start of construction, significant uncertainty remains as to what is to be constructed (Howell et al., 1993). Indeed, other sources point to the nugatory nature of <u>excessive</u> front-end design and/or planning:

'We find a weak relationship (p = 0.0781) between the completeness of the detailed design specification and a lower defect rate.' (MacCormack et al., 2003)

'The definition and dissemination of initial objectives was not significantly related to the success or failure of a project.' (Baker et al., 1986)

'Successful projects were able, over their lifetime, to resolve the initial uncertainty associated with their technical and commercial goals and objectives.' (Baker et al., 1986)

If change if so inevitable and over-specification nugatory, why do we try so hard to plan to the last detail and then to follow that plan at all costs? There are many published answers to those questions but a common theme is that we can better understand complexity through decomposition, thus minimising risk, controlling scope, and enabling measurement of progress. However, agile thinking recognises that changes throughout the project force scope control to be an ongoing task: project scope should only be defined as far as we are currently truly able to comprehend and prioritise it from the perspectives of value realisation and risk mitigation. We can then use project team (including the customer) learning for control and feedback. Thus we are compelled to treat the project as a process and not as a serious of pre-scoped milestones/ gateways.

Agile methodologies commonly control scope through the use of value prioritisation techniques, such as YAGNI (You Aren't Going to Need It) or MoSCoW (Must have, Should have, Could have, Want but won't get this time). Temporal control of projects is necessary because of budgetary implications and knock-on effects - Scrum and some other methodologies, such as Dynamic Systems Development Method (DSDM) use the concept of timeboxes (regular incremental deliveries) which are often rigidly enforced.

The emphasis therefore changes from delivery to a specification within a timescale and budget, to delivering emergent value within similar constraints. Many argue that such agile thinking should be restricted to small, low consequence projects. However, larger projects have been tackled, for instance with up to 800 developers within a 'scrum of scrum's. (Schwaber and Beedle, 2004) The following diagram illustrates the relative shifts between traditional and agile projects.

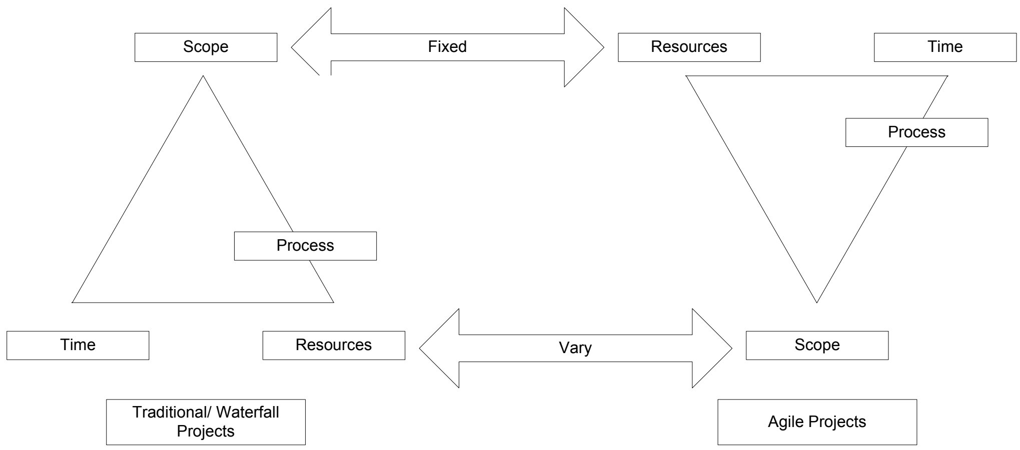

Figure 1: Changing from Traditional to Agile Project Management

Whilst this illustration can easily be mapped to any design or product development process, its application to production scenarios requires caution. For example, construction resources are unlikely to remain fixed if scope is changed.

4.2 Motivational Aspects

Another area of ongoing research concerns the motivational impact of agile processes. On initial review, methodologies such as Scrum and eXtreme Programming (XP) have common themes of limiting the outcome requirements of the team, whether in terms of scope, time or both. Further positive motivational effects of agile processes appear to include the rapid nature of the feedback mechanism, and the supportive nature of interference-free project management. Thus, at a personal level, it may be possible to more easily envision and achieve tasks, and to gain positive feedback.

In view of the stress on small, facilitated and empowered teams, McGregor's theory Y, participative management style is obviously more relevant to agile than theory X, authoritarian (McGregor, 1960). Ouchi's theory Z (Ouchi, 1981) attempts to merge the best of theory Y with modern Japanese management, adding a large amount of freedom and trust of workers. However, it also assumes that workers have strong loyalty and an interest in team-working and the organisation. Therefore, although theory Z management would prove a natural management fit with agile techniques such as Scrum, it fails to cross the cultural divide inherent in many western enterprises.

Whilst it seems probable that definition and facilitation of closer motivational horizons contributes to agile project success, further research is required on the relative efficiency of the different mechanisms employed. However, the following section on human dynamics seems to have a bearing on the effectiveness of such work organisation.

4.3 Complex Systems, Network Theory & Human Dynamics

The approach of management-as-organizing (as opposed to management-as-planning) takes the idea of human activity as inherently situated (Johnston and Brennan, 1996) and thus, planning should focus on structuring the environment to contribute to purposeful acting. In the language/action perspective, described by Winograd and Flores (1986), action is triggered by explicit commitments (promises) resulting from two-way communication. The scientific experimentation model of control, presented by Shewhart and Deming (1939), focuses on finding causes of deviations and acting on those causes. The scientific experimentation model thus adds the aspect of learning to that of control.

However, Ashby's Law of Requisite Variety (Ashby, 1956) shows that complex systems cannot be controlled through a centralised system: only variety can master variety, reducing disturbances and promoting harmonious order. Complex Adaptive Systems (CAS) developments build upon Ashby's ground breaking work, together with observations of the natural world, to provide us with an understanding of pattern emergence and the need for guidance frameworks, rather than rigid adherence to rules or plans. The very nature of the frameworks of CAS are being explored within network theory.

The overall behaviour of a complex system, which we ultimately need to understand and quantify, is as much rooted in its architecture as it is in the nature of the dynamical processes taking place on these networks. We are, however, at the threshold of unravelling the characteristics of these dynamical processes. (Barabasi, 2005b)

The Barabisi model of human dynamics leads us towards an evolving understanding of the nature of human decision making in terms of task prioritization and may eventually help explain why restricted task choice can lead to enhanced human efficiency (Vazquez, 2005). Barabisi raises *the intriguing possibility that animals also use some evolutionarily encoded priority-based queuing mechanisms to decide between competing tasks.* (Barabasi, 2005a) Human activity does not follow Poisson distribution but is of a burst nature, followed by a heavy tail; this behaviour is *rooted in the fact that humans assign their active tasks different priorities, a process* *that can be modelled as a priority queuing system* (Vazquez, 2005). In summary, Barabisi's research may explain why short time periods (such as Scrum Sprints) enhance task efficiency; however, the implications for agile understanding require further research in conjunction with motivational science.

4.4 Feedback & Organizational Learning

An area for future research concerns the nature and efficacy of feedback and organizational learning inherent in any iterative and incremental development process. Whilst the Toyota Production and Product Development Systems stress the importance of both organisational learning and individual training, the nature of the construction industry and its fragmentary and temporary employment patterns (particularly in the UK) mitigate against their effective employment with substantial industry change. Of particular interest is the extent to which value is added through the customer's own learning.

4.5 Metaphysical Underpinnings

Agile project management can be seen as 'management as organising' (Johnston and Brennan, 1996), indeed, an agile project manager is very much seen as a facilitator who enables small, self-organising multi-disciplinary teams to decide for themselves how they satisfy their value goals. Feedback loops in agile project management are used as a lens to focus and re-focus the required value delivery (they do not fulfil a thermostat model (Koskela and Howell, 2002) in terms of flow control).

Whilst a 'theory of agility' to sit alongside general theories of production and management is yet to fully emerge, it is also necessary to understand the deeper foundations, namely the metaphysical commitments underlying our approaches (Koskela & Kagioglou 2005). Since the pre-Socratic period of philosophy, there have been two basic views on the metaphysical (or ontological) question: What is there in the world? One holds that there are things, that is, atemporal entities in the world. The other insists that there are processes, that is, intrinsically temporal phenomena. These metaphysical assumptions tend to strongly influence how the subject of the inquiry or action is conceptualized. The thing-oriented view seems to lead to analytical decomposition, the requirement or assumption of certainty and an ahistorical approach. The process-oriented view is related to a holistic orientation, acknowledgement of uncertainty and to a historical and contextual approach. The theories discussed may be classified according to their metaphysical choices. Generally, the traditional approach is characterized by a substance (or thing) based ontology, whereas the new approaches subscribe to process ontology. However, the ontological choices affect the practical procedures not only through the mediation of theories, but also directly. A project is, of course a process and fits neatly in the area of process metaphysics in the following diagram, however, agile thinking and processes cover both management and production theories. Only once an underlying theory of 'agile' has been resolved can we add this to such a diagrammatic summation of knowledge.

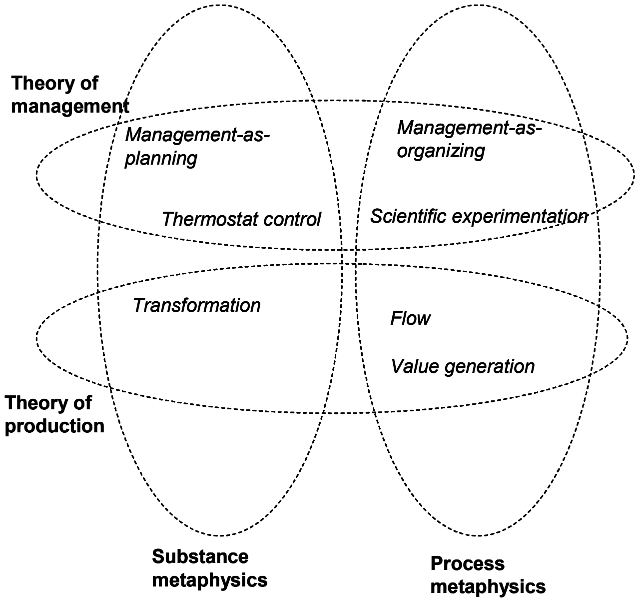

Figure 2: Metaphysical assumptions divide theories of production and project

5 THE APPLICABILITY OF AGILE PROJECT MANAGEMENT TO CONSTRUCTION

As Scrum can be considered as a 'management tool' (Boehm and Turner, 2004), it can be easily used beyond information systems (its origins lie in Japanese manufacturing product development). Similarly, DSDM has been used in organisational development and infrastructure projects and even in construction (Stapleton and Consortium, 2003). However, these ad hoc uses are not widespread and barriers to wider adoption within the construction industry remain.

It has been stated that the prevalent theory of construction is a hindrance to innovation (Koskela and Vrijhoef, 2000), thus calling into question whether agile project management could be adopted in this domain. Also, the scale of any potential improvements in value delivery within the construction industry and resulting economic, utility, environmental and aesthetic benefits remains the target of further research. Current construction industry structures, developed partially to ensure contractual risk avoidance (at least in the UK) appear to be incompatible with Japanese collaborative trust and corporate and individual learning models. There thus seem to be barriers to the employment of agile project management methodologies and thought processes, in view of their inherent requirement for trust and appropriate risk apportionment (i.e., from a value maximisation, rather than a(n apparent) financial risk management perspective). However, the similarities of the two industries suggest that agile would offer enhance project values, should adoption prove feasible.

5.1 Information Systems & Construction Industries - Differences & Similarities

Both the information systems and construction industries use essentially a design and product development process, with limited, tailored re-use of designs and components. Whilst there is some productionisation within construction (e.g. build to print) and information systems industries, this is atypical. In both domains value is only truly realised during use, although it is generally easier for an 'outsider' to envision the functional constraints and opportunities of a building than those of an information system.

One of the common areas between the two domains is the need for requirements definition. In construction *briefing must be seen as a process not an event* (Barrett et al., 1999) and there are tentative moves towards dynamic briefing throughout the project (Othman et al., 2004), a particular need for which is seen in the internationalisation of construction projects (London et al., 2005).

Whilst the need has therefore been recognised for what is essentially an emergent agile value development process, progress in its use has not reached the levels of use discussed for information systems projects. Although it has been reported that approximately one third of information systems organisations still use waterfall methods (Laplante and Neill, 2004), another survey reported that over 95% of respondents would continue to use or would adopt agile processes in 2003 (Shine, 2003).

6 CONCLUSIONS

Agile thinking has a sound basis in both project management and manufacturing in Japan and is currently yielding improved value delivery in the information systems industry. Although a common view of agility is not extant, the core attributes can be clearly stated. The structuring of an enterprise or project to enable it to proactively respond to change and to welcome the opportunity that such change affords to increase value delivery may well be challenging. However, there are many apocryphal stories of successful improvements due to the adoption of agile and even some metrics.

Whilst agile project management in information systems has obvious parallels with the design phase of construction, there are considerable differences in the respective production phases which must be further explored as the underlying rationales for why agile works are better understood. These underlying rationales include the manner with which agile deals with emerging requirements, how individuals are better motivationally organised to produce value, how the structure of work affects outcomes and the manner in which it supports organizational (including customer) learning. Bearing in mind agile's emphasis on 'the individual over process', the field of human dynamics bears further research.

Projects tend to be complex by their nature and it is necessary for humans to manage that complexity in a manner that will deliver the required end result with some degree of certainty. It may be that, by decomposing customer-recognisable value rather than the fragmentary components of a project we maintain greater mental awareness of the process, rather than devoting our efforts to produce some'thing' of immediate import. However, further research is necessary to validate such a hypothesis. A theory of agile has yet to be resolved; however it must fit within current theories of production and management, and their underpinnings.

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AN INVESTIGATION OF PROJECT SUPPORT OFFICE (PSO) IMPLEMENTATION ON PROJECT MANAGEMENT MATURITY (PMM)

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ABSTRACT: A number of drivers led to an Arms Length Management Organisation (ALMO) to seek to improve their project management capability. Different options were considered and after discussions with Leeds Metropolitan University's (LMU) Centre for Project Management (C4PM), a partnership was established. This provided staffing for a temporary one year Project Support Office. The intention was that the PSO would provide and independent but supportive project management presence. The initial work around baselining the organisation's project management capability will be considered along with the derivation of a realistic strategy for a phased implementation of the PSO initiatives. The current status, one year after the start of the project will be examined, along with the lessons learned and opportunities for the future of the partnership.

Keywords – project management, project management maturity / capability, project support office

1. BACKGROUND

In order to be more competitive and address the government directives, such as the Latham (1994), Eagan (1998) principles and the more recent Office of Government and Commerce (OGC) (2005) management best practice initiatives. Construction sectors, especially the public sector organisations have seen the need to develop their project management capability. As construction organisations have moved towards more formal project management process, a need to maintain, support and increase project management capability is seen as important in maintaining and improving competitive advantage (Crawford, 1998). Formal project management as a science has evolved since the 1950's. Engineering, construction and information technology sectors have been involved with and continue to develop the profession (Barnes, 2002). Project management is perceived to add value to a project in terms of cost quality and performance (Lock, 1996). Authors suggest that organisations, which implement project management best practice, can expect to achieve an enhanced level of project success (Barnes, 2002; Reiss, 1998). However the level of success would be dependant upon the level of project management capability that the organisation has. Project management capability can be achieved in a variety of ways. Some organisations would initiate training programmes for their project staff, others may initiate new initiatives within the project management area to support and develop capability. A more recent development within project management is Project Support Office (PSO). A PSO is described as supporting infrastructure to maintain and improve project management competency (Marsh, 2002). This paper is based upon an ongoing research project, which is investigating the implementation of a PSO and assessing the impact upon the organisations project management capability.

The research is located in the Centre for Project Management (C4PM) at Leeds Metropolitan University (LMU). The C4PM, through its links with organisations and the project management community realised an opportunity to develop the research proposal, within this new project management area.

A fledgling public sector organisation, which delivers reactive and responsive maintenance programmes within the social housing sector, approached the C4PM and requested assistance with project management. The discussion between the C4PM and the organisation led to an initial request for assistance with project management, particularly the project planning area and project management software training, for key members of their project staff. This afforded the ALMO with some exposure to project management planning techniques. Consequently, the ALMO was about to undertake a government audit that would benchmark their performance as an organisation. This factor also led to the requested to support project management generally and not just project planning. The audit suggested that they 'project monitored' not 'project managed' their projects. The audit was integral to the amount of budget, which the ALMO received from the government for the delivery of the social housing projects. Other factors drove the ALMO to request assistance with project management capability, these were the need to be competitive within the open market as the principle of the ALMO was to deliver project as if they were a private sector organisation.

The initial talks with the ALMO led to the researcher being embedded within the organisation for an interim period of one year. This position was to be a supportive presence for the project management delivery. As suggested above a new development within the project management arena is the Project Support Office (PSO). This partnership afforded both the ALMO and the University with a valuable opportunity to investigate the effects, which a PSO would have upon a new organisation's project management capability.

2. LITERATURE REVIEW

As suggested formal project management has evolved from the engineering and construction industries and later developments were in the information technology industry. Barnes (2002) suggests that this management science is focused around the delivery of change. He goes on to suggest that the science will continue to develop whilst people and organisations recognise the value of it. Some construction organisations recognise that when formal project management is implemented to assist in the delivery of the projects, it could improve the potential for successful delivery of the product and improve competitive advantage (Bredillet, 2002). Although some construction organisations use project management for the planning and communication of the operational delivery of their projects, for example Gantt Charts (Justice, Bates and Whitehead, 2003). The case study recognised the need to improve their overall project management capability.

Project management will continue to evolve as the construction sector continues to develop, the use and application of project management and related management techniques. Kerzner, (2002) and Burke, (2003) agree and suggest; it offers a structured approach to the management of projects. They describe project management as the development, control, and delivery of a service or product within the specified time cost and quality. Disterer (2002) suggests that some organisations are fast to react to the developments and innovation that project management is creating for project-orientated organisations and that they are increasingly recognising the benefits derived from the development and implementation of these management techniques. Bredillet, (2004) concurs that organisations are evolving, for to a variety of reasons, and there is evidence of increasing use of formalised project management.

Arguably, the construction sector recognises the benefits which project management can deliver for their project environment. Some construction organisations utilise project management as an aid to planning the operational aspects of their projects. As they have moved towards more formal project management process, a need to maintain, support and increase project management capability is seen as important in gaining competitive advantage (Crawford, 1998). Consequently there are an assortment of project management training programmes and qualifications available to assist organisations with their project and organisational development. However, it may be necessary to support these new skills in a variety of ways, once the training and educating of staff is complete. Some organisations have recognised that a support facility is necessary to further develop and maintain the possible remuneration which training could have. Specialists and project management practitioners have developed a function, which could address this area. This recent development within the project management arena is the Project Support Office (PSO).

A PSO could, because of the supporting culture increase awareness of both operational and strategic project management. Block, (1998) and Block and Frame (1998) suggest that the justification for a PSO lies in the supporting of project management process as a whole and because of this the organisation's project management capability should improve as a consequence. Celand and Kerzner (1985)) exemplify this by suggesting that a PSO is an individual or a group of individuals authorised to speak for and support the projects, people and the process used for the delivery.

Marsh (2002) asserts that a PSO is a supporting infrastructure to maintain and improve project management competency. In organisations with some level of maturity around the delivery of projects there may be a comprehensive support function that undertakes the functionality of a Project Support Office (PSO). He describes a comprehensive PSO as the "*business function charged with providing the organisation with the necessary supporting infrastructure and services to ensure that its portfolio of programmes and projects are being effectively and efficiently directed, managed and delivered"*. Hill (2004) concurs and describes the potential significance of such a function in supporting and aligning project outcomes with the delivery of business strategy. Both Marsh and Hill assert that project support does not belong exclusively to organisations with well-developed project management. They suggest a PSO can attain significant advantages to businesses seeking to improve the effectiveness of their project delivery and capability (Marsh, 2002; Hill, 2004). Levin and Rad (2005) state that an organisation need not have a high level of project capability, as the PSO should provide an infrastructure to promote improvements within the maturity levels of project management. They go onto suggest that the formal implementation of a PSO would seek to promote and establish a framework for improvement of the project delivery in the organisation. They describe the benefits of the formal implementation process as "*an exceptionally effective unit in achieving organisational project management maturity"* (Levin and Rad. 2005, pg 1). The research investigated the effects that the implementation of a formal PSO had upon the project management capability of the ALMO. However literature about PSO is limited and based largely upon anecdotal evidence gathered by practitioners implementing the function. Although it could be suggested that the literature is not peer reviewed it is however a valuable source of data as practitioners could be described as specialists within the field and therefore would be experts within the management discipline.

Arguably, the project management capability of the organisation and the functionality of the PSO are intrinsically linked. The PSO should deliver enhanced project management capability for the organisation, thus elevating the probability of project success. The infrastructure of a PSO promotes the project management capability by supporting the development of project management competency. Levin and Rad (2002; p 181) suggest that the PSO infrastructure should include five key components to achieve success. They go on to suggest that these should be: the establishment of a vision and strategy for the overall concept of the PSO, the preparation and execution of a plan for the development of the PSO, the establishment of priorities which need to be addressed at the outset of development, the assistance of individual projects and the operation and maintenance of the PSO. However, these principles are based upon the implementation process following a structured format, which would have to be tailored to the organisational needs (Levin and Rad, 2002; Marsh, 2000; Cooke-Davies, 2002). Perhaps the benefits of incorporating a PSO's influence upon an organisations project delivery would have some impact upon the project management capability of the organisation. The principles of a PSO are to develop a framework for project delivery. The framework would support the project teams with the development of their projects and as such a new framework would not need to be developed each time a project was initiated. This would have the benefit of reducing the cost for the development and implementation of the project. However it should be noted that there are cost implications of setting up and establishing the PSO, although some organisations justify the initial coast against the benefits of the successful implementation that a PSO provides (Englund, Graham and Dinsmore, 2003).

The philosophy of a formal PSO, its infrastructure and approach denotes formality, structure and process. Levin and Rad (2005) argue that a PSO should be the foundation for development and innovation of the project management process. Moreover, the PSO should provide a mentoring, monitoring and measurement function, to facilitate the implementation of a continuous improvement process and to promote and develop Project Management Maturity (PMM). The Oxford English Dictionary (2004; p, 882) defines maturity as "*the state, fact or period of being mature*". The definition of maturity suggests completing a stage of development or competency. Arguably the PMM level of the organisation could impact upon the successful implementation of a PSO and the performance of the project management. Hill (2004) suggests that competency levels of a PSO are integral to the organisation's PMM level. He goes on to suggest that the higher the level of PMM the organisation attains, the greater effect this will have on the integration and development of a formal PSO. The case study organisation at the outset of the partnership, had a low level of project management capability and as a consequence measured maturity and project success around the of what denotes project success (i.e. time, cost and quality parameters). Hill (2004) suggests that this type of measurement would impede the progression of PMM and perhaps stifle the progression and development of a formal PSO. Some organisations are describing themselves as project-orientated; this would suggest the use and implementation of a project management process (Bredillet, 2004). Bredillet suggests that current academic and industry research is focused around the need to benchmark project management capability. He goes on to justify this by exemplifying Crawford's (1998) paper relating to her project management competence research which found that organisations measure maturity based on the assumption that maturity promotes success and success supports stability within a business environment. If organisations are successful within their project delivery, this facilitates competitive advantage and the probability of project attainment, which could lead to organisational success.

If as suggested by Crawford (1998) and Bredillet (2004) organisations are measuring performance to improve competitive advantage, the research sought to establish how organisations achieve project management capability and what impact the early development of a project support environment could achieve for them.

2. METHODOLOGY

The research methodology used was based upon the case study approach principle. The benefits of this type of approach are justified by Bryman (1992, p170) he describes the advantage as the ability of having *"a detailed investigation of one or two organisational examples"* he furthers this by stating that the development of the research aims, and recommendations, can be achieved in a structured and subject specific environment therefore affording and increased opportunity for arriving at conclusion which will benefit the continuation of future research projects within the discipline. The case study approach has allowed the researcher to get closer the aims and objectives of the research, by enabling the researcher to ask questions such as 'why' and 'how', characteristics also associated with case studies (Yin, 1994). As suggested by Leedy, (1997; p3) '*Research is the systematic process of colleting and analysing information in order to increase our understanding of the phenomenon with which we are concerned or interested'*. The research developed an understanding of PSO and project management capability within the ALMO's organisational use and operation. Assessing the current capability and aligning the findings with the theoretical aspects of PSO fuctionallity achieved this. As Levin and Rad (2005) and Marsh (2002) recommend a full spectrum of PSO functions is most effective, and the first stage of implementation will involve benchmarking the current project capability. This process formulated the foundation for mapping out the implementation strategy of the PSO, whilst assisting with the recognition of how the case study organisation integrated and developed project management skills and competency.

As highlighted previously the ALMO, at the start of the project was an embryonic organisation, which had been in operation for one year. This factor was taken into consideration within the benchmarking process, as the organisation had been formed from other public sector departments each with their own developed working practices. The impact of this information at the outset of the research afforded the researcher with some fundamental information necessary to start the development of the implementation strategy, particularly around the area of project management terminology.

Authors suggest to gain maximum benefit from a PSO implementation the process should be developed and delivered as a project (Marsh, 2000; Englund, et al; 2003). Levin and Rad (2002, p175) agree with this and suggest, *"attention should be paid to the project objectives in terms of administrative placement, schedule, cost and measurement metrics"*. A feasibility study was performed to assist with the development of the project plan and the recognition of the current capability. The project plan incorporated the overarching functionality of the PSO, which according to Levin and Rad (2002, p145) should, promote and advocate the project management culture by the way of showing tangible benefits to corporate strategy. It should archive and serve as a clearinghouse for project performance information. Practice and disseminate best practice procedures and guidelines. Train and provide ongoing training in all facets of project management.

Structured interviews were used to gain the information necessary to assess the ALMO's current project management capability; the interviews included the management team and key project staff of the case study. Structured interviews were necessary to mitigate against variations within project management terminology. The researcher interpreted anomalies within terminology by linking the answers to recognised project management language. This process also determined if an informal PSO was evident as Levin and Rad (2002) suggest the existence of an informal PSO would impact upon the project management capability and the starting point of the implementation process. Esterby-Smith, Thorpe and Lowe, (2003; p131) suggests that structured interviews should be formatted to enable the interviewee to feel comfortable and the researcher should avoid stating *"her own views"*, so as not to influence to answerers. This was necessary as suggested the ALMO was a collection of other departments form local government and as such each had developed their own terminology. Consequently the researcher sought to incorporate an informal environment to address these issues by including advice given by Moser and Kalton, (1971) they suggest that accuracy of the answerer to the question can be increased if the interviewer appears 'accepting' of the answerer. PSO authors suggest that questions linking to the development, tracking, controlling and performance of the project would be fundamental to the recognition of the project management capability at the start of the project (Casey and Peck, 2001; Hill, 2004; Marsh, 2000). The researcher incorporated this information in to the interviews to determine the level of project management competency.

Once the first iteration of the benchmarking process was complete there was an understanding of the current capability of the organisation. The current capability was at a low level of maturity generally. However there were some project management skills, for example risk management and performance measurements, which were of a medium capability. Hill (2004) suggests that the overall competency should be recognised and improvements incorporated into the whole spectrum of the organisation's PSO. He goes onto say that the lower level competency issues should be addressed first as the higher level capabilities would be supported by the developments and improvements of the latter. Consequently at the start of the development strategy the lower capability areas of the ALMO were project management knowledge, project planning, project brief definition, approvals procedures and recognition of what a project is.

The next stage was to formulate an implementation strategy using the information gained from the feasibility and benchmarking process. The implementation strategy also included current theory and principles around PSO, project management capability and how organisations develop their capability. The strategy incorporated an iterative approach involving stage gate approvals. Stage gate approval are periods within the project where the project sponsor and researcher can approve key millstones and assess if the project is delivering what it set out to deliver. Stage gate approval are integral to development and acceptance of organisational and business research projects as recommended by Eaden and Huxham, (1996) the involvement of the practitioner (in this case the ALMO) an in particular a close collaboration and acceptance between the researcher and the case study would facilitate a deeper understanding and development of the research topic. The approvals involved both the case study and the researcher. The iterative planning approach was developed by producing a project management approach, planning the implementation and including milestone dates and iterative review points. Stage gate approach ensured that the project remained focused to the aims and objectives and that the capability levels were observed, monitored, assessed and changes when arose were re-planned into the overall research strategy.

Each iteration required structured interviews to record and evaluate the changes and response of the case study. Although this suggests a quantifiable approach to the data collection, the data collected was largely of a qualitative nature and based upon anecdotal evidence, which was interpreted by the researcher to fit within the constraints of the literature available around the subject of the POS. Cunningham, (1995 cited in Saunders et al 2003) argues that the involvement of the practitioner, within the research, promotes a close relationship between the practitioner and the researcher *"for example academics or external consultants"*. Eaden and Huxham (1996) link the academic element of the research to formulating and developing the theoretical content of the research and that the external consultants will link the theoretical outputs to the transferring and sharing of knowledge for the case study organisation. The transfer and the sharing of knowledge is integral to the successful implementation of a PSO, as suggested by Marsh (2000) the PSO should be the focal point of support for the organisation and should form the foundation for knowledge sharing and best practice.

4. INITIAL FINDINGS

As stated above this is an ongoing research project that has initially been developed over a one year period. Authors suggest for an organisation to benefit both in terms of project management capability and the high level functionality of a PSO, the implementation process would take numerous iterations. They go on to argue that this process could take up to five years of development for the organisation to fully benefit (Levin and Rad, 2002; Marsh, 2000; Hill, 2004). Consequently the findings are based largely on the anecdotal and observational evidence up to this point. At the outset of the research project the researcher was a supportive presence, assisting with the project planning aspects of the day-to-day project management. A list of the ALMO's projects were developed, ranked and coded into project types, to assist with the recognition of projects. Marsh (2000) suggests that organisations with limited capability would benefit from this type of initial support. He goes onto suggest that assistance within the project planning area could support the organisation's project staff to accept the implementation and benefits of a PSO. However it became apparent that although project plans were being developed for specific projects and the researcher was supporting the development and implementation process, they were not being implemented or utilised, and the project staff continued to monitor projects rather than develop and manage them. This factor did however depend upon the position of management, which the project team member had. The higher the level of management the greater the acceptance of the project plans. Consequently the supportive presence became a negative rather than a positive factor. The project staff avoided the supportive influence to 'get on with their day to day activates'. Levin and Rad (2002); Williams and Parr (2004) and Englund e*t al* 2003, highlights avoidance by project staff as a problem with the setting up of a PSO. Marsh (2000) furthers the argument at although a PSO is a set of supporting ideas, tools and techniques that, at least at the opening of discussions and development, are not located in a new office and exist only as ideas can have a negative influence upon the hierarchy within a project organisation. He goes onto suggest that the PSO, which in some respects could be seen as a departmental approach typical of a pre-project organisation, may bring with it the political machinations normally associated with a functional organisation. Marsh (Oct 2004) exemplifies the argument by stating that politics and acceptance within the implementation of a PSO centre around the management understanding of what the PSO should do, who will own it, and where the power base lies within the function.

The researcher considered this factor and arranged a development workshop to inform the ALMO staff as to the concepts and functionality of a PSO. The workshop benefited with the communication and acceptance of the project by allowing the participants to be involved with the project. Turner, J. R. Grude, K, V and Thurloway, L. (1996, p13) argues that when people are faced with change they can lose focus on *"what it is we are trying to achieve"* (in this case a supporting network and culture to enhance project management capability). He furthers this by suggesting that by involving the participants within the devolvement phases and allowing them to have *"a say"* in what happens could reduce the risk of non-acceptance for the project. The acceptance of the participants was fundamental to the implementation strategy developed to implement the PSO principles and this factor became an important feature for the next phase of the project.

Once the workshop was completed, a priority list of the requirements was developed including some of the requirements of the participants. The Chief Officer (CO) requested support with the recognition of when "Mrs. Smith, of Bancroft Drive would have her windows fitted" and most of the organisation requested a standard approach to project delivery so that information could be shared between different projects. This was a turning point for the research. It became clear that the anomalies within project management terminology were causing misunderstandings with project information; Hill (2004) argues that a standard approach to project delivery and terminology around the discipline would assist the organisation with progression and development with both PSO incentives and project management capability.

This new information assisted with the development of the next phase, which was a supportive presence with a major merger project. The ALMO was to merge with a citywide twenty-four hour social housing responsive repair unit. This project was to be planned, tracked, monitored, and reported upon by incorporating formal project process, supported by the functionality of a PSO. Using the information gained from the workshop a realist project plan was produced, involving the project team. The literature available substantiated the results of the project, as it was evident that by involving the project team and capturing their knowledge around the operational issues the project delivery increased in capability (Marsh 2000; Hill, 2004). Moreover, supporting them with the project management process and terminology afforded cohesion within the delivery of the project. Consequently, although some of the project team could not 'see the relevance' of a project start up meeting, they commented that they had 'gleaned' relevant information to assist with the development of the project strategy. At milestone meetings it was apparent that the general knowledge around project management had improved and that the project team were *"cohesive and talking the same language"* (Chief Officer, 2005; unpublished).

As discussed the CO and members of the project team commented at the post project review meeting that they were motivated by the fact that they understood 'why' they were using a project management and supportive culture. They were surprised that they understood some (if not all) of the project management terminology and they could now see the benefit of why project plans are produced, tracked, monitored and reported upon. Arguably, the literature available supports the initial findings. Marsh (2000) argues that the key word within PSO is Support, as it promotes motivation and acceptance of project management and with these principles in place and a continuation of strategy, the organisation should expect continuous improvements within their project management capability. Thus, maximizing the potential of sustaining competitive advantage for the organisation.

5. CONCLUSIONS

The research project sought to investigate what impact the early implementation a PSO would have upon the organisation's project management maturity. The researcher analysed the available primary data, in conjunction with the secondary data (up to the present time) and the findings can conclude that, the implementation of a PSO does have a positive impact upon project management capability. However, this is an ongoing research project, which requires further investigation, analysis and discussion to validate the findings.

The initial findings suggest that; support, mentoring, coaching and knowledge sharing are integral to a successful implementation programme and an increase in project management capability. Organisations with a low level of project management maturity require a supporting network to facilitate the implementation programme of the PSO. Moreover that the PSO is the central point for knowledge and project management best practice. A PSO which does not advocate support as the key function would impede the implementation process and the possibility of success for the organisation.

Arguably, the supporting presence of the researcher allowed the organisation's project staff to be guided and mentored throughout the delivery of their projects. The introduction of standard project management terminology raised knowledge and confidence of the project staff (this was evident from the results of the structured interviews). The researcher introduced, structure, a standard approach and stages within the development process for approval points and dissemination of project information to key stakeholders. The overarching functionality and benefits of a PSO suggest that structure, a standard approach to the management of projects and support with the decision making process is fundamental to improving project management competence.

The case study recognised that an increase in project management awareness had occurred, however it is essential that the supporting influence/network continues to develop the PSO principles and assist the case study with the continued implementation programme. Support is necessary during the implementation process to guide, mentor, coach, train and disseminate and capture appropriate knowledge. Without an individual or team supporting and/or delivering the implementation strategy the momentum would be lost in the 'day-to-day' activities of the organisational projects. However, the research findings highlighted that an office or department delivering the changes are not necessary for success, an individual or champion could oversee and support the culture and perhaps minimise the opposition from the participants to the new management process. A new office or department may be seen as competition for the existing project teams, whereas an individual can integrate with and support the existing teams.

Although, the case study's project management capability did not increase from level one to level two of the maturity model. Certainly, there was an improvement to areas which had previously registered low, examples of which are; clarification of briefing process, recognition of what a project is, an increase in understanding of project management terminology, an increased understanding of project management process and an understanding of the importance of a standard approach to the delivery of projects (as highlighted in section 4). Other areas which the case study had an unconscious competency level (are not aware of being competent in a process) also improved due to the principles of the PSO implementation, these were; risk management and financial costing and reporting.

However, the findings would require continued investigation and analysis to substantiate the initial findings of the research. Although the organisation and researcher recognise that improvements have been made to the overall competency levels, the next stage is to incorporate a formal methodology for the case study's project development and delivery. The next phase is intended to continue improvements and support the organisation and provide the researcher with some quantitative data for analysis. As discussed in section 3 the research to date has been validated using anecdotes, personal experience and practitioner views, all of which have been valuable evidence and information. However the research would benefit from empirical data, as this would give the project validity within this new area of knowledge. The case study has recognised the benefits, which a PSO can evoke and have requested an ongoing presence for project support and assistance with the strategic planning for future of the organisation.

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REAL-TIME RISK MANAGEMENT APPROACH TO CONSTRUCTION PROJECTS

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Abstract: If things can go wrong on a construction project they will. With effective real-time risk identification and management we can mitigate the effects of such events. Both public and private sector clients of the industry have become more aware of the effects of risks on the industry and have reduced their margins for error and therefore seek a maximum level of accuracy and precision. In order to achieve these tight margins management of the project are forced to employ a wide range of risk management approaches.

The tools and techniques in use for identification of project risks in the construction industry range from desk based, in the form of computer programmes to workshops and site applications or combinations of various tools which this paper critically evaluates. Based on the survey conducted in the UK construction industry, it has been established that among the various tools and techniques interviews, workshops, brainstorming master-programme, personal experience and checklists are more acceptable than the others. This paper evaluates the tools and techniques in terms suitable stages of application, cost, ease of use, flexibility, reliability and accuracy.

Key words: real-time risk identification, assessment, evaluation and mitigation

INTRODUCTION

In construction projects risk can generally referred to as any development in the course of executing the project that has a detrimental effect on the cost, quality, health and safety of the construction operatives, and the project in general. In other words risk remains as the possibility of an undesirable outcome from a project. Containing costs, staying on schedule and minimising risks are essential to project success and profitability. It all comes down to the level of control exerted by various experts. Criticism and comments of the experts in the construction industry make clear that there is need for the industry to tackle some issues to provide solutions to the problems face by the clients of the industry. In view of that this paper seeks to address one of the major problems constituting concern to the industry - namely real time risk identification.

Latham (1994) suggests that no construction project is risk free. Risk can only be managed, minimised, shared, transferred, or accepted: it can not be ignored. In response to Latham's argument, this research identifies that risks can be minimised, shared, transferred or accepted if properly identified. Therefore the challenge to the industry is to find ideal tools and techniques to identify risk(s) as the first step.

Ahmed *et al.* (date unknown) accept that construction per se is a risk-prone industry, with a poor track record of coping with risks, as a result of which the clients have been enduring the agonising outcomes of failure in the form of unnecessary delays in project completion, cost surpassing the budget and sometimes failing to meet quality standards and operational requirements.

Taking it from where Latham and Ahmed *et al.* left it, this paper therefore suggests that effective identification, analysis and management of construction risks remain a big challenge to the industry.

In construction projects, it may be argued that success now hinges on risks management and maximising opportunities. The success may be subject to the ability of the project manager to identify the project risks, evaluate and decide on strategies for keeping them to a tolerable and acceptable level to all project stakeholders.

In order to achieve effective real time risk management, there is a need for the proper evaluation of the various available tools and techniques that are in use by project managers in identifying risk efficiently by conducting a survey to collect the opinion of the practitioners.

RATIONALE OF STUDY

Based on the outcome of various reviews by Egan's "Rethinking Construction", Latham's "Constructing the team" and Fairclough's "Rethinking Construction Innovation and Research", it is understood that along with the tri-axial factor (cost, quality and time), health and safety are the big construction risks that occur as a result of deficiencies in the real-time risk identification process. These result in the clients of the construction industry spending huge amounts of money and time to undo project failures; which can be minimised if the project team devotes sufficient time to identifying the project risks. This can be achieved through the use of efficient tools and techniques available to the project team. All construction projects are prone to risks that may affect their costs, quality completion time, and health and safety of the operatives. Effective risk management relies on efficient identification of those risks and implementation of an action plan to manage and control the risks during the life of the project.

This paper seeks to fill the gap left by various researches in risks identification by providing ideal tools and techniques that will aid the project managers to identify risks in construction projects. This is in order to discover sufficient means of identification, analysing, accepting and managing risks. It will also address the issues that may be considered by the project managers when assessing the suitability of tools and techniques for analysing risks before accepting them.

RISK

Kerzner (2003) define risk as a measure of probability and consequence of not achieving a defined project goal. Ray (2003) in a broader perspective describes risk as the possibility of an undesirable outcome from a project. Such undesirable outcomes include exceeding budget, overrunning the completion schedule or delivering an unsuitable product. One or the combination the above outcomes can be severe enough to negatively impact an entire business enterprise. MJY Team (1997) sees risk as the possibility of suffering harm or loss.

Having established some opinions about project risks, this paper defines risk as any unexpected or unwanted project development that will affect or disrupt overall planning, coordination and control of activities or entire project. This affects the principal aim of meeting the client's and stakeholders' requirement and expectation of producing a functionally and financially efficient project in terms of cost, quality and time, environmental impact, and health and safety.

REAL-TIME RISK IDENTIFICATION

Real-time risk identification is a vital activity for effective risk management; it prepares the project team for the uncertainties which lay ahead in the course of executing a project with the important aim of not to miss any risks out.

Ward and Chapman (1995) suggest that it is often said that the real risks in any project are the ones that the project team fails to identify. This suggests that the project team have a broad scope when attempting to identify potential sources of risk and thereby reduce the chance of overlooking important areas of risk.

Jenkins (1998) explains that risk identification at the operational level is very effective and can help with on-the-spot improvements and day-to-day management. It is usually a tractable, qualitative process. At the other end of the scale, risk identification at a strategic level can also be done in a very qualitative and broad brush way. The real difficulty is the next step of making the links between risks at all levels and across interfaces.

Tasmania (2002) also suggests that before risks can be properly managed, they need to be identified. One useful way of doing this is defining categories under which risks might be identified: for example, categories might include corporate, health & safety, financial and system risks. These can be broken down even further into categories such as environmental, economic, human, etc. Another way is to categorise in terms of risks external to the project and those that are internal.

This paper suggests that real-time risk identification is an essential methodical process to achieve effective real-time risk management. It sets out to identify likely project exposure to uncertainty or what can go wrong in the course of executing a project. This requires sound knowledge of the project, organisation, the market within which it operates legal requirement, health & safety, social, political and the cultural environment in which the project exists. In other words, the term encompasses strategic and tactical level risk identification.

REAL-TIME RISK MANAGEMENT

Risk management may be defined as a process of controlling the level of risk and to mitigate its effects. Angelo and Day (2001) see risk management as an important part of any project. The proper management of risks limits delays, budget overruns, and claims between parties. Nummedal et al.., (1996) see it as a systematic approach for identifying, evaluating and responding to risks encountered in a project. Some contractors think of risk management as insurance management where the main objective is to find the optimal economic insurance coverage for the insurable risks while Kerzner (2003) did not limit risk management to insurance, he defines it as the act or practice of identify, analysing, and evaluating risk. Dealing with risk involves planning for risk, assessing risk issues, developing risk handling strategies, and monitoring risks to determine how they have changed.

Filling the gap left by various definitions of risk management, this paper defines real-time risk identification as the act or practice of identifying, analysing, evaluating, mitigating and dealing with project risks. Dealing with risk involves planning for risk, assessing risk issues, developing risk handling strategies, and monitoring risks to determine how they change. Figure 1 below illustrates real-time risk management concept.

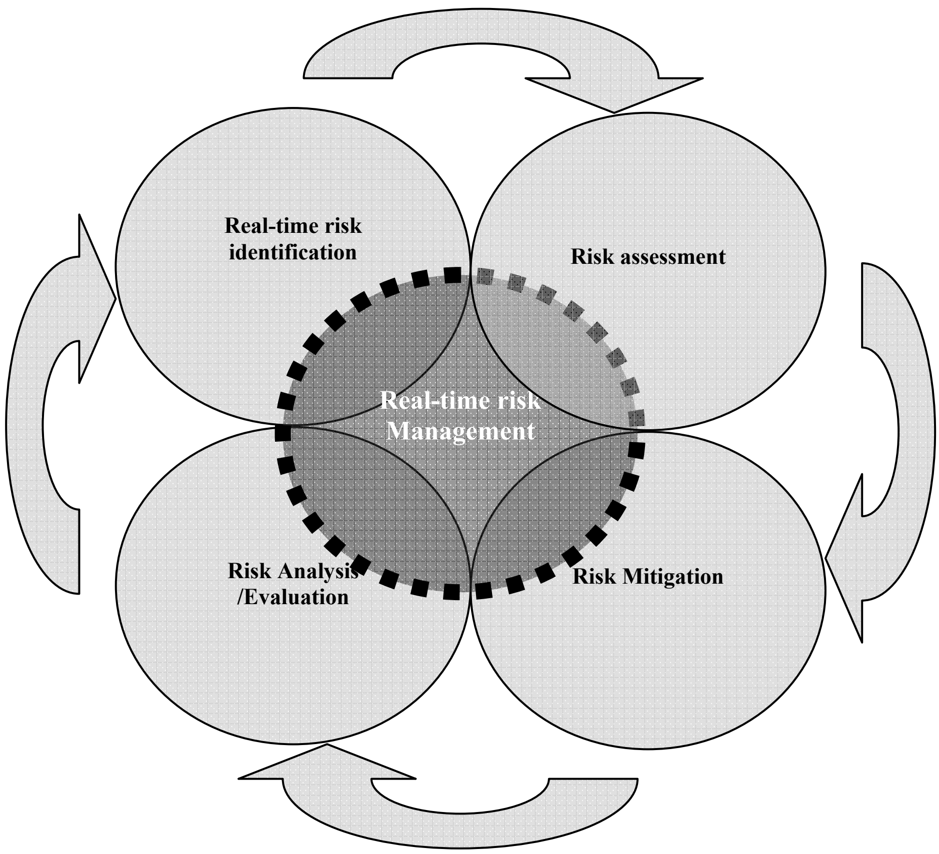

Figure 1: real-time risk management model

In essence, risk management has a broader meaning it should be a qualitative or quantitative, systematic approach for managing project risks. It should deal with both insurable as well as uninsurable risks and the choice of appropriate identification tools technique(s) for dealing with these risks.

Jenkins (1998) suggests that being in business is all about taking risks and maximising opportunities. The core skill of managers is to be able to identify, evaluate and decide on strategies for keeping risks at a level which is tolerable to all stakeholders at proportionate cost.

RISK IDENTIFICATION TOOLS AND TECHNIQUES

There are a number of techniques that can be used in identifying project risks, the ideal ones are probably to use a combination and work with outsiders as well as people who are involved in the project and know it well. Useful techniques include various brainstorming methods as well as systematic inspections and process analysis. Risks can be identified using various techniques at various points or stages of the project life cycle; these techniques include but are not limited to the ones in the figure 2 below:

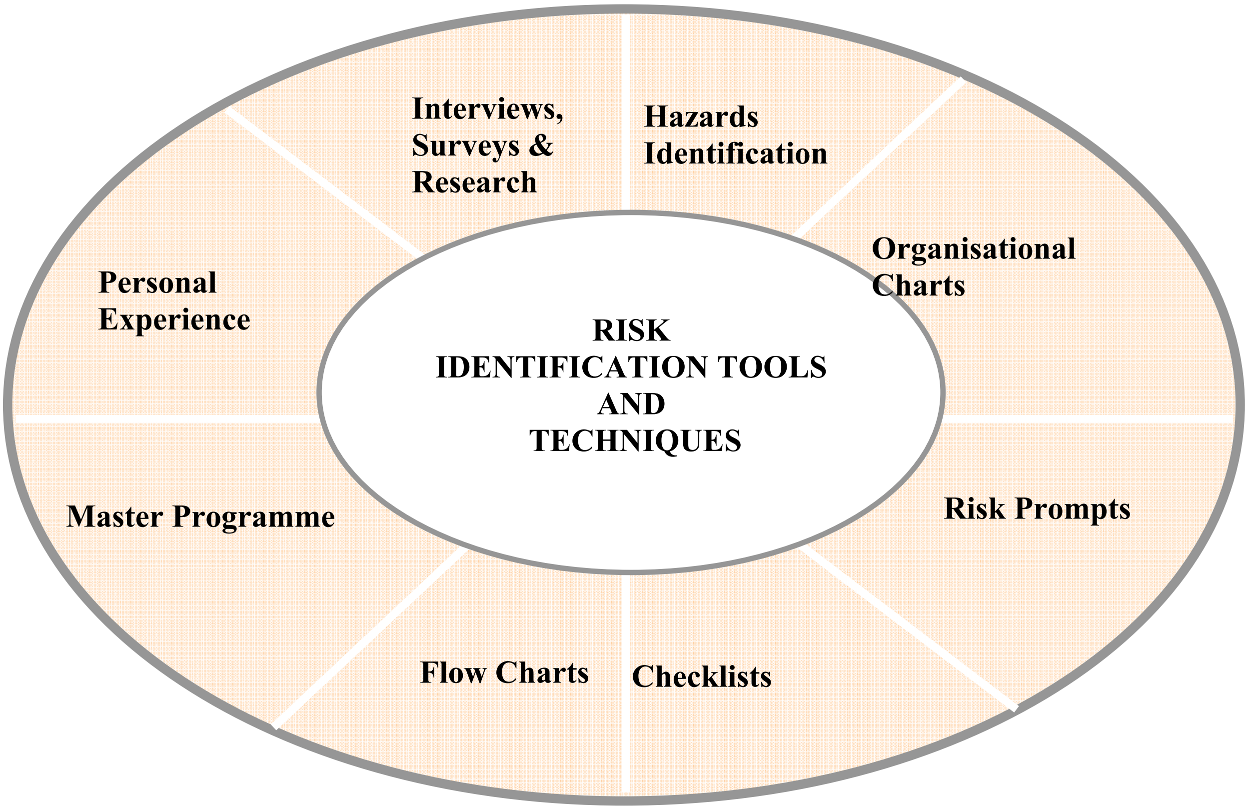

Figure 2: *Risk Identification tools and techniques*

Personal Experience

This method of identifying risk relies on the expertise, knowledge and experience of the project managers and other personnel in the project organisation. Tweeds (1996) suggests that in construction projects that however schemes are usually unique and different, thus the experience gained from one project can only be transferred to a limited degree to another. This approach usually encounters cognitive limitations due to the potential biases associated with the views of individuals.

Interviews, Surveys and Research

Jones (1998) observes that interviews, surveys and research can provide information on the number and nature of specific project risks. With regard to a specific type of construction risk, he further argued that some of the construction risks relate to geophysical conditions. Therefore more work on understanding those conditions will lead to a reduction of the risks through a better assessment of the costs likely to be incurred as a result of construction in those geophysical conditions. Interviewing the project personnel and stakeholders from every construction discipline, staff within organisation who have experiences of similar projects ensures that corporate knowledge and personal experiences are utilised in the process of identifying risk.

Smiths (2002) accepts that this technique allows project personnel to have their say about the risks they anticipate in the project, and gives them a feeling of involvement in the process and ownership of the identified project risks, which will lead to greater acceptance of any risk mitigation measures implemented. Jones (1998) accepts that, apart from physical observations, other data acquisition methods include one-to-one interviews, questionnaire surveys, observations, etc.

Master Programme

Master programme can be used to identify the major sources of risk. Hayes *et al.* (1986) suggests that project managers will find it useful to develop their own detailed list based on their own experience in the type of projects with which they are usually concerned. The risk identification here is done by checking the detailed construction programme to identify the risks at the dependencies from one stage to another.

Checklists

Dickson (1987) discusses that checklists are cheap, simple, adaptable, and allow for comparisons to be made between different sets of data. On the other hand, the production of generic checklists can be slow and lead to ambiguous results. Carter *et al.*., (1994) suggest that the completion of the checklist does not guarantee thoughtful answers. Heemstra and Kusters (1996) explain that the use of recorded information in the form of checklists can help in the identification of risks.

Simister (1994) notes that checklists were frequently utilised by project risk analysis and management (PRAM) practitioners. Uher and Toakley (1999) also found this method to be in common use in Australia.

External Consultation

In some specialised projects, experts are consulted when their knowledge is thought to aid the identification of project risks. Carter *et al.*., (1994) however point that external consultants require time to fully understand a new setting and often leave with their expertise after the assignment.

Risk Prompts

Simon *et al.*, (1997) are of the opinion that risk prompts are used to jog memory. They consist of open-ended questions that can assist in the identification of risks in a certain aspect of a project. Risk prompts are similar to checklists; but prompts are more generic and thus fewer in number.

Assumptions Analysis

According to Simon *et al.* (1997) at the project definition stage, many aspects of the scheme will either be unknown or uncertain. Assumptions are then made to enhance a decision on whether the project should proceed or not. These assumptions can be used as a means of identifying the risks (uncertainties) surrounding a project scheme.

Organisational Charts

Dickson (1987) argues that organisational charts can show areas of work duplication, concentration and dependencies. Conrow and Shishido (1997) explain that organisational charts can also help to identify the structure that is in place for managing risks in the endeavours of an organisation

Flow Charts

Dickson (1987) also suggests that flow charts depict the sequential flow of activities in the practices of an organisation While flow charts in themselves do not identify risks, they can be used to ask 'what if' questions; leading to the identification of the risks posed by different activities, personnel, machines, etc. Flow charts are commonly used in construction practice (Uher and Toakley, 1999).

Hazard Identification Studies

Dickson (1987) argues that hazard identification studies utilise prompts to identify risks or hazards and aid decision making, especially at the planning or design stage In such studies, the different ways in which an activity or component could deviate from a planned course of action are explored in order to provide a basis for pre-emptive action. Hazard analyses are 'largely unknown' amongst Australian contractors (Uher and Toakley, 1999).

FRAMEWORK FOR SELECTION OF REAL-TIME RISK IDENTIFICATION TOOLS AND TECHNIQUES

Real-time risk identification is double-edged technique for use at various stages in construction of construction project. Based of the survey conducted, it has been discovered that the under-listed tool and techniques are more acceptable and widely used in real-time risk identification. The analysis is carried out using the indices of cost, simplicity in use, flexibility, reliability and accuracy.

Below are useful frameworks developed from the statistical analysis and evaluation responses from a questionnaire base survey conducted on sixty selected construction companies. Table 1 (below) seeks to evaluate the real-time risk identification tools and techniques within the various stages/ phases while table 2 evaluated the tools and techniques within bounds of important consideration of cost of application, simplicity, flexibility, reliability and accuracy.

Framework Based on the Adequacy Analysis Responses	Conception	Inception	Feasibility	Briefing	Design/ Construction
Interviews/surveys					
Workshops sessions					
Site visits					
Brainstorming/ Intuition					
Master Programme					
Personal experience					
Checklists or prompt words					

Table 1: Selected tools and techniques and their respective stage of use

The shaded portions if interpolated indicate acceptance of the tool and technique for the respective stage.

Tools and Techniques	Expense (cost of use)	Ease of Use (simplicity)	Flexibility	Reliable	Accurate
Interviews/surveys	**Cheap**	**Simple**	Not	**Yes**	**Yes**
Workshops sessions	Expensive	**Simple**	**Yes**	**Yes**	**Yes**
Site visits	**Cheap**	**Simple**	**Yes**	**Yes**	**Yes**
Brainstorming/ Intuition	**Cheap**	**Simple**	**Yes**	**No**	No
Master Programme	**Cheap**	**Simple**	No	**Yes**	No
Personal experience	**Cheap**	**Simple**	No	**Yes**	No
Checklists or prompt words	**Cheap**	**Simple**	**Yes**	**No**	No

Table 2: Factors of consideration to select a tool

Looking at the tables above, this paper suggests that to achieve real-time risk identification and management, if any tool fails 2 out of 5 should be replaced with another more effective one; that will be in terms of stage of use and expense, simplicity, flexibility, reliability or accuracy. The tools take fail only 1 out of 5 can be used but it may not be as effective as the ones with score of 5 out of 5.

CONCLUSION

Real-time risk identification and management requires experience of construction team and cannot be done by one person alone, forming the right team to identify the risks demands a serious investment of effort, time and selection of the right tools and techniques.

To be fully effective and efficient, real-time risk management needs to address the whole project life cycle. The scope and depth of analysis should increase as the project progresses toward the construction stage, it is important that prior to each stage a preliminary risk identification and analysis should be taken. Real-time risk management is an integral part of project management designed to accommodate the focus of each stage in an integrated manner.

From a system approach, any activity on a project is a reference point in a larger system affected by the wider system (whole project) with potential to affect the delivery of the wider system. One of the implications of risk management is the degree of interdependency between (component) projects, the need for sound risk management approach to address the overall system increases dramatically as the interdependency between projects increases.

The paper discussed about concept of real-time risk identification and management and explored the available tools and techniques in use in the construction industry for identification of project risks in the construction industry.

Recommendation for Further Studies

In view of the dynamic nature of technology in construction and the demand of clients for higher quality and more value for money, these translates to need for perfection and precision in our approach to the techniques, methods, and tools in use (for risk identification and management) to enhance our abilities to identify and manage project risks. Such tools and techniques span traditional areas such as cost estimating and quality assurance to less traditional ones such as organisational behaviour and personal risk aversion.

As the project demands become more sophisticated, these tools may not stand the ever-increasing demand and sophistication in technology (which goes along the same direction with projects risks) of the project demand, thus there is need for the industry to search and research, view and review for the variables that will lead us to the development of more efficient tools and techniques for risks identification. There are still more efficient tools and techniques waiting out there to discovered and put to use.

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INFORMATION TECHNOLOGY PRODUCTIVITY PARADOX

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ABSTRACT: The paper looks at the development of the Information Technology Productivity paradox by examining the viability of IT investment and its impact on productivity. The work in this area will be critically examined in order to establish the patterns associated with IT investments and their impact on productivity and investigate the sources of productivity paradox. The paper will also reveal the main issues that are considered as the source of the conflicting views within the research community in this area. The work in this paper is part of a broader research project, the aim of which is to develop an operational framework regarding impact of information technology on productivity. The resulting framework is intended for exploitation by the developing countries by learning the experience of developed countries Particular reference will be made to Botswana where information and communication technology infrastructures are fairly developed**.**

Keywords – Developing countries, Information Technology Investment, Information Technology, productivity paradox.

Key:
IT – information technology
ICT- information and communications technology
EPR- enterprise resource planning
ITS- integrated tertiary software
EFQM - European Foundation for Quality Management

1. INTRODUCTION

There has been a lot of debate regarding the impact of IT investments on productivity. The majority of literature indicates that there has not been any conclusive result in proofing or disproving whether IT investments leads to productivity gains. Interest in the impact of computers in organisation increased significantly in the 1980's. (Brynjolfsson and Erik, 1998) are among the researchers who did a lot of work in the subject. However, research did not lead to conclusive results on the economic value of IT. The debate and research was propelled further after the Nobel Prize economist Robert Solow summarised the problem by stating that "We see the computer age every where except in the productivity statistics" in the New York Times Book review in July 1987. Solow's statement received wide coverage in the media. Ives (1994) called IT professional to understand issues relating to productivity paradox so that knowledgeable contribution can be made to the issue. This lack of consensus has been referred to as information technology productivity paradox (Oz, 2005).

This paper forms part of a broader research project, which looks into the impact of ICT application in performance of government departments of Botswana. The focus of the paper is a critical evaluation of literature on the issues about the information productivity paradox. A global view of literature is taken and this will form the basis for determining the appropriate conceptual model that can be used in Botswana. The literature review has shown results of research that has been done in western countries. There is very little work on the impact of IT in developing countries. However, developing countries have also invested in IT. Countries like

Botswana have IT budget currently at 3.7% of the total budget (Table 1). Previous research was done before the internet exponential growth. The internet, which is one of IT applications, has revolutionised the world through e-commerce, e-learning etc. These concepts were not developed during the era of intense debate about IT productivity paradox. There is a need to do further research to see if the IT paradox still exists as it was claimed about ten years ago.

2. METHODOLOGY FOR THE INVESTIGATION

The methodology that has been used for the investigation consists of quantitative and qualitative approaches to literature review. The quantitative approach, referred to as "abstracting", was used to get a quick overview of current and previous research on the topic. The abstract review process is a method of quickly getting feel of a paper under review without reading it completely. Under this process, the paper is located using the normal search tools available, and then copies of abstract and conclusions of paper are made. The reviewer then read through the abstract and conclusions and summarises the paper and the conclusions that have been made. The main aim of this method was to get an overview of the different schools of thought on the information technology paradox and determine the main issues and pattern emerging. The qualitative approach is the next phase of the research and is not covered in this paper. The following sections discuss findings of the abstract review discussed above.

3 CRITICAL EVALUATION OF LITERATURE

The literature has revealed a number of research results, which try to explain why there is the information technology productivity paradox. Several approaches were taken by previous researchers to study the problem, for example. (Black and Lynch, 2001) looked at work practices and IT, (Jing et al., 2003) applied economic model of duopoly and (Peslak, 2003) used financial and market based measures. In trying to get a holistic view of conclusions from the literature, the following broad areas appear to be the most frequent. The following sections discuss findings of the abstract review process.

3.1 Measurement Errors

The problem of measurement errors in determining the impact of IT has been identified by a number of authors (Mahmood and Mann, 1993) indicated the problem of measuring IT impact due to the fact that there are other factors that contribute to an organisation's performance. [(Anderson and Rust, 1997), (Brynjolfsson, 1993) and (Hitt and Brynjolfsson, 1996) etc.], are some of the authors who have also linked the problems of determining IT impact to what is measured. This is because of other factors that come into play in organisations such as infrastructure, assets etc. Also it is difficult to isolate the impact of other factors and attribute output to IT only. A closer observation reveals that research published in the early 1990's tend to highlight the problem of measurement often. This is the period when IT was mainly being used to automate manual processes and the communication capabilities were still at an early stage. (Strassman, 1997) also indicated problem with measurement and how they were used to calculate productivity improvements. Strassmann was looking at the work of (Brynjolfsson and Hitt, 1996) when they thought they have disproved the IT paradox.

3.2 Adaptation Strategy

The strategic adaptation of IT in organisation was also reported to be a contributing factor. This emerged from research work covering the end of the 1990's. The argument was to link IT strategy with business strategy so that IT becomes a supportive tool to business not a burden. This emerged after the automation era of the early 1990's when organisations created numerous islands of automation that were difficult to communicate with one another. [(Sugumaran and Arogyaswamy, 2003), (Schrage, 1997) etc] brought to the discussion the fact that it was the strategy that organisations use that influences the impact of IT. Gates, (1999) summarised this by stating, "…unfortunately computers will only help business that adjust its daily operations to take advantage of the computer". This problem still exists today. Organisations are still not using the computer to its maximum capacity to support their business. (Carr, 2003) support this by stating that "studies of corporate IT spending consistently show that greater expenditure rarely translate into super financial results. In fact, the opposite is usually true".

3.3 Effective Use

Another issue in dealing with the impact of information technology that emerged from literature is that of effective use. Here effective use means the ability of an organisation to use the power of information technology to its maximum. (Sircar et al., 2000) argued that being able to use computers effectively was more important compared to the amount of money being spent on them. The improvement in hardware performance and software capabilities has been faster than the adaptation of IT to business environment. This has lead to IT pushing organisation to invest rather than organisation discovering that there is a need to invest. Under utilisation of IT is also a factor (Carr, 2003). This is evident from the popularity of using word processors more than any other office application programmes such as spreadsheet or database. This might be due to the legacy of typewriters, which were used for a long period of time. Also the major activities in most organisations are mainly dealing with text-based documents. However, despite under utilisation, there is a need to meet costs associated with upgrade and licensing fees of programmes including those under utilised. The problem of lack of effective use has also been reported by (Davenport, 1997) who stated that "But information-or at least the effective use of it-has not improved at the same rate as technology spending". This state of affairs cannot be allowed to continue if mankind is to reap the rewards from ICT capabilities.

3.4 Type of Business

Impact of IT has also been linked to the type of business where it is being used for example, in research by (Quan et al., 2004) it was found that, IT investments impact on firm's performance depended on market sensitivity to changes in the competitor's price and quality of service. (Stratopoulos and Dehning, 2000) pointed that the positive impact of IT does not last long as it is easy for IT to be implemented by competitors when they realise positive results from their business rivals who have invested in it. The secret seems to be -invest in IT and use it effectively to gain market share before your rival gets in. Carr (2003) stated, "… the window for gaining advantage from infrastructure technology is open only briefly" to emphasise the point of responding quickly to demands in the market place. Dearlove (1999) has identified that among the ten secrets of Microsoft Success, " Be in the right place at the right time " was number one.

3.5 Positive Impact

From around 2000 onwards, research reports showing positive impact began to emerge e.g. work of (Chowdhury, 2003) showed impressive results of IT investment in the banking industry. This research was done in developing countries of the Asia and Pacific Basin region. This might be an indication that IT applications were beginning to show maturity after the initial implementation and adaptation phase of the 1990's. Hence companies, which have position themselves appropriately in terms of use of IT, were beginning to get the rewards. (Devaraj and Kohli, 2000) reported positive impact in the health care industry. Another issue that emerged was that positive impacts take time [(Dewan and Kraemer, 1998), (Brynjolfsson, 1998), etc]. The main problem that face organisations is that IT calls for continuous investments through upgrade of both hardware and software; hence any positive impact gained is overtaken by the cost of upgrade.

Although previous research in the productivity paradox were inconclusive, most of the research reports were mainly on business and technology. The issue of people has not received thorough research coverage.

4. ICT IN BOTSWANA

Botswana despite being a developing country has a fairly developed ICT infrastructure. This has been acknowledged by other external agencies for example, UK Development of International Development chose Botswana when it sponsored research on ICT and Small Enterprise in Africa. According to Duncombe and Heeks, (2001) Botswana was chosen due to "its relatively well-developed ICT infrastructure, and its favourable policy environment". Moore, (2000) wrote, "Botswana has a greater degree of digitalisation than Japan", acknowledging Botswana's advances in ICT. Botswana has invested significant financial resources in ICT as shown in Table 1.

Table 1. ICT Expenditure from NDP 7 to 9. Source: (Maitlamo, 2004)

NDP No.	Duration	Amount in Pula (P)	% of Government Budget
7	1989-1996	19.3M	.2
8	1996-2003	600M	2.7
9	2003-2010	1.3BN	3.7

4.1 ICT Applications and Productivity in Public Sector

There is a need for Botswana to aim to utilise ICT to the benefit of the nation. One of the areas where ICT may play a role is in service delivery. Politicians, public as well as the business community, have accused government departments of performing to below expectation. While government red tape bureaucracy may also be a contributing factor, ICT has the potential to open up government resources to its nation. (Venson, 1986) looked at lack of productivity in civil service in her MSc thesis. This shows that concern for improved performance in civil service is older than introduction of IT in central government. Of late even ICT has been blamed for contributing to the problem (Maine, 2005).

It can be argued that concern of lack of productivity has always been there; hence it is not appropriate to link ICT to it. This is a fair comment, however ICT has potential to contribute to improvement of productivity. Unfortunately the implementation of ICT in central government was rapid due to external pressure among the few who were IT literate at the time and did not follow a systematic approach; there was no ICT policy at the time. A policy is the best guiding document for any government. IT is only now that the policy is being discussed through the Maitlamo project.

4.2 ICT Applications and Need for Change

Government of Botswana has been commended for commitment to ICT development (Moore, 2000). Unfortunately the culture of most government departments is still dominated by the old non-computing era. Hence ICT implementation was tied to old business processes rooted in people's minds, which may not be able to sustain the culture of information era. Faraj (2005) highlight this point by stating, "Users must give up old ways of doing their job, whether manual or automated, and adjust to accomplishing the same tasks with the new system". What is needed now is to transform employee's attitude towards work, so that they can be able to utilise IT to serve. It may be the case that, ICT in Botswana is being utilised to a large extent for data storage. The problem is in retrieving that information from databases or data store to meet different needs. The following three cases illustrate this point.

4.3 Information Technology Acquisition in Botswana

A lot of ICT system in Botswana are bought from outside. The country does not have an industrial base to produce things like hardware. However for application software, which is application specific, the country still import such products. At the beginning the problem was due to the fact that there were very few qualified citizen in the field of software development, i.e. programmers. Through a massive training campaign, the government provided funding for locals who have successfully completed higher secondary education as well as serving officers to go for further training in ICT related programmes. There was even an establishment of computer science department in the local university (University of Botswana) to develop ICT skills locally as it was too expensive to train them outside e.g. in UK, USA etc. (Maitlamo, 2004) has called for further research to determine whether ICT goods and services products are based in Botswana or outside. This research will contribute to this request for more work in the area.

There is now abundant human resource trained in the areas of ICT, unfortunately their expertise is not been put to use when software applications are developed outside the country. The philosophy of software acquisition in Botswana needs to be re-examined so that the appropriate approach is taken to empower citizens. It is the intention of this research to also determine the financial implications of all the systems that have been bought from outside. (Maitlamo, 2004) also reported that company executives were not willing to assign implementation of complex IT applications to locals. This might be because such companies are foreign based and are not willing to invest their resources within the country.

The other problem with imported ICT systems is that due to commercial reasons, the supplier may not make source code & test data of such systems available. However such information might be useful for maintenance at a later stage. Botswana is not alone in buying off the shelf systems; many organisations resorted to comprehensive packages called enterprise resource planning (EPR) which emerged in the mid 1990's. There was hope that EPR will reduce costs associated with system development and maintenance in house (Faraj, 2005). EPR have a lot of functionality for an organisation e.g. Integrated Tertiary Software (ITS) of South Africa provides almost all functions performed by an academic institutions e.g. financial, administrative, academic etc. As EPR has a lot of functionality they cost a lot more. Hence if they are under utilized, this will be a loss to an organisation.

4.4 Declining Revenue for Government

Lately the country has been facing a lot of challenges e.g. persistent draught, HIV/AIDS etc that are all calling for financial intervention. These challenges have tremendously reduced government revenue for example the budget allocation for fighting HIV/AIDS is almost more than that of some ministries. It is for these declining financial resources that government must look at some of the possible ways to reduce cost of foreign services and systems like in ICT. Government HIV/AIDS intervention accounted for 85% of budget of Ministry of State President budget of P1.11 billion (Gaolathe, 2005). This figure is more than twice the budget for the army.

5 THE BROADER RESEARCH PROJECT

Recent concern raised by various institutions in Botswana about the problem of lack of productivity in central government e.g. (Ibrahim, 2005) as well as the steps taken by government to provide the appropriate ICT infrastructure to support service delivery has prompted this research. (Maine, 2005) associated ICT with poor performance. These have prompted for a thorough investigation to find what could be missing in ICT implementation and use.

The argument for this research is presented in Figure 1. This is based on Taulmin's structure of a research argument.

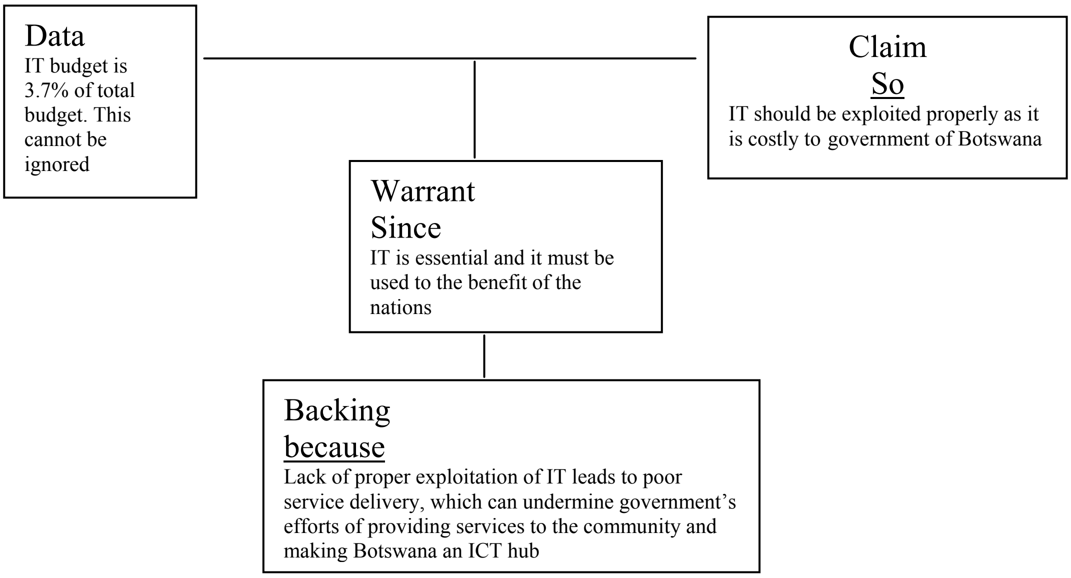

Fig. 1. Proposed Research Argument adapted from (Hart, 1998)

The next stage of literature review will be using the qualitative approach, now that the various schools of thoughts have been put into perspective. It is now moving from abstract review to critical literature review where a paper will be analysed and evaluated in order to get a scholarly view of its message. The epistemological approach, which forms the basis of the research, is the constructionism approach. This is because the topic under research is looking at how people interact with technology in order to gain understanding of their attitudes that may lead to low performance. It does not fall on the objectivesim or subjectivisim, as this problem is more of social science than pure science. The philosophical position is phenomenology. Figure 2 illustrates the research approach.

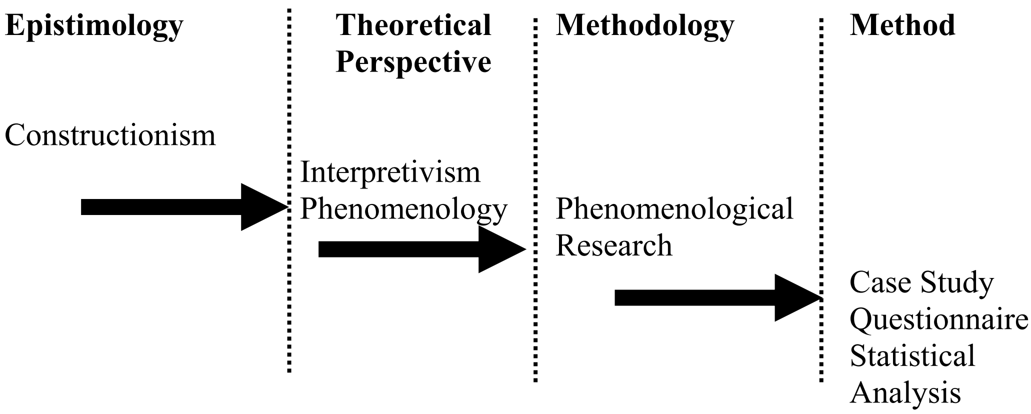

Fig 2. Stages of Conducting Research, Adapted from (Crotty, 2003)

A case study method will be used to gain further understanding of the research problem. Case study method is chosen, as the researcher does not have any direct influence on the subject or environment under study. There will be a pilot study in UK to test the method before it is finally used to collect data in Botswana.

6. FURTHER AREAS FOR RESEARCH

In order to understand the impact of ICT in organisations, there is a need to do further work on people issues, both as users and recipients of services offered through ICT. This will form a very important contribution, as it is ultimately the people that use the technology and are to be served by the technology.

6.1 People Issues

Literature review has not yet been concluded; the issue of people in organisation (employees) needs to be further researched. Employees are the one who use ICT and they have a role to play in understanding the IT productivity paradox. There is the question of how users are supposed to adapt to the new environment. Often it looks like users are expected to just get on with ICT and do the job. This might be true especially for large IT systems, which is bought of the shelves as compared to small in-house, IT development.

IT systems are developed using system analysis and design methodology. (Tudor and Tudor, 1997) stated three objectives of systems development all of which try to capture the business environment as best as possible. This approach tries to capture as much as possible the business environments so that the system will support current and expected future needs. It therefore follows that if the methodology is used to develop in-house IT systems; the true business environment is likely to be captured. The main problem with off the shelf systems is that they are based on a model which may not necessarily conform to the organisation's working model, hence the organisation has to adapt its business strategy to IT instead of the other way round.

6.2 Human Issues in ICT

Employees of organisations are human beings and hence people have individual way of communication as well as emotional behaviour, which cannot be ignored in the business environment. Embedded human beings qualities are hard to be incorporated into any computer programme. System development methodologies have not yet been able to capture the enter-personal communications and emotional intelligence of human beings. This is why experts system did not deliver up to what was expected out of them, the reason being that psychology of human being will always remain with a person and it changes unpredictably. (Davenport, 1997) also argues that where information changes too fast to maintain, this will make it difficult for expert systems to generate useful knowledge. Davenport (1997) stressed the importance of people by stating that, "information and knowledge are quintessentially human creations, and we will never be good at managing them unless we give people a primary role". An area that has been under researched in determining the impact of ICT is that of people. This is the area, which will be covered by this research. Unfortunately people cannot be controlled by a computer programme hence human communication and attitudes must be incorporated in studying the problem of IT productivity paradox.

Alter (1996) identify only three types of people namely, participants, users and IT professionals. (Underwood, 2005) showed that an information system is made up of three interacting components namely information technology, processes and people all participating in and environment as shown in Figure. This shows that people are fundamental to ICT success. This research will bring in the fourth group of people namely customers. These are people who are to be served by ICT applications. They are also the people who bring value to an organisation as their satisfaction about service can determine the rise or fall of any business.

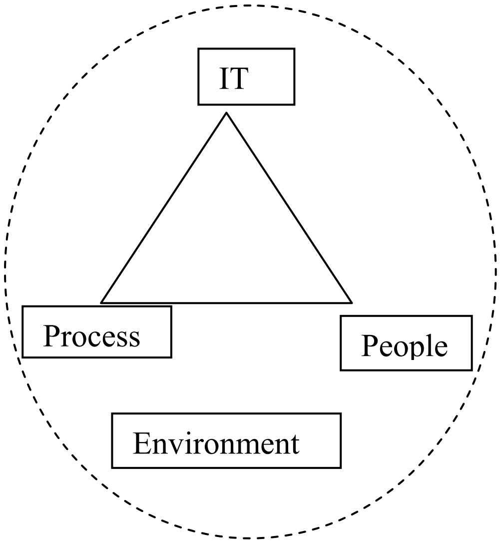

Fig. 3. Interaction of IT, People, Process and the Environment adapted from (Underwood, 2005)

The role of people in ICT evaluation has also been noted in European Foundation for Quality Management, 2001 (EFQM). In the EFQM excellence model people are identified as on of the five enablers to attain results. The other enablers are leadership, policy and strategy, processes and partnership & resources.

For Botswana, the IT side is established, the processes are in place and the environment is ideal. This has been acknowledged by external academics e.g. the ICT's and Small Enterprises in Africa project, which was funded by British Overseas Development Agency (Duncombe and Heeks, 2001).

7. CONCLUSIONS

This paper has demonstrated that the information technology paradox discussions were mainly in the 1980's and 1990's. However it has not had any influence on companies reducing their IT budget. On the contrary IT budget continue to grow. The productivity paradox research was intense in the 1980's through to the end of the 1990's. This was before the internet revolution swept across the globe. There is need to do further research to see the type of impact the internet era has had towards the problem of information technology paradox. This is especially true for developed world where internet is heavily used to provide services to the communities. May be the information technology paradox has been reduced now. However for Botswana, the information technology paradox is still there, as shown by recent literature in Botswana.

The problem of lack of exploitation of ICT in Botswana appears to be linked to people using the technology. It is the intention of this research to investigate this problem further. A pilot study will be conducted in the UK. The pilot study is intended to investigate ICT utilisation and its impact. The results of this study will contribute to understanding latest developments regarding the information technology productivity paradox. It will also test the case study research method before it is used in Botswana for the main research. In Botswana, the research will cover government departments. By nature government agencies are not in business to make profit, but to provide better service to the people at minimal costs. These will be the focus of the research in Botswana.

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TOWARDS THE SEMANTIC WEB ENABLED MOBILE LEARNING

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ABSTRACT: Semantic Web technology enables applications and machines to understand and process well-defined, meaningful data on the web. However, Semantic Web technologies have not yet been applied widely to deliver learning materials and support e-learning. The use of mobile and wireless technologies in e-learning enables personalised learning anywhere anytime. The existing metadata standards and specifications aim at traditional e-learning in a desktop environment. These standards need to incorporate mobile learning activities as learning becomes possible whenever needed regardless of the location. The emerging Semantic Web technologies provide rich medium for facilitating e-learning via the semantic annotated learning objects and shared repositories. The wireless and mobile technologies enable discovery, search and retrieval of learning objects from repositories anytime anywhere. This paper introduces learning standards, semantic web, wireless and mobile technologies to enable mobile learning.

Keywords- Learning Objects, Learning Standards, Mobile Learning, Semantic Web, Wireless and Mobile Technologies

1. INTRODUCTION AND BACKGROUND

Learning is the process of acquiring knowledge and skills through study and experience. With the ever increasing availability of the information and Internet technologies, the way of teaching and learning and delivery of learning materials are changing. As a result e-learning has begun to evolve.

E-Learning has a plethora of definitions. Hall and Snider (2000) define e-learning as the process of learning via computers over the Internet and intranets. (LSDA, 2003) states that e-learning is the use of electronic technology to deliver, support and enhance teaching and learning. Rosenburg's (2001) definition of e-learning refers to the use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance. While (NCSA, 2001) defined e-Learning as;

> "The acquisition and use of knowledge distributed and facilitated primarily by electronic means. This form of learning currently depends on networks and computers but will likely evolve into systems consisting of a variety of channels (e.g., wireless, satellite), and technologies (e.g., cellular phones, PDA's) as they are developed and adopted. E-Learning can take the form of courses as well as modules and smaller learning objects. E-Learning may incorporate synchronous or asynchronous access and may be distributed geographically with varied limits of time."

E-Learning resources, applications and tools need to use learning standards and specifications in order to provide application and platform independence. Standards and specifications enable reusability of educational content, sharability of learner information and interoperability. They also enable users to discover, locate and retrieve the learning materials and to deliver them tailored to learners' preferences and needs.

In order to facilitate e-learning as just-in time, personalised and on-demand learning, it has to be mobile and portable. Hennessy (1999) says that mobile technologies provide an opportunity for a fundamental change in education away from occasional use of a computer in a lab towards more embedded use in the classroom and beyond. Soloway et al (2001) have further argued that to make any difference in the classroom at all, computers must be mobile and within 'arm's reach'. Vavoula and Sharples (2002) suggest that there are three ways in which learning can be considered mobile:

> "learning is mobile in terms of space, i.e. it happens at the workplace, at home, and at places of leisure; it is mobile between different areas of life, i.e. it may relate to work demands, self-improvement, or leisure; and it is mobile with respect to time, i.e. it happens at different times during the day, on working days or on weekends".

Kukulska-Hulme (2002) suggests that mobile devices have to be seen as an extension to current e-learning tools rather than replacing it. Mobile devices can be used for different purposes in learning activity. UniWap project uses WAP technology to create an operating environment for studying and teaching (Sariola et al, 2001). An m-learning project at Ultralab is producing learning materials for mobile devices to support the learners with lack of literacy and numerical knowledge (Collett and Stead, 2002). It also created a WAP portal for WAP enabled phones to provide educational materials for young people with the literacy problems. A system is developed at Kingston University to send SMSs to students about their timetable, examination dates and marks. LIVE (Learning in a Virtual Environment) project at the University of Helsinki explored the use of SMS to share the images between teachers. LAND (Location Activated Nomadic Discovery) project at the Ultralab explores the possibility of deliver rich context aware information via the mobile devices (Taylor at el, 2002). HandLeR project at the University of Birmingham has developed a mobile learning organiser with the context aware information. It provides time manager for scheduling lectures and course manager for organising course materials (Sharples, 2003). Mayorga-Toledano and Fernandez-Morales (2003) suggest Java midlets as learning tools in higher education.

The existing mobile learning applications use SMS, MMS, VoiceXML, J2ME, WAP and mini browser to create learning materials and tools. Colley and Stead (2003) argue that none of the above technologies is rich by itself and suggest that these technologies in a combined form may provide beneficial experiences to learners. To deliver a rich learning experience, Popat and Stead (2004) are using these technologies with the web programming languages such as PHP, ASP, JSP, JavaScript and Flash.

Learning object is any digital resource that supports learning. Rodin (2004) explores the potential of using learning objects for mobile learning. He argues that there is not one type of learning object, instead learning object is a software object that supports learning. Matthews (2005) says that Semantic Web clearly has large application to e-learning, supporting both distance and local education and suggests that if learning objects are used properly, it is a useful and powerful concept and Semantic Web has much to offer to support e-learning. Semantic Web and learning objects concepts are obviously not yet applied to mobile learning to deliver learning materials and learning objects via mobile devices.

This paper introduces learning standards, wireless and mobile technologies, ontologies and semantic web technologies and elaborates how these technologies enable creation of mobile learning objects repository to facilitate learning anywhere anytime. It also presents some findings from existing mobile learning applications and addresses the needs for semantic annotated learning objects and Semantic Web based mobile learning environment that can be accessed from anywhere anytime. The following section explores the existing learning standards and specifications and identifies the benefits of using them in e-learning in order to achieve interoperability.

2. LEARNING STANDARDS AND SPECIFICATIONS

The development of e-learning content is often expensive and time consuming. Curriculum developers always reinvent the wheel as they find it difficult to locate the learning materials to reuse within the e-learning systems. Learners often face problems in discovering learning materials they need. Learning content developed for a learning management system may only be used within the system itself. Therefore, learning content needs to be interoperable with different learning environments and produced in a standardised way to maximise their reusability. Since many of the learning materials and learning management systems lack interoperability with other systems, there is a need for standards to be used in e-learning. Ahmed and Shaik (2005) argue that standardisation using learning standards is the ultimate solution to achieve interoperability in e-learning. Learning standards provide standardised data structures and communication protocols for learning materials and learning management systems. Learning standards are technical protocols, which promote easy exchange of content or data between different systems based on different technologies. They are designed to facilitate description, packaging, sequencing and delivery of educational content, learning activities and learner information (Currier and Barker, 2002) and also facilitate the following:

- Interoperability – Learning content that is developed for one system is not locked to that system by proprietary encoding.

- Reusability - Learning objects are easily used in different curriculum and learning settings.

- Manageability - The system tracks information about the learner and the content.

- Accessibility - Learners with different learner profiles including educational and physical needs, easily access and assemble the content at the appropriate time.

- Durability - The technology evolves with the standards to avoid obsolescence.

Learning content has to be labelled in a consistent way to be discovered by various learning tools. It also needs to be packaged in a standardised way to be transported to different learning systems. Together with the learning content, learner information has to be shared between multiple learning tools and components. Therefore, there is a need for standardising the labelling and packaging of the learning content and learner information. There are different types of standards that exist for these purposes. The existing learning standards and specifications can be classified into some general categories:

Metadata
Learning contents and objects must be labelled in order to support query, discovery and search by various users and tools. There are number of organisations in the process of creating metadata standard. The IEEE Learning Technology Standards committee produced a draft standard called Learning Object Metadata standard (IEEE LOM). The Dublin Core Metadata Initiative has a different metadata standard with the less elements compared to IEEE LOM. Dublin Core metadata is widely used by libraries, publishers and government organisations. The IMS Global Learning Consortium and the Advanced Distributed Learning Initiative have adopted IEEE LOM as the metadata standard. CanCore and SingCore have

also developed metadata standard based on IEEE LOM with their country-specific terms and properties.

Content Packaging

Content packaging standards and specifications allow courses to be transported from one learning system to another. Content packages consist of learning objects and information about how these learning objects can be put together to form learning modules. They also specify the protocols for content delivery to learners. There are number of initiatives dealing with content packaging specification including IMS Content Packaging specification, IMS Simple Sequencing specification, Aviation Industry CBT committee guidelines for computer managed instruction and Advanced Distributed Learning Initiative Sharable Content Object Reference Model (SCORM).

Learner Profile

Learner profile standards allows different learning components to share information about learners including personal data, learning plans, learning history, accessibility requirements, certificates, skills and status of participation in the current learning. There are number of initiatives to standardise the learner profile including IMS Learner Information Package (LIP) specification and IEEE Personal and Private Information (PAPI) specification.

Learner Registration

Learner Registration standard allows learning delivery and administration components to know what offerings should be made available to a learner and provides information about learning participants to the delivery environment. IMS Enterprise working group created a specification for exchanging offering and enrolment data among learning systems.

Content Communication

Content Communication standard allows sharing of learner data, learning history and completion status across multiple learning environments. The Aviation Industry CBT Committee's Computer Managed Instruction includes content communication and the Advanced Distributed Learning initiative's Sharable Content Object Reference Model (SCORM) includes a JavaScript API for content communication.

Although these standards provide a standardised way of sharing learning content and learner information to facilitate the interoperability in desktop environments, there is a need to achieve interoperability with the mobile learning systems by adapting existing standards and specifications. (Veith and Pawlowski, 2005) argue that mobile learning systems need more information on the nature of the materials to evaluate which content can be delivered to a specific end user device and suggest that this information should be added to IEEE LOM standard as an mobile learning extension. However, the increasing use of mobile devices in everyday life creates new opportunities in e-learning. The next section explores wireless and mobile technologies and identifies their suitability to support anywhere anytime learning.

3. WIRELESS AND MOBILE TECHNOLOGIES

The wireless and mobile technologies create wide range of possibilities to support learning. Educators, learners and organisations are motivated to make use of these technologies in learning environments. Savill-Smith and Kent (2003) identified five main reasons for the motivation such as relatively low cost devices, offer ubiquitous computing, promote information literacy, help collaborative learning and support independent learning.

The increasing use of mobile devices such as mobile phones, PDAs, handhelds and smart phones and continuing expansion of broadband wireless networks and 3G networks, is creating new opportunities for integrating wireless and mobile technologies with e-learning. This technology, combines telephony, messaging, multimedia and computing is offering a rich medium to facilitate learning anywhere anytime. The section to follow, explores the existing wireless technologies and their usability in supporting on-the-move learning.

3.1 Wireless Technologies

Wireless technologies provide great possibilities to learners and educators with their flexibility and adaptability to various learning environments. Wireless technologies are being investigated as a platform for supporting learning in classrooms. They also enable always-on connection to the learning system regardless of the learner location.

The 3G, third generation mobile telephone technology provides the ability to transfer voice and non-voice data over the wireless network. It also provides ability for face-to-face calling and downloads information such as movies. The GPS (Global Positioning System) is a satellite navigation system used for finding accurate location information. It is widely used for route navigation, but can be used for providing content-aware information to learners. The following table (Table 1) summaries the existing wireless technologies that can be used in e-learning environment.

Table 1. Wireless Technologies

Wireless Technology	Transmission Protocol	Transmission Speed	Transmission Range	Technical Notes
Mobile/ Cellular	GSM CDMA GPRS	13.4 -14.4 Kbps per channel	Cellular network	Code Division Multiple Access; Mobile data service for GSM mobiles
Wireless LAN/ Wi-Fi Wireless Fidelity	802.11a 802.11b 802.11g	2Mbps 11Mbps 54Mbps	100 feet 300 feet 300 feet	Multiple devices can be connected to network
Infrared	-	Up to 4 Mbps	3 feet	Device to device transmission; Line of sight required
Bluetooth	-	Up to 1 Mbps	30 feet	Device to device communication; Use of radio frequencies to link enabled devices
3G Third-generation wireless	WCDMA Wide-band CDMA	2Mbps	Cellular network	high-speed data and global roaming
WiMax Worldwide Interoperability for Microwave Access	IEEE 802.16	Up to 75Mbps	30 miles	provides high-throughput broadband connections over long distances

Intel® IT Innovation Centre in Ireland is working towards to use Wi-Fi and WiMAX technologies to develop mobile learning applications (Smyth, 2005). WiMAX is a Non-Line-of-Sight, point-to-multipoint technology that offers wireless broadband access with the throughput of up to 75Mbps and range up to 30 miles. These features make it ideal wireless technology to enable learning anywhere anytime. The next section gives overview of existing mobile technologies and devices.

3.2 Mobile Devices

Mobile devices with 3G, GPS, Bluetooth and WiFi technologies and better processor speed and memory capacity, enable the creation of new learning practices, tools, applications and resources to suit learners learning needs, goals and preferences. A small, portable device that is always connected to network and internet allows easy input through keyboard, input device such as pen and speech, provides the ability to download and view images, movie clips and files and offers wireless internet to surf the net anytime anywhere, has the potential to facilitate learning regardless of the location.

Figure 1 shows the variety of mobile devices currently in use. The new portable hand-held game consoles offer not only gaming facility, but also wireless internet access and movie watching facilities.

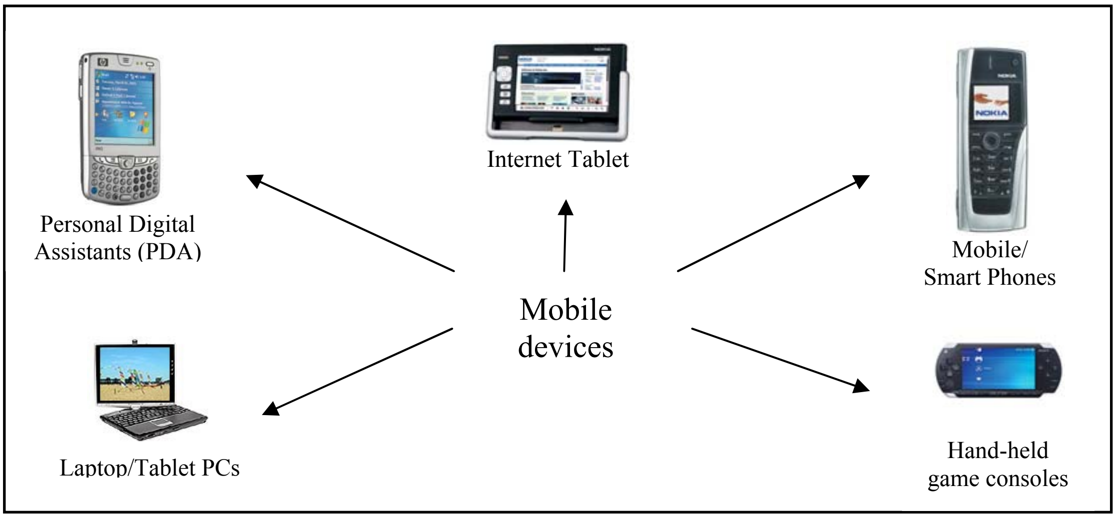


Fig. 1. Mobile Devices

The vision of mobile computing device is that portable computation, rich interactivity, total connectivity and powerful processing. Klopfer et al (2002) identify five properties of mobile devices that produce unique educational experiences.

- Portability – the size and weight of the mobile devices increase the portability
- Social interactivity – interaction with other learners for sharing learning materials and collaboration can happen face-to-face
- Context sensitivity –context information such as location and time can provide personalised learning environment based on the location

- Connectivity – Bluetooth, Infrared and WiFi technologies enable communication with other devices and networks

- Individuality – learning can be personalized to suit learners goals and preferences

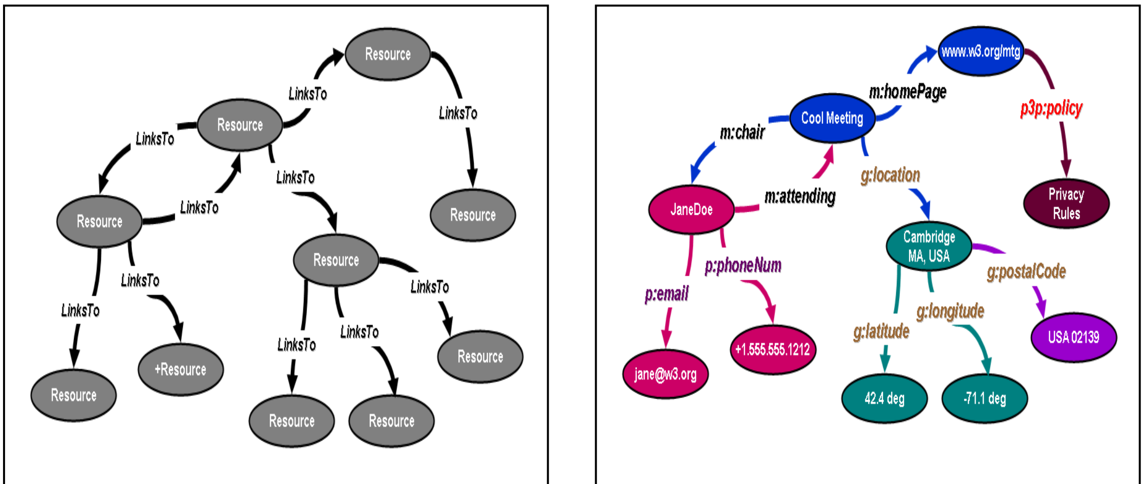
These educational experiences presented by mobile devices create new mobile learning environment that will facilitate personalised flexible learning anywhere anytime. The portable mobile devices with the context-aware information have the always-on connection to the learning system via wireless technologies. The web based, mobile learning environment enable learners to discover, search and retrieve learning materials via mobile devices and hence makes learning possible whenever needed. Standardised learning content with the semantic annotation can then be semantically searched and discovered using Semantic Web technologies. The next section introduces Semantic Web technologies and ontologies and identifies how these technologies can be used to develop a mobile learning environment.

4. SEMANTIC WEB TECHNOLOGIES

Semantic Web technologies support presentation and delivery of learning content tailored to learners needs and preferences. Learning content can be retrieved from Semantic Web based shared repositories using mobile devices anywhere anytime. The following section explores Semantic Web concept.

4.1 Semantic Web

Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation (Berners-Lee et al, 2001). The current web, called Syntactic Web can only be accessed by humans and just provides information in a syntactic manner. But in Semantic Web concept, information is given well-defined meaning that can be accessed by both humans and machines. The following diagram (Figure 2) shows how the Semantic Web differs from the current Syntactic Web.



Current Web: Syntactic Web | Future Web: Semantic Web

Fig. 2. Syntactic Web Vs Semantic Web (http://www.w3.org/2005/Talks/0623-sb-IEEEStorConf/#(18))

Resources and links in the Semantic Web have well-defined meaning compare to Syntactic Web which enable semantic search, discovery and retrieval of information. A set of technologies, tools and standards are developed as part of Semantic Web vision. The following section explores the technologies associated with the Semantic web.

4.2 Semantic Web Layer

Semantic Web has been developing a layered architecture with the technologies and standards. These form the basic buildings blocks for the Semantic Web to support the development of meaningful web. The following Fig. 3 shows the latest architectural layer for the Semantic Web.

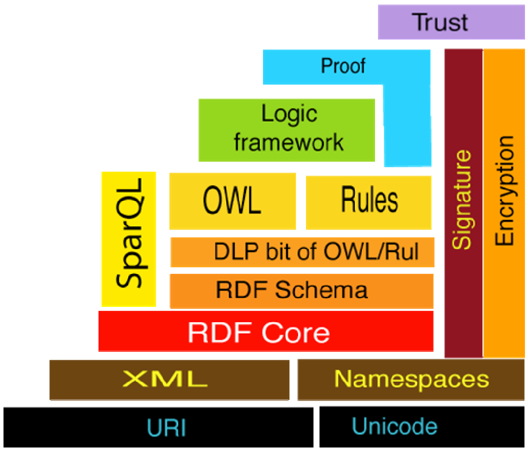


Fig.3. Semantic Web Layer (http://www.w3.org/2005/Talks/1110-iswc-tbl/#(12))

In the Unicode and URI layer, Unicode is the standard for computer character representation while URI is the standards for identifying and locating information on the web. URIs can be used to identify definitions for concepts. XML separates data from presentation and forms a common way of structuring data on the web. It also associated with some other related standards such as Namespaces and Schemas. The Resource Description Framework (RDF) is the first layer that forms the Semantic Web. An RDF graph is a set of triples; each triple consists of a subject, a predicate and an object. RDF represents metadata using URIs to identify and locate resources and information on the Web. It provides a graph model for describing and defining relationships between resources. RDF Schema is a modelling language for defining and describing classes of resources in the RDF model. Ontologies provide rich medium for defining and describing complex relationships between classes and properties. Logic and Proof layer provide reasoning support for the ontologies and to make new inferences. SPARQL is a query language for getting information from such RDF graphs.

Ontology plays major part in the Semantic Web. It defines the concepts and vocabularies that form the basis for the Semantic Web. The next section introduces the ontology and Web Ontology Language.

4.3 Ontologies

Ontologies are specifications of the conceptualization and corresponding vocabulary used to describe a domain (Gruber, 1993). In the other words, ontology is an explicit description of a domain and defines a common vocabulary as a shared understanding. It defines the basic concepts and their relationships in a domain as machine understandable definitions.

The OWL (Web Ontology Language) is a language for defining and instantiating Web ontologies. The OWL language provides three increasingly expressive sublanguages designed for use by specific communities of implementers and users. OWL Lite supports those users primarily needing a classification hierarchy and simple constraint features. OWL DL (Description Logic) supports those users who want the maximum expressiveness without losing computational completeness and decidability of reasoning systems. OWL DL includes all OWL language constructs with restrictions such as type separation. OWL Full is meant for users who want maximum expressiveness and the syntactic freedom of RDF with no computational guarantees. OWL Full allows an ontology to augment the meaning of the pre-defined RDF or OWL vocabulary.

Semantic Web technology together with the ontologies has the potential to enable anywhere anytime learning. Semantic Web based shared repositories with the learning content will enable semantic discovery and retrieval of learning resources anywhere anytime and hence facilitate interoperability and sharability. The next section explores mobile learning and mobile learning objects to enable anytime anywhere learning.

5. MOBILE LEARNING

Mobile Learning (mLearning) is e-learning through mobile devices. Milrad (2003) defines e-learning as learning supported by digital electronic tools and media and mobile learning as e-learning using mobile devices and wireless transmission. Attewell (2005) finds that about 62% learners are enthusiastic about mobile learning and they are keen to take part in future mobile learning. After analysing the evidence collected from the m-learning project, Attewell (2005) also suggests that use of mobile learning may have a positive contribution to encourage both independent and collaborative learning experiences, to remove some of the formality from the learning experience and engages reluctant learners and to remain more focused for longer periods.

The following diagram (Fig. 4) illustrates the mobile learning with mobile learners who access and/or retrieve variety of learning materials, tools and applications using mobile devices via wireless technologies.

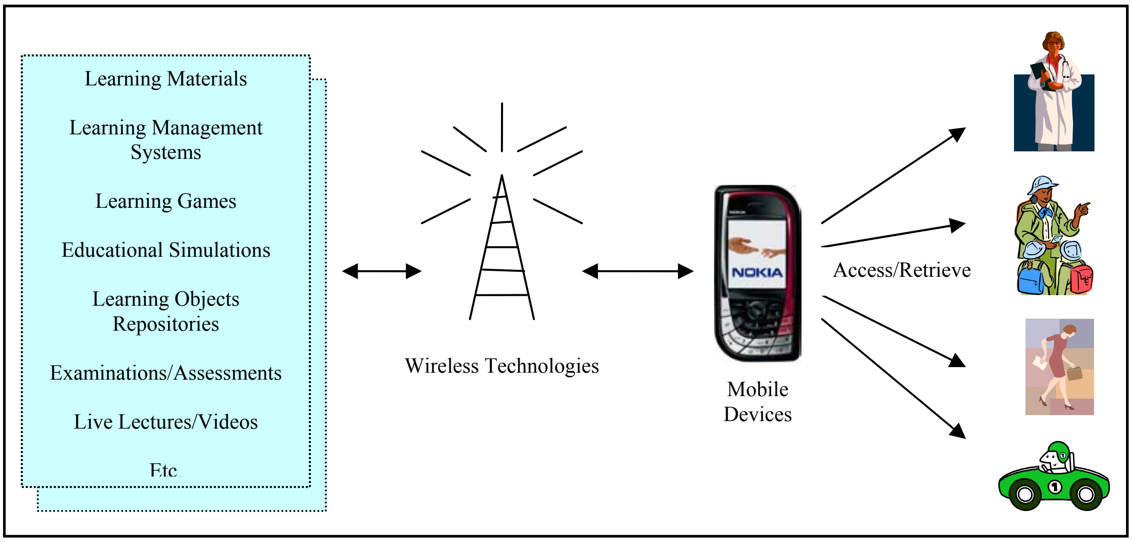


Fig. 4. Learning Anytime Anywhere

5.1 Learning Objects for Mobile Learning

The main aim of creating learning objects is to achieve the goal of maximum reusability, leveraging the high cost of production of quality materials without sacrificing the learning meaning. The concept of learning object emerges from the need to introduce and elaborate e-learning content with pedagogical aspects in a way that can be reused in different learning scenarios.

The IEEE Learning Technology Standards Committee(LTSC) defines learning objects as "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning"(LTSC, 2000). It also suggests that learning object can be a multimedia content, instructional content, learning objectives, instructional software and software tools, persons, organisations, or events referenced during technology supported learning. Although LTSC definition is too broad to actually define a learning object, Wiley (2000) defines learning object as "any digital resource that can be reused to support learning". This definition includes anything that can be delivered across the network on demand, be it large or small.

A prototype learning object on Java programming for the PDA was developed at London Metropolitan University by employing a number of constructivist learning techniques that encourage active learning (Bradley at el, 2005). Although students felt that this mobile learning object offered more interactivity, the lack of semantics make it hard to share and reuse in the learning object repositories. Learning objects should have semantic content in order to facilitate reusability, sharability and interoperability. Learning object metadata will form a part of semantics, but it may not adequate to support semantic discovery, retrieval and search. The figure 5 shows how the semantic annotated learning objects can be constructed using metadata and ontology and how the repository can be accessed via mobile devices using Semantic Web.

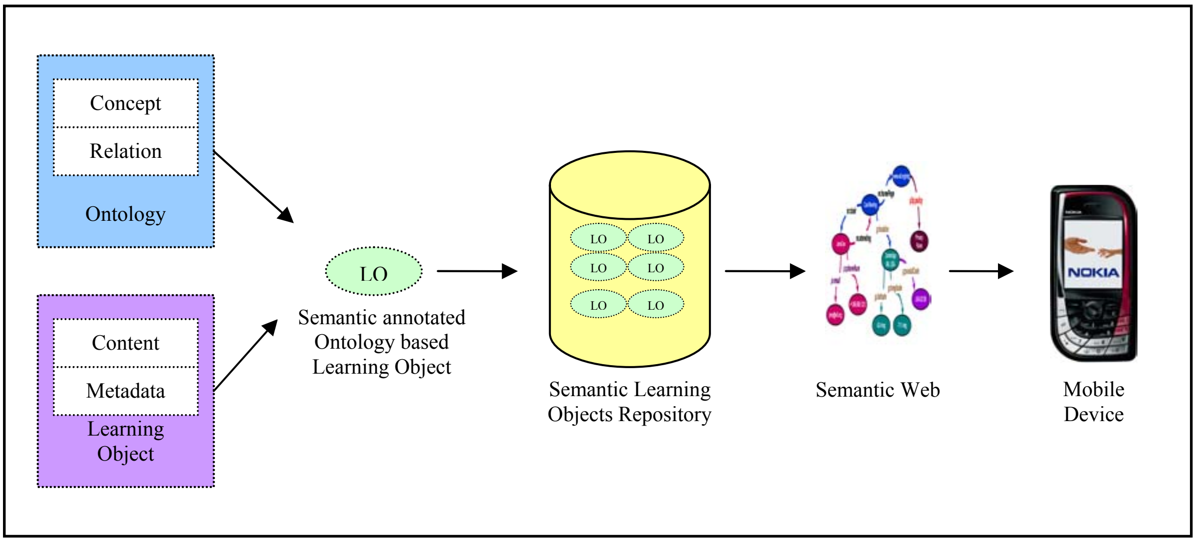


Fig. 5. Semantic Web based Mobile Learning Objects Repository

Ontology based semantic content will enhance the retrieval of the learning objects. Ontology must explicitly specify the relationships between the concepts and will therefore enhance the interoperability of learning objects between different learning environments. Although semantic learning objects and knowledge-based ontologies will facilitate semantic discovery and retrieval, the learning environment will need to be built in a way that supports semantic annotation, semantic discovery and semantic searching. The emerging Semantic

Web technology has the potential of supporting semantic actions and will clearly have the large application to m-learning.

6. CONCLUSIONS AND FUTURE WORK

The Semantic Web technologies clearly have potential to facilitate m-learning in a large scale. It is also a rich medium for facilitating m-learning using semantic annotated learning objects. The wireless and mobile technologies will enable search and retrieval of semantic learning objects anywhere anytime. This paper introduced existing learning standards and specifications, wireless and mobile technologies, ontologies and Semantic Web technologies. It also argued the needs for the development of the semantic annotated learning objects and Semantic Web based learning objects repository for mobile devices to facilitate mobile learning. It further sets the first research step towards adapting and extending existing learning standards for mobile learning in order to develop a learning objects repository for mobile devices that will facilitate interoperability, sharability and reusability.

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MEASURING THE READINESS OF AN ORGANISATION PRIOR IS/IT IMPLEMENTATION

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ABSTRACT: Several studies have revealed that major changes in IS/IT are profoundly affecting the people, processes, structures and strategies of an organization. The hardest thing when dealing with such changes lies in changing the people system or better known as 'soft issue'. The resistance to change might occurred due to lack of creating a sense of need and urgency for change among the employee and consequently might lead to the IS/IT project failure. Therefore, to reduce the resistance to change among the employee, it is essential that an organisation needs to determine the level of readiness for change prior the introduction of new IS/IT implementation by measuring its internal capabilities. A failure to assess organisational readiness prior the IS/IT implementation may result in mangers spending more time dealing with the resistance to change or even worst may result in IS/IT failure. To date various methods have been developed and introduced in the field of IS/IT measurement. However some IS/IT measurement methods become obsolete and suffered with a many problem. Majority of current IS/IT measurement approaches are mainly post-investment measures which fail to address the readiness issues. On top of that, there are constantly lacks of understanding of the human and organisational issue in the current IS/IT measurement approaches. Furthermore, those approaches also lacks of a holistic perspective on IS/IT which unable to describe the complex impacts within organisations. Therefore, this paper will address the issue of organisation readiness prior IS/IT implementation. A proposed IS/IT maturity model will be developed as an attempt to address the problem issues with current IS/IT measurement approaches.

Keywords – Holistic, IS/IT, IS/IT Measurement Approach, Readiness, Soft-issues

1. INTRODUCTION

The increased competition in the global marketplace, the reduction of trade barriers, the deregulation of markets, foreign competition in local markets leaves many firms with no option other than to make investment in information system (IS) and information technology (IT) frameworks for their continued business survival and future business expansion plans (Smithson and Hirschheim, 1998; Serafeimidis and Smithson, 2000). Furthermore, the supply chain of products and services are expanding across regions and countries to find the lower costs suppliers and to maximise productivity (Spanos, *et.al,* 2000). As a result of the increase competition, many firms had to change their workflow and processes (Love and Irani, 2004).

The key requirements for organisations to survive in this competition depends on their flexibility, speed, and ability to innovate, in both product/services and process (Volberda, 1992; Appelbaum, *et.al* , 1998; Smithson and Hirschheim, 1998).It is well recognised that globalisation, deregulation and innovation, propelled by IS/IT are the key forces shaping the economic landscape (Spanos, *et.al,* 2002). On top of that, there is a need to transform organisation (i.e. reducing managerial layers, increasing flexibility, using team based work etc) to facilitate integration pertaining to functions at all levels (Farbey, *et.al,* 1994; Johnessen, 1994; Spanos, *et.al.*,2002).

The past decade has seen a rapid development of IS/IT to facilitate such changes in many industries (Clegg, *et.al.*, 1997; Smithson and Hirschheim, 1998; Serafeimidis and Smithson, 2003; Hussien and Selamat, 2005). Avgerou (2000) defined IS/IT role in organisational changes as an "enabler" of organisational objectives. Undoubtedly, IS/IT is well known as a tool to enable organisation to quickly respond to market changes and therefore improve product/service quality (Porter and Millar 1985). IS/IT is also recognised as a powerful agent for social and economic change (Chan, 2000).

In their study, Graeser, *et.al.* (1998) expected, in some organisations, the investments may exceed 50% of annual capital investment and it has been suggested that, by 2010, the average IT expenditure will be 5% of revenue. A year later in 1999, Remenyi and Smith (1999) claims that more than 50% of all business investment is spent on IS/IT. According to May (2001) it is expected that the average Fortune 200 firm will spend 20-40% of its operating budget on IS/IT just to stay competitive.

2. TRADITIONAL IS DEVELOPMENT METHODOLOGY (ISDM)

The development of IS/IT during 1980s involves a number of phases as shown in Figure 1 (Avison, 1992; Avison and Shah, 1997; Maguire, 2000). This type of approach have been grouped under the heading of ``hard systems methodologies" and has proved popular with IS/IT professionals since it caters for their needs as technical staff who view information system development as systematic problem-solving (Checkland and Howell, 1998; Maguire, 2000).

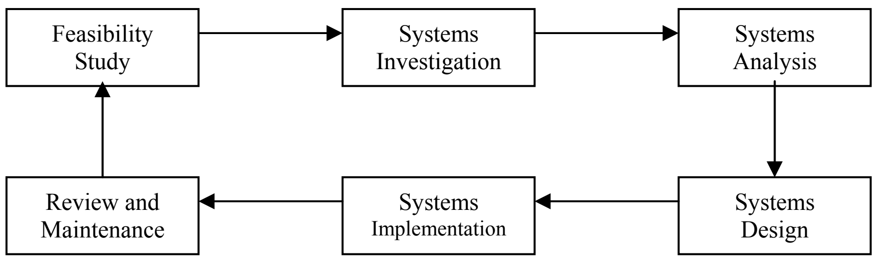

Figure 1: Conventional systems analysis – the systems development life cycle

However, this IS/IT methodology suffered several criticisms from many authors. The majority of IS/IT development have been developed using a predominantly technical perspective and insufficient attention is given to the social and contextual aspects of IS development (Avison and Wood-Harper, 1990; Avison, *et.al.*, 1998; Maguire, 2000). Another view by Avison (1992) claims, such methodology faces many problems such as failure to meet the needs of business, inflexibility, user dissatisfaction etc.

By the early 1990s, this approach was no longer sustainable as the managers started to realize that the IS/IT evaluation should be based on business results rather than technical performance (Serafeimidis and Smithson, 2003). (Figure 2)

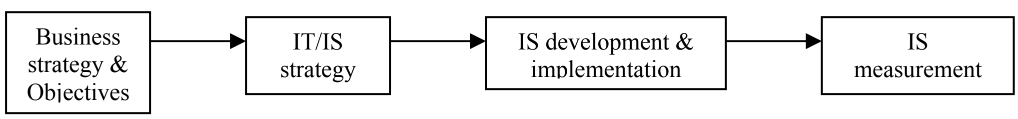

Figure 2: The systems development life cycle – early 1990

In spite of IS/IT development approach has been revised to suit the current needs, there are still high rate of systems failure. In their study, Clegg, *et.al.* (1997) find that 80%-90% of IS/IT investments do not meet their performance objectives and around 80% of new systems are delivered late and over budget. A report of The Chaos (1995) by the Standish Group, incorporated data from several thousand IS/IT projects, revealed that 31.1% of projects will be cancelled before they ever get completed. Furthermore, in his study, Ewsui-Mensah (1997) reported that 31% of new IS/IT projects are cancelled before completion at an estimated combined cost of $81 billion and that 52.7% of the projects completed are 189% over budget at an additional cost of $59 billion. This high rate IS/IT failure has described the significance of IS/IT evaluation to measure the effectiveness of the system particularly that emphasis on holistic and broad evaluation framework which incorporates the different IS/IT success measurements (Brynjolfsson and Hitt, 1998; DeLone and McLean, 1992). Meanwhile, Hochstrasser (1992) argues that the high rate of IT/IS failure is partly attributable to a lack of solid but easy to use management tools for evaluating, prioritizing, monitoring, and controlling. Another opinion by Voss (1986) claims that new IS/IT investments fail due to organizational problems, and identified economic justification as a significant contributing factor.

3. ORGANISATIONAL IS READINESS

The organisational change process is always problematic to the organisation particularly when the changes is due to the introduction of new IS/IT (Appelbaum, *et.al*, 1998). Karake (1994) identifies major changes in IS/IT are profoundly affecting the people, processes, structures and strategies of an organization. Katzenbach (1996) and Smith (2005) suggests the hardest things when dealing with the organizational changes lies in changing the people system that including organization's structures, planning and control systems, job specialization, training and education programs, degree of centralization, delegation and participation (Volberda, 1992).

The resistance to change might occurred due to lack of creating a sense of need and urgency for change among the employee (Kotter,1995; Clegg. e*t.al.*,1997;Smith, 2005) and eventually organizational members unable to share the vision and mission for change if they do not feel any dissatisfaction with the current practices.(Smith, 2005). Lack of internal capabilities to communicate a vision and mission to its employees also can contribute to the resistance to change (Appelbaum, *et.al*, 1998; Bernerth, 2004; Smith, 2005). In their study, Cunningham, *et.al.* (2002) successfully hypothesized, that proper communication of change would improve employee's perception towards required competence, service quality and relationship and consequently reduce the possible of resistance for change. Appelbaum, *et.al* (1998) added that the successful organisation change only will come in reality when managers achieving the agreement or consensus of employees. This is obvious when the changes involving the introduction a new IS/IT because it is not just a change in technology, but also a change in structures, duties, tasks, and personnel. (Volberda, 1992; Jones, *et.al.*, 2005).

Therefore, to reduce the resistance to change by creating sense of urgency to change and improve communication, it is essential that prior the introduction of new IS/IT, the organisation needs to determine levels of readiness for change by measuring its internal capabilities (Beckard and Harris, 1987; Schein, 1990; Appelbaum, *et.al.*; Smith, 2005). By knowing the level of readiness, an organization is able to create such activities i.e. training and education that needed prior IS/IT implementation (Appelbaum, *et.al.,* 1998). A failure to assess organisational readiness prior the IS/IT implementation may result in mangers spending more time dealing with the resistance to change or even worst may result in IS/IT failure (Smith, 2005).

There are many definition of readiness can be found in the literature. Armenakis, *et.al.* (1999) defined readiness; *"as a state of mind reflecting a willingness or receptiveness to changing the way one thinks."* Whereas Jones, *et.al.* (2005) defined readiness; "*as the extent to which employees hold positive views about the need for organizational change (i.e. change acceptance)."* Furthermore, Appelbaum, *et.al* (1998) suggests a readiness;"as *the extent to which people in the organization are ready to adopt and use the new technology and will determine the magnitude of the change efforts needed"*.

In order to measure current and expected organizational capabilities for a particular IS/IT project, it should adopt the maturity-level techniques to measure the level of the readiness (Galliers and Sutherland, 2003; Saleh and Alshawi, 2005). The gap between the current and expected organisational capabilities is known as "Readiness Gap" (Saleh and Alshawi, 2005). However, some authors describe this gap as a "Discrepancy Gap" (Armenakis, *et.al*. 1999; Smith, 2005). Each maturity level should address the four key organisational elements i.e. IS infrastructure, people, work environment and process (Trahant and Burke, 1996; Ruikar, *et.al.*, 2005; Saleh and Alshawi, 2005). By knowing the readiness gap, its will assist organizations to focus on specific areas such as knowledge, skills and abilities that need to be addressed in order to create the critical energy for change to occur (Beckard and Harris, 1987; Hitt, *et.al.*,1996; Appelbaum, *et.al.*,1998).

4. PROBLEM OF EXISTING MEASUREMENT APPROACHES

To date various methods have been developed and introduced in the field of IS/IT measurement. However due to the rapid developments of IS/IT, some IS/IT measurement methods become obsolete and suffered with a many problem (Smithson and Hirschheim, 1998; Kempis and Ringbeck, 1999; Remenyi and Smith, 1999, May, 2001; Saleh and Alshawi, 2005; Serafeimidis and Smithson, 20003; Leem and Kim, 2004). According to the literature, there are numbers of problems of current IS/IT measurement method, however the central issues are circulating within four categories:

1) Mainly on post- investment measure

In their study, Kumar (1990), Saleh and Alshawi, (2005) state that the majority of current IS/IT measurement approaches are mainly post-investment measures. Small and Chen (1995), Kempis and Ringbeck, (1999) claims the organisation will lack of management guidelines to support investment decision making and they are not successful in embodying detailed and protocol evaluation procedures prior the investment. Clegg, *et.al.* (1997) found that careful and systematic measurement of the operational performance of IS/IT investments against their objectives very rarely takes place. Kumar (1990) also added that the most of IS/IT measurement has been done in practice is post-implementation evaluation that is due to the project closure and not project improvement.

2) The majority of existing measures of IS/IT are related either to the product itself or to its underpinning processes.

The product based measures are concerned mainly with technology, user satisfaction, use, and financial impact. Remenyi and Smith (1999) suggest most of IS/IT projects implemented with technology objective and therefore more focus on technical evaluation. Stewart and Sherif (2003); Ballantine, *et.al.* (1996) demonstrated that technology success does not guarantee that it would be accepted or used by the user. Despite of that, satisfying an individual user does not mean the systems is success. Furthermore, Grembergen and Amelincks (2004); Peacocka and Tannirub (2005) raised the limitation of financial approaches, such as Net Present Value (NPV), which have been shown inadequate in capturing qualitative and quantitative benefits, and techniques developed.

Process-based measures also suffer many limitations. For example, they are developed to assess the process which underpins the development of IS/IT projects and not to assess the effectiveness of IS/IT projects on business processes and business objectives (Saleh and Alshawi, 2005). In addition to these two types of measures, IS literature outlines other approaches which focus on assessing organizational maturity in terms of IS/IT planning, IS/IT infrastructure and utilization, and the management of IS/IT functions. Although the general measurement approaches explain the basic idea behind the evolution of IS/IT in organisations, they are simplistic and may not reflect reality, especially in light of the current pace of change in technology (Saleh and Alshawi, 2005).

3) Lacks of human and organisational aspects (soft issues)

Smithson and Hirscheim (1998) warned that the new IS/IT investment normally has social, organizational and human impacts and is not just a costs and technological activity. In the past, there has been a failure to integrate socio-technical issues with regard to IS/IT measurement (Hendrick, 1995). This is support by Willcocks and Lester (1993); Serafeimidis and Smithson, (2003) stated that in implementing and measuring the IS/IT, there is constantly lack of understanding of the human and organisational issue.

4) Lacks an holistic and broad evaluation

Many researchers has agreed with the issue of lacks of a holistic perspective on IS/IT measurement. Serafeimidis and Smithson (2003) mentioned the existing IS/IT measurement do not take into account the fact that evaluation is a socially embedded process in which formal procedures entwine with the informal assessments by which actors make sense of their situation. Therefore, they contribute to one piece of the picture but are not rich enough to describe the complex impacts within organizations. Meanwhile, DeLone and McLean (1992); Coleman and Jamieson (1994); Esther and Brooze (1995); Remenyi, *et.al.* (1996) suggests new measurement approaches are needed to support a richer examination of these intangible aspects.

6. PROPOSED MATURITY MODEL

The proposed model is an attempt to address the problems issues described in the previous section;

- The model is intended to be used prior IS/IT project implementation

- The model is a holistic in nature and focus on soft issues which embrace all the key organisational elements; IS/IT, People, Business Processes and Work Environment.
- The model should adopt the maturity-level techniques to facilitate the measurement of the "Readiness Gap" i.e. the gap between the current and the required state of readiness, prior to the implementation of a selected IS/IT project.
- Each maturity level should provide guidelines for managers to improve the readiness status and progress through the maturity levels.

The proposed model is a maturity model composed of six progressive stages of maturity that an organisation can achieve in their investment and implementation of IT/IS. These maturity stages are cumulative; which means, in order to get a higher position in the maturity stages, the organisation must comply with the pre-ordained requirements for that stage (in addition to those for all the lower stages). Table 1 describes the scope of the proposed model. Whereas Table 2, 3, 4 and 5 provide the summary of each elements.

The proposed maturity model offers three key IS/IT capabilities for an organisation:

(1) As a tool for internal evaluation of the organisations' capability of IS/IT.

(2) As an indicator to the state of the organisation's readiness prior to IS/IT investment.

(3) As a road map that organisation can use for improving their IS/IT future investments

7. RESEARCH METHOD

The combining quantitative and qualitative methods known as 'triangulation' will be used to develop a proposed maturity model. The use of triangulation method is due to different variables (organisational factors) exist in the proposed model (Sekaran, 1984; Neuman, 1997). The validation process will be carried out over a few case studies which will enable to validate the details of the model, in real life. The assessment will be undertaken through a number of interviews with the concerned people within the organization. This process is expected to follow these steps i) a meeting with IS/IT Department's representative to explain the concepts of the model and secondly to identify an IS/IT system within the organization that is appropriate for validating the model. With the help of the IS/IT Department's representative, suitable people will be identified for a short interview ii) a number of meetings will be carried out with the identified individuals. These meetings will follow semi-structured interviews where data will be collected to validate the model.

8. CONCLUSIONS

The paper highlighted the changing climate of business environment that urge a company to reshuffle their organisation in order to meet the challenge. In this scenario, IS/IT is seen as a predominantly tool to facilitate this changing. A million of pound of IS/IT investment has been spend particularly to address this issue; however the failure rate of this investment is still high. This is a 'wake up' call for the industrialist and researcher to review the way of IS/IT is been developed and what method and means has been used to evaluate the successful of IS/IT implementation. This has led to the development of proposed model to provides a quick and easy reference for the manager to improve their IS/IT management toward the highest maturity stage.

Table 1: The Scope of the Proposed Model

Key Elements	Attributes	Sub-Attributes	Characteristics
IT/IS Infrastructure	Top management perception	• Drivers • Aims of application • The Requirements	Describes top management strategic thinking and direction towards the development and utilisation of IS/IT in their organizations.
	System and Communication	• Focus • Application • Communication	The development and utilisation of IT/IS applications in support of organisations' direction and strategic plan. The IS/IT network to support the communication and information exchange.
People	Users Involvement	• Relationship	The level of involvement of staff in the IS/IT developments in organisations and the relationship between users and developers.
	Roles and responsibility of IT staff	• Position • Roles	The roles and responsibility of IT staff in organisations who are involved in the development, implementation and management of IS/IT.
	Skills	• Type of skills • Training	Skills available/required to effectively implement the IS/IT in organisations
Process	Business Processes	• Business Process • Success	Represented by the process "Practices" within the organisation
Work Environment	Organisational behaviour	• Characteristics	Organisations' perceptions on the use of IS/IT
	Leadership	• Participation • Communication	The leadership style at both operational and strategic level
	IT Department	• IT Governance	The role and responsibility of the IT departments to provides IS/IT services including infrastructure and applications

Practically, there is not compulsory for all key elements or attributes of the proposed model to be at the same level of maturity to be considered as successful IS/IT implementation. This is due the factors that the required state of readiness may be different for each element for any given IS/IT and the nature and requirements could vary from one organisation to another. The proposed model is might be useful in that it takes a holistic view of IS/IT implementation issues. While the proposed model cannot pretend to give all the answers, it does provide a model which enables appropriate questions to be raised when setting out an appropriate IS/IT implementation plan. Further testing and refinement of the model is needed to provide a sufficient useable and useful model to assist managers in their IS/IT implementation.

Table 2: IT/IS Infrastructure Element

Level of Maturity	Drivers	Aims of Applications	The Requirements for IT/IS	Focus	Application	Communication
6	Global Competition	Strategic Use	Strategic Alliances	Strategic business core-capabilities	Inter-organisational	Inter-organisational network
5	Partner's Supply Chain	Supply Chain	Supply Chain Relationships	Supply-chain	Supply-chain	Supply-chain network
4	Business Process Improvement	Organisational-Wide	Mainly In-House with Vendor Interruption	Decision making	Decision support	Organisational network
3	Organisation Communication	Organisational-Wide	Mainly In-House with Vendor Interruption	Full integration	Data management systems	Organisational network
2	Work Task Requirements	Business-Units	Partially In-House and mostly from Vendor	Information co-ordination	Business operation	Business unit network
1	Copying/Duplication	Operational Tasks	Vendor	Operational tasks	Functional	Standalone

Table 3: Work Environment Element

Level of Maturity	Organisational Behaviour	IT Governance	Participation	Communication
6	Knowledge culture	Hybrid/Federal	Participate in continuous improvement	Continuous communication improvement
5	Capability approach	Hybrid/Federal	Participate in measuring IT/IS effectiveness and efficiency	Well documented and integrated communication planning
4	Organisation approach	Centralised with application organization-wide policy	Participate in most IT/IS activities	Communication plan for all activities
3	Cost approach	Centralise	Participate in large IT/IS implementation	Organisation-wide policy and standards for communication
2	Technology approach	Decentralised	Ad-hoc participation	No established standards for communication
1	Ad-hoc approach	No policy control	No participation	No communication

Table 4: People

Level of Maturity	Type of Skills	Training	Position	Roles	Relationship
6	IT core capabilities	Inter-organisational sharing experience	IT Manager with full member of board of director	Business strategy	Central IT/IS reference
5	Cross disciplinary	Knowledge sharing	IT Manager with senior management status	IT strategy	Permanent member in IT/IS project team
4	Decision making	Central training	IT Manager with middle management status	Organisation information management	Focus group consultation
3	Technical project management	Central training	Technical IT Manager	Purchasing policy & centralised IT/IS activities	Focus group consultation
2	Purely technical	Team-based	IT Manager at IT department	Technical support	Individual consultation
1	Basic	Individual effort	No IT personnel	No role	No user involvement

Table 5: Process

Level of Maturity	Business Process	Success
6	Continuous improvement	Partner's project team
5	Capable to set quality goals and measure	Supply chain relationship
4	Standard description model	Business process integration
3	Documented, standardised and integrate across organisation	Business process integration
2	Identify scope	Work group team effort
1	Unpredictable and constantly change	Individual capabilities

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VIRTUAL ENTERPRISES IN THE WEST EUROPEAN CONSTRUCTION INDUSTRY

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ABSTRACT: The construction industry based on three pillars: design & engineering, construction, and the supplying industry affects network systems supporting collaboration and cooperation. Contracts as e.g. public private initiatives (PFI), public private partnerships (PPP), concessions, virtual contracts (VC's), and performance contracting (PC) require integrated cooperation. Referring to the essence of the construction business and its processes organizing construction capacity will be enforced by adaptation and application of emerged information and communication technology (ICT), which has an enormous impact on business process reengineering.

Keywords: Network systems; Integrated Cooperation; e-Business models; virtual enterprises

INTRODUCTION

This paper on the subject of virtual enterprises points in particular at the West European construction industry. During the last two decades the construction industry of Western Europe shifted partly from craftsman thinking in organizing and controlling the construction process towards industrial thinking. The construction industry in the UK, France, Germany and the Netherlands represents currently about 7 to 9 % of annual GDP according to figures of the CPB (2002). So the construction industry is of importance as an economic indicator for national economic growth. However, is the construction industry a sustainable factor as an independent industry?

Considering the importance of maintenance and renewal of five major infrastructural components as living, connectivity, working, leisure and storage organizing construction as such is still business. Due to the achievements established during the reconstruction period between 1945 and 1990 the current situation centres mainly on quality of the infrastructure and not on capacity. Current demand on the property and real estate markets is determined by quality instead of capacity. Demand for quality of infrastructure points at forces supplying e.g. houses, offices, railways, airports, motorways, leisure parks, and store houses meeting the quality standards of respectively real estate and property markets. The construction industry is based on three pillars: design & engineering, construction, and the supplying industry affecting network systems supporting collaboration and cooperation inducing contracts as public private initiatives (PFI), public private partnerships (PPP), concessions, virtual contracts (VC's), performance contracting (PC), and enforced design teams (EDT's).

Considering the construction industries' use of the Internet as a medium and adaptation of Internet technology is expected to lead to a transition of traditional business models into entering the web and elaborate web-based e-Commerce and e-Business models. The construction industry in Western Europe partly uses e-Commerce and it is of relevance to point at the transition into e-Business models (Kalakotra 2001) in particular looking at the rapidly changing current socio-economic environments. Integration of design, engineering, construction and asset management to manufacture (build) products for real estate and property markets induces a paradigm shift of the construction industry towards a paradigm of organizational markets serving adjacent markets as the real estate and property markets.

Title

The current situation of the construction industry and the extension of use of ICT, which are the main factors to do further research, the author comes to the following thesis for this paper:

"Organizational markets driven by ICT induced business models as e.g. e-business models matching virtual enterprises will replace the construction market".

Organizational markets are driven by equilibrium between demand and supply on adjacent markets as those for housing, property, financial services, public services, transport, leisure, and storage. ICT induced business models for instance virtual networks and virtual enterprises, which are based on contracts between legally independent partners and their economic sense to achieve the same objective pointed at a maintenance or building concept. The construction market appears to be a metaphor of the past due to the fact that division of labour is an autonomous factor on adjacent markets and a substitute of the general contractor. The general contractor has become an engineer outsourcing 90 % of his contract to establish and build an object and adding 10 % value. To find explanation and proof for the thesis statement research is focused on the critical success factors of the e-Business model of the virtual enterprise, which relates business strategy, culture (including individual roles, structure, and operational management), and technology. The virtual enterprise is assumed to be related with a sustainable performance and according to Strickland (2000) aligned to a feasible strategy.

Objective

To find explanation research is pointed to detect, analyze and conclude on the alignment of ICT enforced business strategy, business culture, and information technology in the strategic process, to come to choice on the e-Business-model of virtual enterprises and forming strategic content and on the long run change current industrial organization of the European construction industry. Considering the fact that trends in development of information and communication technology enable organizational changes and business process reengineering disappearance of the construction industry will occur. A shift by concurrent engineering induced specific supply towards adjacent organizational markets serving housing, business property, leisure, and connective infrastructure will occur within 5 to 10 years.

Research

Given the objective of this research paper the review of literature and survey is pointed at: Alignment of business strategy, culture covering operational management orientation on concurrent engineering and structure. Technology and in specific the Internet technology enabling an ICT strategy to support the e-Business model of virtual enterprises.

Theory

New Economy

During the 19-nineties the New Economy was the hype on economics. Kenichi Ohmae addressed it as the Invisible Continent (Ohmae 2000) and explained it in four dimensions. The first dimension is the visible dimension, which is related with the local physical present capacity of economies. The second is the borderless dimension, which is due to the internationalisation of the “information climate”, which became imaginable since the 19-fifties. The available information will change decisions based on competition by politicians and executives. The Cyber dimension is the third, which makes it possible to walk with the electronic mobile wallet and get the right information when you need it. Dimension of High Multiples forms the fourth. The unprecedented leverage factor provided by the Internet will lead to expansion of capacity of businesses and its networks (Liautaud 2000; Kalakotra 2001). The Internet as an applied technology offers a borderless world, which connects the individual with local networks and wide area networks and makes according to Grantham (2000) transborderdataflows (TBDF’s) possible.

The society of industrialized countries is confronted with the limits of the industrial revolution and has to deal with inequalities between economies in a different way than it used to do. Meeting the borderless dimension knowledge and experience on design & engineering, and construction proofed to be important production factors, which are known and promoted through the Internet. However, due to inequality between economies construction capacity & capabilities in the industrialised world shall and will be shared by transfers of knowledge and experience meeting the visible dimension. Rethinking construction (British report 1998) suggests the connectivity of all production factors and demands for virtual organizations based on co-operation and partnerships that bridge space and time, and build communication to come to co-ordination to deploy our capabilities. E.g. natural resources are becoming more and more the domain of global operating industries and clustering is found around the dispersed sites of these industries and influence of local regulation. Globalisation has become unavoidable and strategic alliances are considered part of business. The Internet makes a flow of information from PC to LAN (local Area Networks) to WAN (Wide Area Networks) to Economies possible, or in other words transborderdataflows TBDF’s are part of our daily existence and practise. The key challenges to find solutions are: Communication, co-operation, co-ordination, and documentation. The construction industry meets problems using IT and CT due to the fragmentation of the industry, no dominant factor to enforce ICT than procurement; the client is not interested in organizing construction but in the product; companies are involved in more than one network; the focus is on short term relationship and not on long-term partnership. The future of work is determined by development and use of technology to augment human function, but not being used to augment humanity as Charles Grantham (2000) argued. Network computing is becoming a dominant factor in organizational structures and obsolete. Computer networks acknowledge two transmission techniques (1) broadcast networks and (2) point-to-point networks. A computer network is a distributed system of autonomous computers connected by middle ware on the World Wide Web (www) and presenting themselves as a business paradigm. A system of dispersed workplaces accepting certain rules and procedures to connect and to be part of a network. Digital information is of importance to small medium enterprises and to large-scale enterprises. Client server models proved to iterate and combine two processes of clients and servers into a powerful communication medium of which e-mail, distance writing of reports and videoconferencing are till now the most used applications. When in particular focussing on the construction industry virtual organizations and enterprises are long-term alliances between two or more firms with compatible objectives mainly focused on projects. The construction of an object is a compatible objective in particular because they are focused on projects or specific businesses. To erect objects information and communication is required on the project and its processes.

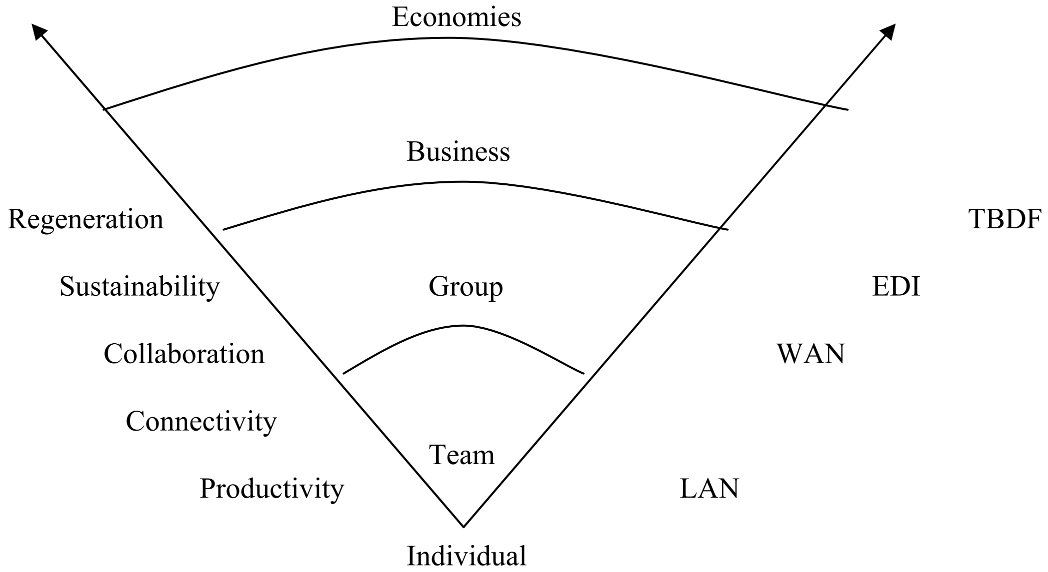


Figure 1: Source Charles Grantham (2000) Technology's impact in the workplace diffusion of technology over time.

The Construction Process, supply chain, and Information and Communication Technology (ICT)

The construction industry is considered to be traditional referring to the fact that it is a fragmented industry, locally organized and primarily focussed on capacity. Many participants in the construction industry offer the solutions of clients' needs. The businesses of these agents cover three activities: (1) design & engineering; (2) organizing construction and procurement, and (3) the supplying industry. Design & engineering induced by developers and project initiators cover the activities of city building, architecture, engineering and asset management. Construction networks cover organizing construction capacity, capabilities, and procurement pointed at regulation, co-ordination, mobilisation and allocation of labour, equipment, and supply of services and materials. The supplying industry is part of global operating industries that organise supply of concrete, bricks, and prefabricated wooden elements, glass, cement and polymers. These industries show breadth in the products and services they supply. Considering Construction Networks the distinction between the value chain and the supply chain is of importance to detect a basis to organise these virtual organisations. The value chain covers the material distribution from the moment of decision till delivery to use. The supply chain covers the physical distribution from the moment of starting construction till key delivery. The construction industry is according to its habits traditionally organised. The invention of the steam engine and electric engine offered in combination with the industrial revolution the opportunity of industrialising the construction process. However, tailor made solutions require often craftsmen on the production site in particular when building of houses is involved. Because of that the traditional approach to build often remained. The following figure (source: Krijgsman 2001) points at integration of the value and supply chain:

Looking at the fact that organizing people, equipment and construction technology on a production site is the raison d'etre of construction firms, ICT will play a major role in organizing project management in the near future. Referring to the previous model the relations are described as follows:

Customers' needs and demand are specified by design, description of materials, construction method and level of completion. Overall design is printed in drawings and written in a construction manual. The architects and engineers deliver design, mathematical calculation, drawings of engineering and construction, and list of materialization with level of completion.

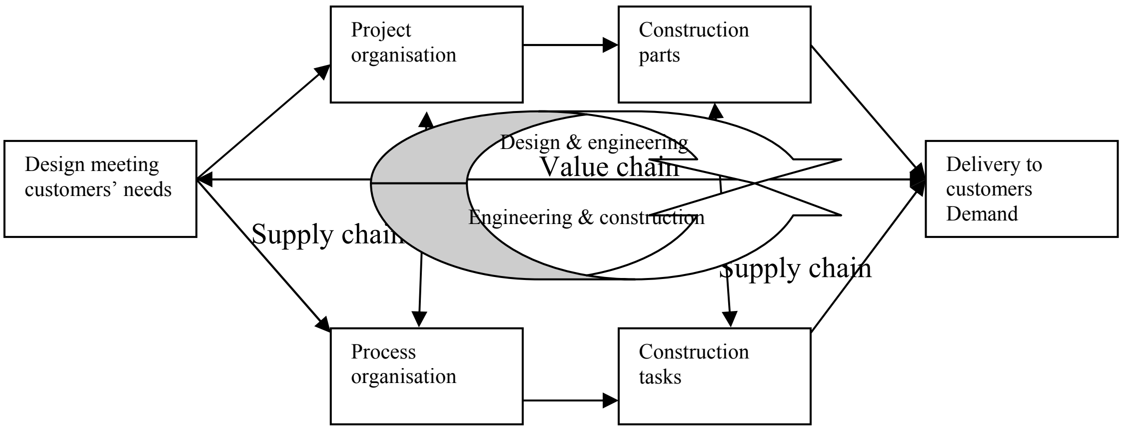
Project organization covers the necessities to come to construction, which are:

- Design and engineering (drawings, specifications, mathematics, physics, and calculations)
- Brands of prefabricated elements of construction and level of quality of completion.
- The construction contract; Guarantee arrangement; and Quality assurance.

Process organization covers the actions of mobilisation and allocation of tangible goods, labour, and equipment on the right time and moment to complete the construction tasks.

Network development fulfils a major role to establish the marketing – mix of a construction firm and is essential for its future existence.

Figure 2: Model relating project and process organization integrating the construction chain

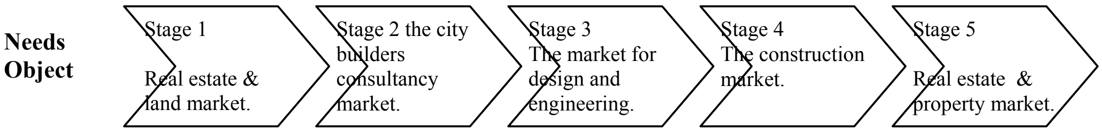


Source: Krijgsman 2000/Worst 2004

When using the Internet to implement virtual organization of construction it is of importance how alliances and partnerships are connected to local networks. Of importance is the feasibility to implement these often-traditional networks into virtual organizations. Given the elements of the construction project it is of importance to know, which party is of dominance during the phases of the process, from the moment of the initiative and feasibility analysis till the moment of delivery. When relating the previous matrix to model 2 of the value chain the construction process and construction tasks are defined per stage of the value chain and the adjacent markets of the construction market. Communication is based on application of concurrent engineering (CE) as is the concurrently relation with adjacent markets.

Referring to the research of Prof. Bakens (1988) five distinct scenarios occur for the construction industry to meet the challenges, e.g. changes of demand and supply, changes and application of information and communication technology determining the future environment. These scenarios were described from the point of view of the leading parties in the construction process. Co-operation between partners in the process exists because of dominance of one of the parties in the process. Segmentation and fragmentation of the construction process are the main determinants for dominance in the construction process. Co-operation and domination are different per project. According to Bakens (1988) the five scenarios are considered to have general identifiers. General identification is made by him considering the dominance of partners in **organization** in particular focused on **co-operation** and **co-ordination** between participants and the coherence between project organization and process organization. Collaboration, co-operation, co-ordination and communication are critical drivers for the construction process as in many similar highly perplexed, creative, intellectual processes and scientifically discussed in papers and research reports (Ancona and Zorgno 2001) in particular pointed at the construction industry in comparance with other industries as e.g. the automotive industry.

The traditional construction process is based on a strong demarcation between design and engineering and construction. The architect was the representative of the principal (customer) and dominated as director the construction process, however, it is odd that customer is often not involved in the process. The modern construction process includes the principal (customer) and the bar between design & engineering and construction has partly disappeared. Basic for the modern construction process is the bar between design & engineering and construction.



|-------------------------Demand---------------------------| |----------------Supply---------------|

Figure 3

In fact the fourth stage and the closest to the customer by completion and delivery of the product is traditionally determined in the model of the following supply chain.

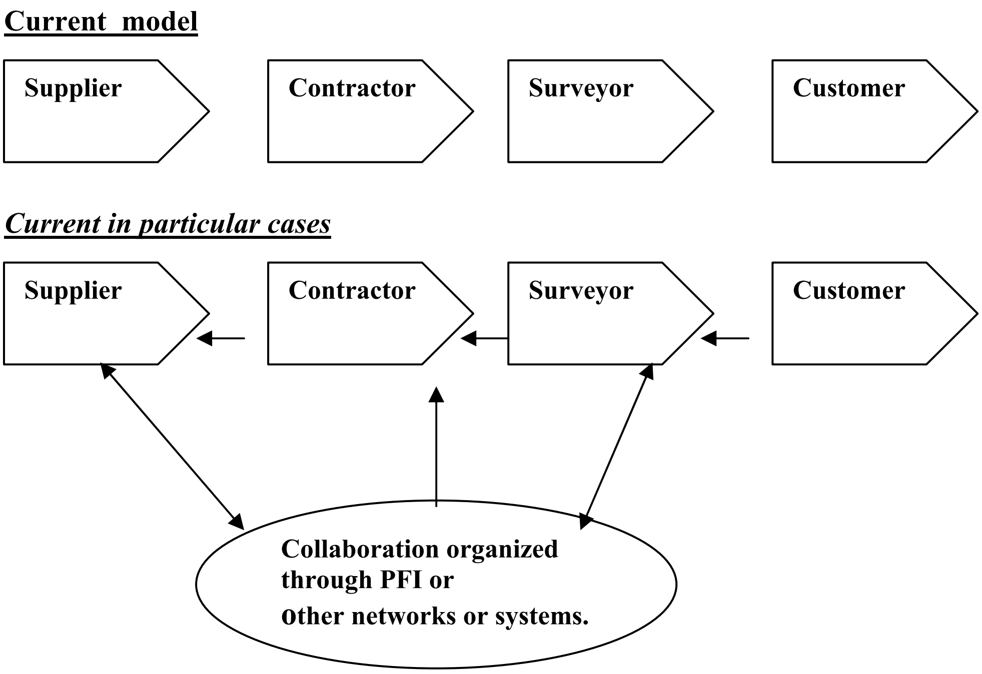


Figure 4: Current cases

According to the ideas of Kalakotra and Robinson(2001) it might emerge to the following (soll = as the model should be) position.

Emerging model

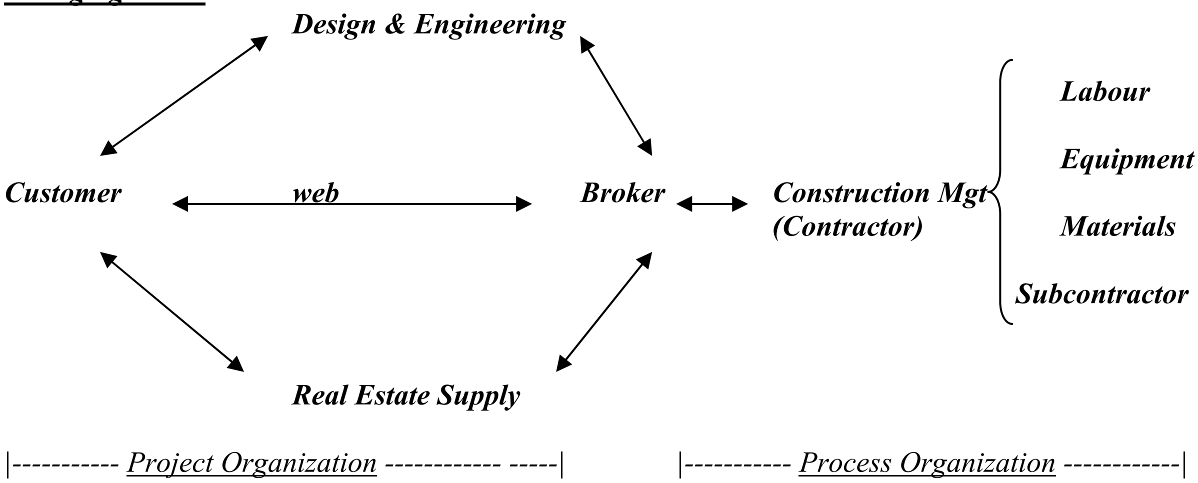


Figure 5: The impact of information technology.

The future of work is determined by development and use of technology to augment human function, but not being used to augment humanity as Charles Grantham (2000) argued. Network computing is a dominant factor in organizational structures and obsolete. (Peer-to-Peer; Client-Server; the Grid).

Virtualization

When in particular focussing on the construction industry virtual organizations and enterprises are long-term alliances between two or more firms with compatible objectives mainly focused on projects. The construction of an object is a compatible objective. Organizing collaboration, cooperation, coordination and communication is done through structuring information flows by transferring project organization into construction parts and process organization into construction tasks as shown in the transfer model. This is the main topic to come to an e-Business model for organizing construction Networks are essential to organize collaboration and cooperation, and establish communication between different partners. Regarding virtual organizations literature provides several definitions of which the most challenging given the objective of this paper are mentioned hereafter:

1. Ahuja & Carley: “A virtual organization is a geographically distributed organization whose members are bound by a long-term common interest or goal, and who communicate and co-ordinate their work through information technology”.
2. Leimeister: “A virtual organization is a form of co-operation between legally independent companies, institutions and/ or persons that joint forces on the basis of a common economic sense and/ or objectives in order to create a service or a product”.
3. Lipnack & Stamps: “A virtual team is a group of people who interact through interdependent tasks guided by a common purpose that works across space, time, and organizational boundaries with links strengthened by webs of communication technologies”.

According to Prof. Dr. Charles Grantham (2000) emergence of multimedia, virtual reality, and the Internet are more than tools. These technologies have changed the nature of work and education, because integration of technologies means integrating computers and Internet, education, telecommunication, and work practises. Networks provide the day-to-day practise of knowledge and skills and require new ways of thinking and approaching problems. Transferring the previous definitions to dispersion, co-ordination, co-operation, and communication the following matrix is extracted:

Matrix 1: Relation between determinants and reasons.

DETERMINANT OF VIRTUAL ORGANIZATION:	REASON WHY COMMITTED TO A VIRTUAL ORGANIZATION:
Geographically distributed members	Long-term goal or interest
Communication and co-ordination	Through IT
Co-operation	Staying legal independent as companies
Joint forces	Common economic sense or objective to create a service or product
Interaction	Through interdependent tasks
Bridging	Space
Bridging	Time
Bridging	Organizational boundaries
Strengthened	By webs of communication technology

Enterprises are based on the ability to think of new activities or ideas and make them work and defined according to WorldNet 1.5 Helper as "the people belonging to an organisation created for difficult ventures". The IEEE Communications Society, the technical Committee on Enterprise Networking introduces "the Enterprise Networking is the interconnection of corporate, departmental, local, and remote computing and communications resources to create an enterprise-wide information utility (an "enterprise" is an organization, such as business, government, administration, institution, etc., having business or other operating needs)" (Nikolik 2002). Organizing networks through local area networks (LAN's), wide area networks (WAN's), enabling transborder data flows (TBDF's), use of the Internet technology and communication, and working with databases are topics to build networks based on computer networking and relevant in the context of this research. The way we communicate has changed during the last two decades. Communication is done face-to-face and by multimedia networks. Information items are data models, multimedia, compound documents. Information technology approaches a level of connectivity and sophistication, while application is not pure a technical matter, but too a matter of structure. The model connecting a large number of independent computers is doing the job and uses a transmission technique to transfer information and communicate. Looking at transmission techniques point-to-point networks are of major importance to come to a structure of virtual organisations. Small and medium enterprises want to share information and will in particular focus on sharing digitised information. A distributed system as the World Wide Web connecting autonomous computers through middleware present itself as a paradigm. The paradigm of a client server model uses two processes pointed at the client machine and on the server machine. The World Wide Web offers improved communication to do business and serve according to Tanenbaum (2003) 4 objectives: E-mail, distance writing of a report and videoconferencing, E-commerce focused on business to business, and E-commerce focused on business to consumer. E-commerce means the same for the construction industry as for other industries. E-commerce will be transient through transition of business models into virtual construction enterprises (VCE's) establishing formal cooperation between legally independent partners to collaborate, coordinate and communicate on a common economic sense to achieve a common objective in civil and utility construction. Clear ICT strategies pointed at ICT development and ICT structures pointed at ICT acquisition and application by all partners require implementation of a virtual organized framework. The question is which partner will be of dominance to control the projects to deliver the final product and who will manage the virtual construction enterprise (VCE) considering the many parties involved in the construction process. The West European construction industry has to deal with different forces of change, which are determinants for the future on the long term. They are explained as follows:

1. To improve performance on the long run the strategic choice of general contractors need to be focused on pursuing differentiation combined with internationalisation, and globalisation. Project leadership is the main objective to improve performance. Labour and equipment are domestic resources mainly locally/regionally controlled.
2. Procurement is the main driver to come to partnerships. Competition on domestic markets will be focused on quality and branding. Because of its fragmentation current virtual construction organizations and enterprises are locally and regionally organised and mainly focused on the opportunities of e-Commerce by addressing purchasing power to benefit from economies of scale.
3. Total quality systems and ICT are partly used to control the construction processes in the value chain. Information and communication technology is mainly focused on organizing procurement on the condition of full collaboration, cooperation, coordination and communication. Clear ICT strategic choice (response to technological change) followed by a clear ICT structure (planning and control) are drivers for gaining competitive advantage.

Modelling alignment of strategy

According to Venkatraman (1991) ICT (and MIT'90) is recognized as an enabler for business transformation in coherence with redesigning business processes and business relationships to come to a reviewed definition of business scope as shown in the following alignment model (*figure 6)*.

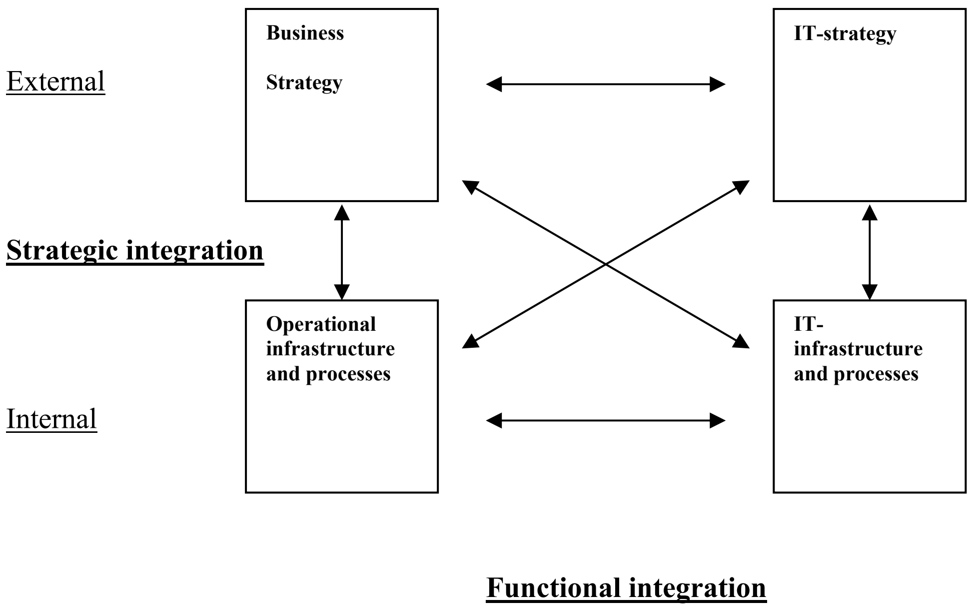


Figure 6: Adapted from Henderson and Venkatraman.

Due to the growing importance of ICT in the 19-nineties top management accepted an alignment of ICT in the business mission and the business infrastructure according to J.M. Burn (1997). However, looking at annual reports of large-scale construction firms in Europe

ICT is not seen as an enabler for change, but as an enabler to gain competitive advantage on cost behaviour, total quality management, and gathering accurate and complete data structurally framed in management information models to control the construction process. Referring to the conclusions of Janice M. Burn (1997) on effective management of alignment the following findings are regarded:

- **Alignment** is not a one-time activity but a constant balancing act between a lead or lag strategy.
- **Alignment** through lead-lag is typified by cycles of change, and these cycles tend to be specific to particular organizational types and particular industries.

Knowing these cycles of change and your interrelated organizational position will facilitate management of the alignment process. By forming an alignment groups or equivalents support each other. It is supportive to the business, however, considering the state of the art at 2005 of the construction industry the reverse is required in particular when looking at the demand for change of business models forwarded by the impact of available Internet technology and ill used capacity.

In their research ("Cahier de recherché "Institut de recherché sur les PME" published in June 2002 in Business Excellence I titled Strategic alignment of information technology : Performance outcomes in small and medium-sized firms. The authors are Francois Bergeron University Laval Quebec, QC, Canada GILK 7P4, Louis Raymond, University Quebec at Three Rivers, and Suzanne Rivard Ecole des Hautes Etudes Commerciales") on strategic alignment of information technology published June 7 2002 the authors conclude that:

- "The strategic alignment model (Venkatraman) constitutes a valid theoretical foundation on which to further investigate the fundamental ICT problem for organizations, namely how to achieve value from ever-increasing ICT investments. On a methodological basis, the covariation perspective used to operationalize the strategic alignment concept seems most promising in its capacity to describe, predict, and explain the performance impacts of information technology, as opposed to other fit perspectives used in previous Information Systems alignment research.
- "Hence, when shifts in the business environment (exogenous and endogenous factors) require strategic choices or provide strategic opportunities, resulting changes must be interlinked and assessed continually across strategic orientation, organizational structure, ICT strategy, and ICT structure in a systemic manner if the firm wants better performance".
- Approaching co alignment transcends strategic integration and operational integration to achieve systems integration and increase performance. They conclude further:
  "When strategic orientation is the driving force, management must see to it that its formulation of a new or enhanced business strategy is simultaneously implemented in two forms, one being the formulation of an appropriate ICT strategy, and the other being the design of an organizational structure with the appropriate levels of formalization and differentiation. This requires an appropriate ICT infrastructure in the form of enhanced ICT planning, acquisition, implementation and control processes."
- "In an economic context that has become fundamentally globalized and virtualized, business enterprises must leverage information technology in order to transform themselves into "intelligent" and "agile" organizations, continuously adapting and changing in a process of strategic alignment or fit".

Web-based business environment.

Web-based business models are part of the paradigm shift in the ICT industry due to rapid technological change. Integration of data and information exchange is confronted with three ("Sources of information value" 2004 by Joan E. Ricart-Costa; Brian Subirana, and Josep Valor – Sabatier PwC/IESE/EBcenter) different concurrent trends opting for structuring future client software. The first trends indicates a shift from PC based software applications to server-based or web-based applications. A second trend is the shift to use of other devices than PC's e.g. mobile phones, iMode apparatus and extended notebook laptops. The third and most important trend is a shift from proprietary software to submission of "open source" software. However, "open source" software is considered very vulnerable. These three trends will influence industrial organization of the construction industry in the near future and will be of dominance to establish change in corporate business strategy. The web provides a mean to elaborate communication, co-operation, document, and co-ordination between partners of alliances and in partnerships. Connectivity through the Internet offers the opportunity to deal with a fragmented industry and make the construction business more transparent. Redesigning the construction industry to come to conceptual frameworks of virtual enterprises will be of importance to all stakeholders involved in organizing construction projects and processes. Dealing with a changing business environment and the opportunities offered by information technology affects new ways to communicate, co-ordinate, and co-operate when it concerns the position of the general contractor. For instance enterprise resource planning (ERP) software focuses in that matter on Internet applications offering an opportunity to deal with anticipating the new paradigm.

Factor of change

Transition of e-Commerce into e-Business points at the use of the infrastructure provided by the Internet to connect supply and demand. All strategic models must be evaluated in the context of the available Internet technology and its structure. Transforming networks into virtual enterprises and implementing concurrent engineering means passing the threshold of infrastructure, education and training, and being realistic on the time of deployment of all the opportunities. Entering a virtual enterprise offers a different perspective on restructuring firms' activities in particular when focused on supply chain management, which is of major importance for contractors to come to meta organizations and beyond the ordinary or the usual. Virtualisation is pointed at the reverse of business logics and come to a revised paradigm on construction in the form of a virtual enterprise in particular when concerning the enormous capacity on available intangible resources on knowledge and experience in the architectural, engineering, and construction domains. Katzy, Shuh and Millar (1996) describe the roles of participants in virtual construction accepting the presence of a network connecting value systems. Virtual construction exists of firms, who want to expand their capacity, are legally independent, enable concurrent engineering, see a common object, and are looking for e-commerce based on collaboration, cooperation, coordination, and communication through use of the Internet. The reference model of a virtual organization points at value systems, networks and value, because the business opportunity is served by the value system (chain). These value systems serve short-term requirements of the construction projects, but as a co-operation of fully independent partners they could serve long-term goals. Culture, ICT, Processes and Logistics (Material and Physical distribution) are main determinants (critical success factors) for value systems to establish concurrent engineering. In some construction stages one may expect some rather complex elements in form of decision taking, sequence and iterative sub-processes. To that the author refers to the SPICE (Standardized Process

Improvement of Construction Enterprises) project and the use of the Capability Maturity Model (CMM) pointing at assessment of purpose, scope, constraints, and responsibilities when looking at the reference model. The indicator set is pointed at the process performance and process capability knowing the process profile and the assessment context. The concept of the reference model is one of widely used models within the standards of the community (harmonisation of different approaches to a problem or a group of problems). CMM points at five levels of increasing capability and maturity, which are initial level (experimental), repeatable level (implemental), defined level (organisation is defined), managed level (the model is established), optimising level (to make things effective and possible).

The virtual enterprise.

The phenomenon of a virtual enterprise in particular when it concerns the construction industry is not to distinguish from its context of industrial organization. In theory the virtual enterprise is a group of firms that interact through interdependent tasks guided by a common purpose that works across space, time, and organizational boundaries with links strengthened by web of communication technologies to cooperate and coordinate activities related to the purpose. Virtual enterprises are complex and require a focus on their best practices on peoples' experiences. A virtual enterprise represents a team of non co-located and independent firms, who collaborate, cooperate, coordinate, document, and communicate to specify a project and may even more work together again. When considering the old paradigm of the construction industry companies entered virtual enterprises mainly to share risk, share capacity, and financial resources focused on organizing building capacity and were after realization of the project never working together again. The OSMOS project in Finland (Source: OSMOS: IST-1999-10491) was initiated to add ICT to collaboration models of the construction industry. Scalability is one of the advantages which can be obtained by entering the virtual enterprise. Using ERP (enterprise resource planning) models will be of great importance for small and medium enterprises (SME's) and by entering virtual enterprises SME's will expand their capabilities and capacity. Due to the structure of industrial organization and current available information technology the construction industry demonstrates a lack of homogeneity (e.g. architects do not apply technology due to the fact of an existing bar between design and construction), a lack of scalability (Scalability means ICT usable on different scales and due to that in different scopes.) e.g. in organizing capacity craftsman thinking wipes out industrial thinking), differences in level-entry costs, and a tendency of continuously focussing on a project or spatial solution. Considering the paradigm shift because of the opportunities Internet and IT are offering the following issues are of importance:

- The integration of different software platforms and document sharing.
- The communication between the different teams and their IT infrastructure
- The peculiarities of organizational structure and the culture of legally independent firms.
- The orientation of organizing operational activities.

Evaluating these issues the virtual enterprise represents an organization nearly approaching the structure of a firm forwarding a solution to the clients' spatial demand e.g. on housing, working space, infrastructure and other properties. IT driven teams forming a virtual enterprise will elaborate the use of the e-Business model for more than one project, while traditional virtual teams cooperate only once to deliver a building project.

Data collection, path model analysis and conclusion.

From 30 Dutch companies data on independent variables as virtual strategy, concurrent engineering, awareness of SOAP and XML standards were related towards about 224 companies to come to conclusion on the topic of this research paper. Strategy, Culture, and Technology are related in the following simple **path diagram**.

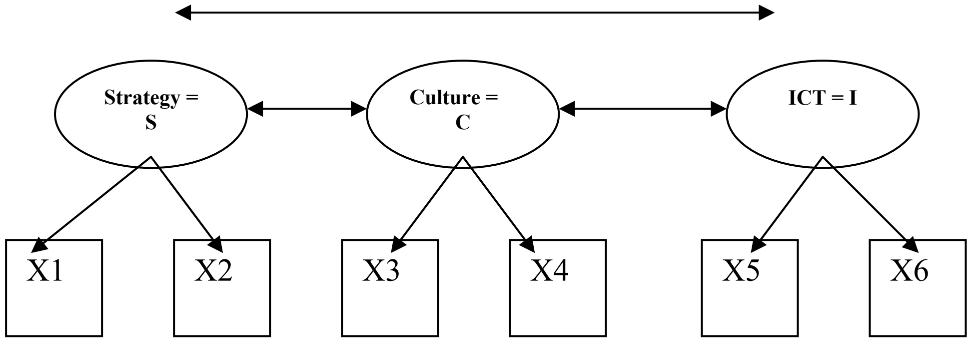


Figure 7 Source of model MX32

Confirmation requires a factor (the one headed arrow) analysis, which has to equal a lambda (l) value of 0,75 according to the RAM Fit approach using Mx32 to program the structural equation model. The double headed arrow points at a correlation between the latent variable which are denoted in the ellipse. The squares denoted the explanatory or independent variable. The error value is assumed zero (E=0). So the following equations occur: S = l1 X1 + E; S = l2 X2 +E; C = l3 X3 + E; C = l4 X4 + E; I = l5 X5 + E; I = l6 X6 + E Strategy and Culture are correlated with coefficient 0,82; Culture and ICT are correlated with coefficient 0,83 and Strategy and ICT are correlated with coefficient 0,9. However there is no relationship (0,75) between IT strategy and X1 and X 2 because X1 represents dominance on markets and X2 adaptation of XML and SOAP standards, which appeared not to be related with strategy. Culture in particular the attitude of participants and adaptation of ICT enabling virtual enterprises meet partly the following hypothesis “Strategic choice induced through information technology adapted in business strategy and culture is positively related to establish virtual enterprises”. Further research on the subject of virtual enterprises is currently initiated by the author.

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Figures

MODEL BASED OPTIMAL CONTROL FOR INTEGRATED BUILDING SYSTEMS

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ABSTRACT: Building performance simulation has traditionally concentrated on the use of basic and conventional control methods, which are of limited use since they cannot solve all the challenges encountered. With this regard, there is a great interest in the concept of modern control strategies for integrated building systems. To explore this potential, the paper focuses mainly on the application of model-based optimal control to buildings. In this case, a performance criterion minimized by linear programming is proposed in order to maintain the temperature of indoor environment comfortable while minimizing energy consumption. Particularly, this paper is concerned with the relevance and reliability of integrating control and building performance simulation environments by run-time coupling, over TCP/IP protocol suite. In addition, this paper involves a case-study with two important steps; the first step consists of experiments obtained in a test-cell that demonstrate the potential ability of advanced control strategies in buildings, and then simulation results are obtained with the use of distributed control and building performance simulation software by run-time coupling.

Keywords – Building performance simulation, run-time coupling, model-based optimal control, and energy consumption.

1. INTRODUCTION

Modern control theory is an emergent discipline that has been mainly applied to large-scale projects and complex systems, used broadly in aeronautic, automobile and space industry since early sixties. For the building domain, there is still a need for developing optimal control strategies for rapid response of HVAC (Heating, Ventilation and Air-Conditioning) and lighting systems of buildings to achieve the desired comfort (including its effect on satisfaction and productivity) while minimizing energy consumption and cost. Especially the advent of computer-based Building Automation Systems (BAS) has fueled the investigation of building equipment and components, in order to attain optimal control and management of their functions in an efficient and rational way while reducing fossil fuel consumption and green house gas emissions (see e.g. IEA, 2002). Modern control methods are in fact an efficient way for handling emergency issues in buildings, as a central computer of a BAS can in turn devise an optimal control strategy for specific urgent situations. As an example, Lute J. P. (et al., 1995) attended to find a cost-effective optimum to supply heat to the building using a predictor for the indoor temperature, while maintaining a comfortable temperature in the building within a certain range of variation. Furthermore, the control of the temperature in heating or cooling mode is kept between two predefined limits, instead of maintaining a process variable, as long as possible, constant at its set-point.

As mentioned by e.g. Galata (et al., 1996), multivariable control systems are an efficient and consistent way to control building energy services as a whole, with a potential of energy savings around 18% for the HVAC systems over the year, and around 52% for lighting. Integrated control strategies for heating, cooling and artificial/natural lighting are regulated simultaneously by one multi-controller rather than individually by various control strategies. Besides this important potential, many additional perspectives may exist, like stability of comfort aspects in buildings and steady-state concepts used generally as a basis for multivariable systems. Most building components (e.g. valves) are basically characterized with saturations constraints. This limited factor must be prioritized by means of state space methods, which are not only useful in analysis and design of linear systems, but are also an important starting point for advanced optimal and nonlinear control in buildings.

However, these previous studies do not take into account all building material and construction properties plus system components and performance aspects including requirements imposed by occupants and environmental conditions. In most cases, this necessitates appropriate methods to control comfort and energetic aspects involving one or more limited factors (like for instance, the measured variable must rendezvous with the set-point before the required time is accumulated). To tackle these problems, an approach to distributed control and building performance simulation environments by run-time coupling has been developed and implemented. The run-time coupling uses Internet sockets in order to exchange data to each other during simulation. In this approach, the building model and the control system, separated in different environments, work together through run-time coupling. The models can be located on different kinds of hosts where performance simulation is much faster than using a single computer.

To deal with the indoor temperature controller under constraints that avoid undesirable operation regimes, a model is developed using the notion of the block diagram representation of the temperature control process of a space, modeled by a continuous-time transfer function of different elements forming the feedback control system. This paper describes a model-based optimal control strategy that suitably regulates the indoor temperature in a building. In this case, a performance criterion minimized by linear programming is proposed in order to optimize the comfort aspects within the minimum use of energy cost. This model-based optimal control is in terms of a reduced steady state form, derived from experimental studies within a test-cell, located at Delft Technical University (TU Delft). Then, through a run-time coupling between domain independent building environments and domain specific building performance simulation software, the same proposed model is used to obtain simulation results with respect to the same material proprieties and climate data used for experiments.

The first part of this paper presents a brief description of distributed control and building performance simulation. The next part elaborates the concept behind our idea concerning the integrated performance assessment by identifying the overall effect of innovative control strategies for integrated building systems. Then, a mathematical formulation for heating mode is described that proposes a performance index for the optimization of the comfort and energetic aspects. The fourth section consists of the synthesis relevant to the control feedback structure for integrated building systems. The last essential part of this paper is a case study resulting on a balance between theoretical aspects and practical applications.

2. DISTRIBUTED CONTROL AND BUILING PERFORMANCE SIMULATION

One key of the issues facing us when we want to simulate a building modeling plus environmental control systems is that frequently certain system components and/or control features can be modeled in one simulation environment while models for other components and/or control features are only available in other simulation software. In other words, there is domain specific software for building performance simulation (BPS) is usually relatively basic in terms of control modeling and simulation capabilities (e.g. ESP-r, TRNSYS). On the other hand, there exists domain dependent control modeling environments (CME), which are very advanced in control modeling and simulation features (e.g. Matlab/Simulink). To alleviate the restricted issue mentioned above, it is essential to reason behind our hypothesis that marrying the two approaches by run-time coupling would potentially enable integrated performance assessment by predicting the overall effect of innovative control strategies for integrated building systems.

Previous (in Yahiaoui et al., 2003 and Yahiaoui et al., 2005), it has been described that a promising approach to run-time coupling between ESP-r and Matlab/simulink is an IPC (Inter-process Communication) using Internet sockets. This approach performs distributed simulation by a network protocol in order to exchange data between building model and its controller, as it relatively happens in a real situation. Both building model and its controller which are separated and work together through run-time coupling can be located on different kinds of hosts in which the performance simulation is much faster than using a single computer. Consequently, the development of this new advent would potentially enable new flexible functionalities of building control strategies that are not yet possible.

During the simulation, commands and data are transmitted between ESP-r and Matlab/Simulink. If for instance the building model (i.e. ESP-r) has to send its current measured process to its controller (i.e. Matlab/ Simulink) with TCP/IP-stream, a method called encodes them and transmits them with a defined control sequence via TCP/IP to a method received. This then receives the control sequence, decodes data from TCP/IP-stream format and sends data to the recipient (Matlab/ Simulink). When the controller has to send back the actuated process to its building model via TCP/IP, the same procedure is in this fact repeated, as shown on figure 1.

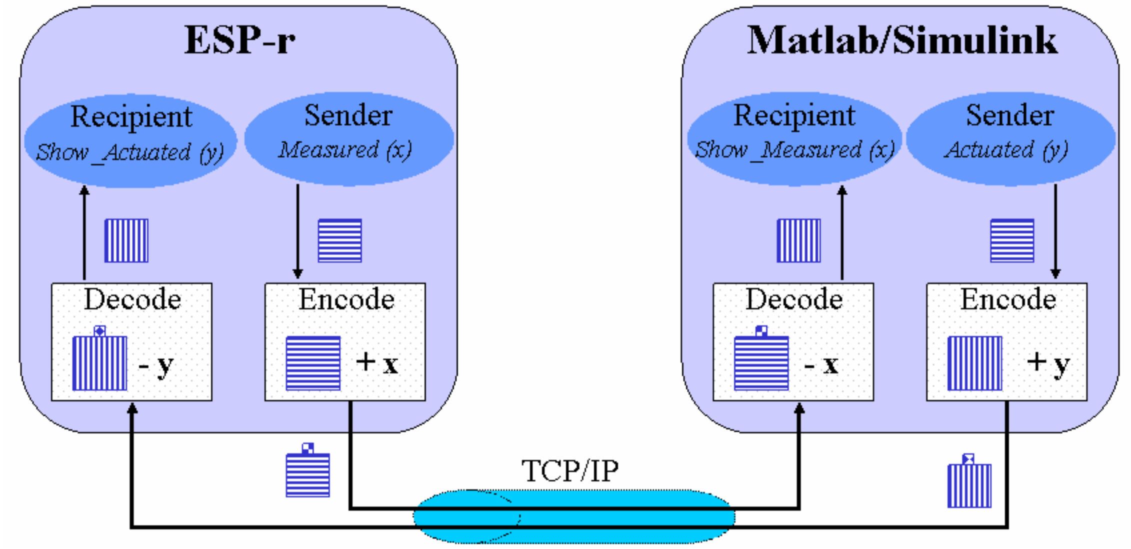

Fig. 1. Distributed control and building performance simulation environments

In the current implemented approach of run-time coupling between ESP-r and Matlab, it is ESP-r which starts simulation. Indeed, Matlab is launched at every ESP-r time-step as a separate process. If the connection between ESP-r and Matlab breaks down the data to be exchanged cannot be transferred until the communication between them is reconnected. More detail about distributed building domain specific and domain independent software tools by run-time coupling can be found in (Yahiaoui et al., 2004 and Yahiaoui et al., 2005).

3. OPTIMAL CONTROL CONCEPTS FOR INTEGRATED BUILDING SYSTEMS

The design process of optimal control uses a sequence of high-level steps similar to those of pole placement design. In optimal control, it necessitates first to develop optimality criterion for the controller gain. Then, mathematical algorithms compute this gain to produce a compensation factor that satisfies the proposed criterion.

Integrated building systems involve all the physical elements and user requirements that affect the design of buildings, including structural systems like mechanical, electrical and so on. Those elements can consist of HVAC (Heating, Ventilation and Air-Conditioning), lighting, power and energy, fire and safety, and water supply systems. Besides, most process control problems in buildings are related to the control of flow, pressure, temperature, and level (e.g. light, daylight, etc), in which it is not suitable to use traditional or conventional control methods. Optimal control theory is the powerful tool to solve closed set constrained variation problems. Although in design of such control systems, it is sometimes necessary to design controllers that are not only effectively regulate the behavior of a system, but also minimize or maximize some user defined criteria such as energy or time conservation, or obey other physical or time constraints imposed by the environment. Hence, the advantage of using this technique consists of finding a feasible control law (model) so as the system starting from the given initial condition transfers its state to the objective set, and minimizes a performance criterion.

3.1 Optimization for Modern Control

The main purpose of the automatic control systems can be formulated as multi-objective optimization tasks (Andersson, 2000 and Coello et al., 2002), in which a building system must focus more on numerous distinct goals:

- Optimization of comfort aspects (thermal and visual);
- Safety of occupants;
- Satisfying occupants' wishes; and
- Minimization of energy consumption.

Each of these objectives may conflict with others- for instance, attempting to maximize conflicting thermal comfort requirements of different occupants can be expected to result in increased energy consumption if not well optimized at the system level. Nevertheless in the literature, several methods have been proposed to address multi-objective optimization tasks (e.g. Lute et al., 1995). In fact, optimization is a very useful technique for conducting realistic studies when the cause and effect relationship between objectives and outcomes can be specified mathematically or through simulation. Optimization seeks to mathematically minimize (or maximize) an objective functional of many parameters in the presence of one or more constraint functions. Although, the optimal control of building processes and plants under dynamics conditions, i.e. the concerned variables are changing with respect to time and this time is involved in system description that needs dynamic optimization techniques to be solved, differential equations are used as good means to describe their processes and plants.

3.2 State Space Based Modeling Procedure

The traditional and conventional control theory and methods (for instance root-locus) that have been used in buildings so far are based on simple-input and simple-output description (SISO) of building plants, usually expressed as a transfer function. These methods do not use any knowledge of the interior structure of the building equipment and components, in which it means that those methods do not capture all building dynamics and disturbances that affect its components. In fact, those methods allow only limited control of the closed loop behavior when the feedback path is used.

Modern control techniques, for instance optimal control theory, can solve such limitations by using a much “richer” description of the building plant dynamics (such as valve actuators). The so-called, the state-space representation provide the dynamics as a set of coupled first-order differential equations in a set of internal variables known as state variables, together with a set of algebraic equations that combine that state variables into physical output variables. With this description, the Multi-input Multi-output (MIMO) plants are formed through a complete building model.

For time invariant systems, mathematical model for building plants are based on physical laws normally results in a state space model of the following form:

$$\begin{cases} \dot{x} = f(x,u) \\ y = h(x,u) \end{cases} \qquad (1)$$

where $f(\cdot)$ and $h(\cdot)$ are nonlinear functions of their arguments: $x(t)$ is the internal sate vector, $u(t)$ is the control input vector, $y(t)$ is the measured output vector and $\dot{x}(t)$ represents the differentiation with respect to the time t. The first equation, called the state equation, is used to capture the physical dynamics of the system and has memory inherent in the n integrators. The second equation, called the output, or the measurement equation, is used to represent the way on how the measurements of system variables are performed, in which the results depend on the type of sensors used.

3.3 Linear Quadratic Regulator Design

The purpose of linear quadratic regulator (LQR) design is to realize a building system with practical components that will provide the desired operating performance. The desired performance can be readily stated in terms of time-domain indices. In this steady state and transient periods, the performance indices are normally specified in time domain and therefore it is obvious to enlighten some of those practical aspects, which should be considered when designing controllers for real applications.

Optimal control theory provides the mathematical tools for solving problems, either analytically or through computer iterative methods, by formulating the user criteria into a cost function (e.g. Burns, 2001). This control theory consists then of finding a control function u, either in an open-loop form $u(t)$ or a feedback (a closed-loop) form $u(x,t)$, which can drive a system from the state x_1 at the time t_1 to the state x_2 at the time t_2 in such a way to minimize or maximize the performance index $J(U)$, as follow:

$$\min_{u \in U} J(U) = \int_{t_1}^{t_2} (xQx' + uRu')dt, \qquad Q \geq 0, \qquad R > 0, \qquad (2)$$

where Q is a state weight matrix in which its choice may lead to a control system that requires the state x larger than desired and R is a control weight matrix in which its choice may lead to the controller gain k such that the feedback control law is:

$$u(t) = x_{ref} - K.x(t) \qquad (3)$$

where x_{ref} is the desired state, called set-point.

3.4 Indoor Thermal Comfort

Previous research reported in (Bloomfield et al., 1977) has described that intermittent conditioning can save the energy used in buildings. Then (lute et al. 1995) mentioned that it is also possible to save energy by a certain variation from the temperature set-point. But neither of those studies tried to minimize energy by keeping the indoor temperature as long as around the set-point. In the current case, a mathematical performance criterion is proposed in order to minimize the energy consumption so that the temperature of building stays as close as possible to the set-point. The control is designed to maintain an indoor temperature within the adaptive optimum comfort temperature used in winter for buildings with natural ventilation, in which it can be deduced from the ASHRAE 55 standard (see e.g. Hensen et al., 2001).

For the period of non-occupied of an office building, the indoor temperature can float library and sometimes it cannot be in certain safe boundaries. Though the energy is saved, i.e. the heater is completely switched-down; the performance of controller can be tested to see how long the controller takes to get the indoor temperature to the set-point. During the occupied period of an office building, the controller is designed in order to minimize the energy consumption and to optimize the indoor temperature together with the Predicted Mean Vote (PMV) by choosing an appropriate weighting state matrix of the controller. In addition, PMV is a measure used to predict a comfortable situation in buildings.

4. MATHEMATICAL STATEMENT OF THE PROBLEM

As a heating system for Delft test-cell is sealed up a building model shown schematically in figure 2. A simple model of its plant is represented as the rate change of the temperature difference in the heat flow Q_{in} supplied by the heater, and the heat rate Q_{loss} lost through the wall insulation, related by the following equation:

$$mc\frac{d}{dt}(T_{in} - T_{out}) = Q_{in} - Q_{loss} \tag{4}$$

where m is the building mass (Kg), c is the average specific heat ($J/Kg.K$), Q_{loss} and Q_{in} are heat flow rates (J/s or W), and T_{in} and T_{out} are temperatures (^oC).

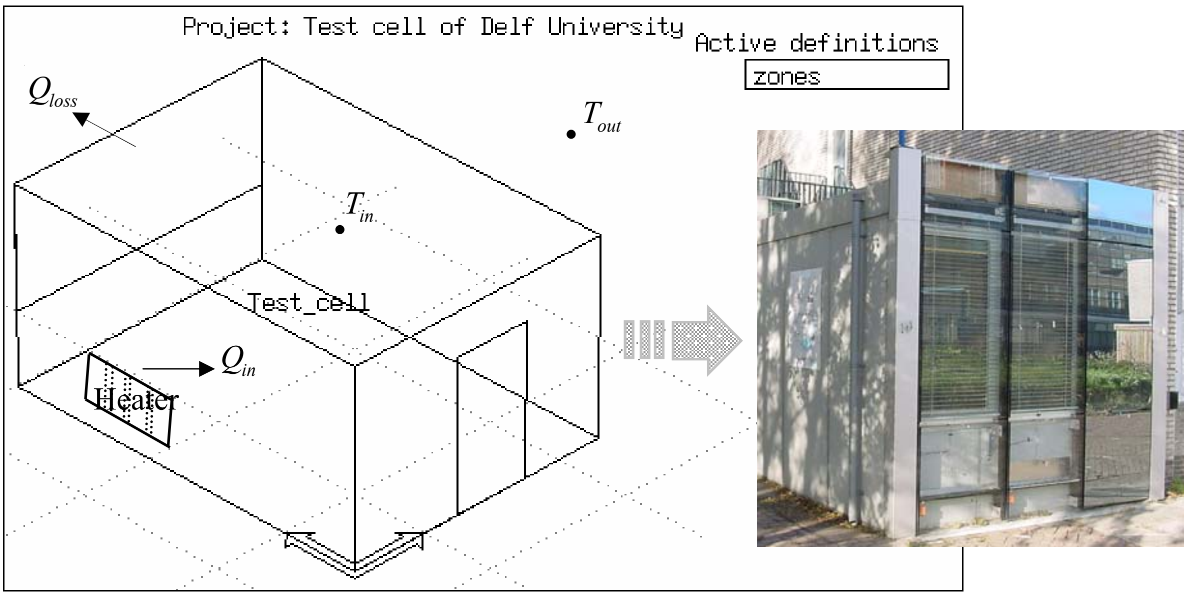

Fig. 2. TU Delft test-cell case study

When the outside temperature T_{out} is constant (or very slowly varying), the relation given by equation *(4)* can became, $mc\frac{d}{dt}(T_{in}) = V_h^2/R - Q_{loss}$ *(5)*

where V_h is the heater voltage, and R is the electric resistance of the heater.

The rate of heat Q_{loss} lost through the wall insulation is proportional to the temperature difference across the insulation, in which it is given by $Q_i = U_0(T_{in} - T_{out})$ *(6)*

where U_0 is a heat loss coefficient (W/K)

Submitting from equation *(6)* into equation *(5)* gives a relation in form of the state-space representation, which is as follow:

$$\frac{d}{dt}T_{in} = -\frac{U_0}{m.c}T_{in} + \frac{1}{m.c}Q_{in} + \frac{U_0}{r.c}T_{out} \qquad (7)$$

where the $\frac{U_0}{r.c}T_{out}$ factor is the effect of the disturbance input.

According to state-space form represented in *(1)*, the notation of the equation *(7),* used in this paper becomes, $\dot{x} = -\frac{U_0}{m.c}x + \frac{1}{m.c}u + \frac{U_0}{r.c}\xi$ *(8)*

The value of c for this example consisted of using common proprieties for air temperature in which it is taken from table with respect to the average temperature of the building in winter time, as mentioned in (ETB, 2005). On the basis of this table, c is something like $1.005\,(k.J/Kg.K)$. The value of m is also calculated with respect to density ρ, which is in the order of $1.205\,(Kg/m^3)$. The heat loss coefficient U_0 is calculated in relation of U-value defined by each area in relation with all areas of the room model.

Sensors are installed more or less all over different places in the room to provide timely detection of potential temperature changes where the indoor temperature is the average of all measures collected by those sensors. An optimal controller strategy needs to be designed in order to optimize the thermal comfort in the room and to minimize the energy consumption within the cost function that satisfies the requirements imposed by occupants.

The answer to that issue depends on the satisfaction of thermal environment in an office building and the energy saving. The mathematical formulation is proposed as follows:

- Performance index, minimize the total expression over time period t_1 to t_2:

$$\min_{u\in U} J(U) = \int_{t_1}^{t_2}(q_1x^2 + R.u^2 + q_2.(100PMV)^2)dt, \quad with \quad Q = \begin{bmatrix} q_1 & 0 \\ 0 & q_2 \end{bmatrix} \qquad (9)$$

- Constraints on energy $u(t)$ and on comfort PMV are:

$$\left.\begin{aligned} u_{\min}(t) \le u(t) \le u_{\max}(t) \\ PMV_{\min} \le PMV \le PMV_{\max} \end{aligned}\right\} \qquad (10)$$

In the performance index defined by the relation (9) three terms contribute to the integrated cost of control: the quadratic form xq_1x' which represents a penalty on the deviation of the state x from the initial (which is the desired state), the term uRu' which represents the performance of the controller and the last term $q_2.(100PMV)^2$ signifies the optimum comfort temperature in the room.

5. CONTROLLER SYNTHESIS

The purpose of optimal control theory is to give a systematic method to synthesize control laws with proprieties specified to optimize a performance index (or criterion) or a cost function. The remaining problem is to obtain the control gain K. In consequence to do so, the control feedback structure for an integrated building model, shown in figure 3 is performed in order to assign the control system with the parameters required for optimization. But to obtain the simulated results, the controller realized for experiments is the same carried-out in Matlab side and the extensive building model is entirely implemented in ESP-r side.

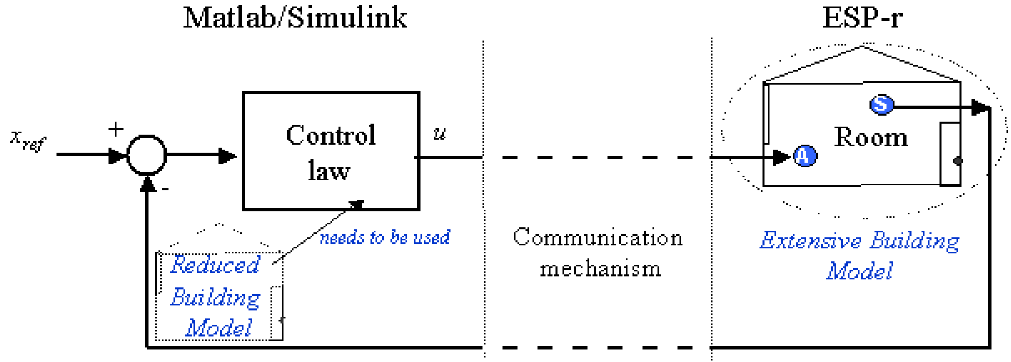

Fig. 3. Control feedback structure for integrated building model

5. 1 Solving Control Problem

Solving the control problem with equality constraints is computationally not complex since it does lead to boundary values. A controller is defined to minimize the performance index:

$$\min_{u \in U} J(U) = \int_{t_1}^{t_2} (q_1 x^2 + R.u^2 + q_2.(100PMV)^2)dt, \text{ with } x(t_1) = x_1,\ x(t_2) = x_2 \quad (11)$$

subject to the dynamic system $\dot{x} = -\frac{U_0}{m.c}x + \frac{1}{m.c}u,\ x(t_1) = x_1$ *(12)*

The Hamiltonian for (11) and (12), is

$$H(x,u,\frac{\partial V}{\partial x}) = (q_1 x^2 + R.u^2 + q_2.(100PMV)^2) + (\frac{\partial V}{\partial x})'(-\frac{U_0}{m.c}x + \frac{1}{m.c}u), \quad (13)$$

The first-order necessary conditions for optimally (a J minimum) is

$$\dot{p}(t) = \frac{\partial H(x,u,\frac{\partial V}{\partial x})}{\partial u},\quad p(t_1) = p(t_2) \quad (14)$$

The derivative of the Hamiltonian exists, and control function $u(t)$ is found by (14). In particular when x gets to a set-point, we have $\frac{\partial H}{\partial u} = 0$ *(15)*

and we find the following optimal control $u = -R^{-1}.(\frac{1}{m.c}).\frac{\partial V}{\partial x}$ *(16)*

From (15) and (16), the minimization of J leads to the following nonlinear differential equation (the so-called Riccati equation) in order to find the unknown (symmetric matrix) p:

$$-\dot{p}(t) = R - 2.\frac{U_0}{m.c}.p(t) - Q.(\frac{1}{m.c})^2.p^2(t),\quad p(t_f) = 0 \quad (17)$$

Solving (17), the control law is then obtained with (16) in the form of time-varying. When $t_f = \infty$, the optimal controller becomes time-invariant.

6. BUILDING TEST CELL: -CASE STUDY

The current case study is illustrated to investigate an application with two objectives. The first consists of comparing between experiments and simulation results obtained by using the same building model and the same model-based optimal control within the same time step of 1mn/hour. The second qualifies the importance of the run-time coupling approach when it involves the integration of advanced control applications in building performance simulation.

6.1 Experiments

A test cell of dimensions (3.15*3.85*2.6 m^3) is built in TU Delft with light construction materials for the purpose to investigate causes that influence the indoor environment of passive solar buildings. Those causes can include natural ventilation, radiant or solar heat gain and heat loss coefficient. A model-based optimal control for real-time specification is developed and implemented in Matlab/Simulink. This controller actuates the electrical heater of 1750 (W) with proper amount of power needed for the actual situation through a data acquisition located in the room. The obtained experimental results are presented in figure 4.

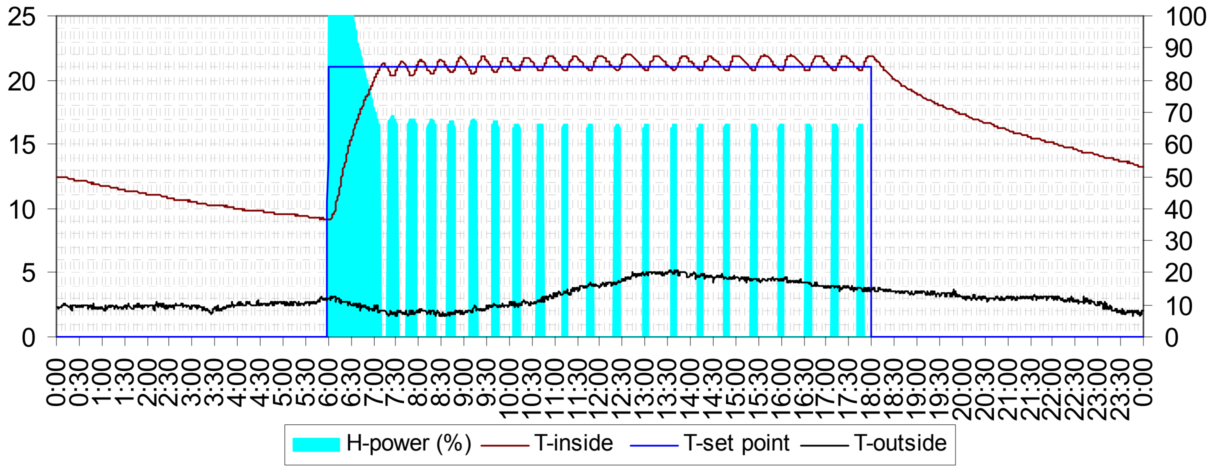

Fig. 4. Experimental results

6.2 Simulation Results

Test-cell building model is implemented in ESP-r with new databases created to carry out the same material proprieties used practically in the construction, as shown in figure 2. The climate measurements are also partially integrated since ESP-r considers their values on an hourly basis. The simulated results, shown in figure 5 are obtained typically within the same model-based optimal control developed on the same (Matlab/Simulink) environments respectively used for experimental results. Although the run-time coupling approach, described above is used to exchange data between ESP-r and Matlab/Simulink, which is synchronously launched at every ESP-r time step as a separate process during the occupied period, exactly from 6 to 18 o'clock.

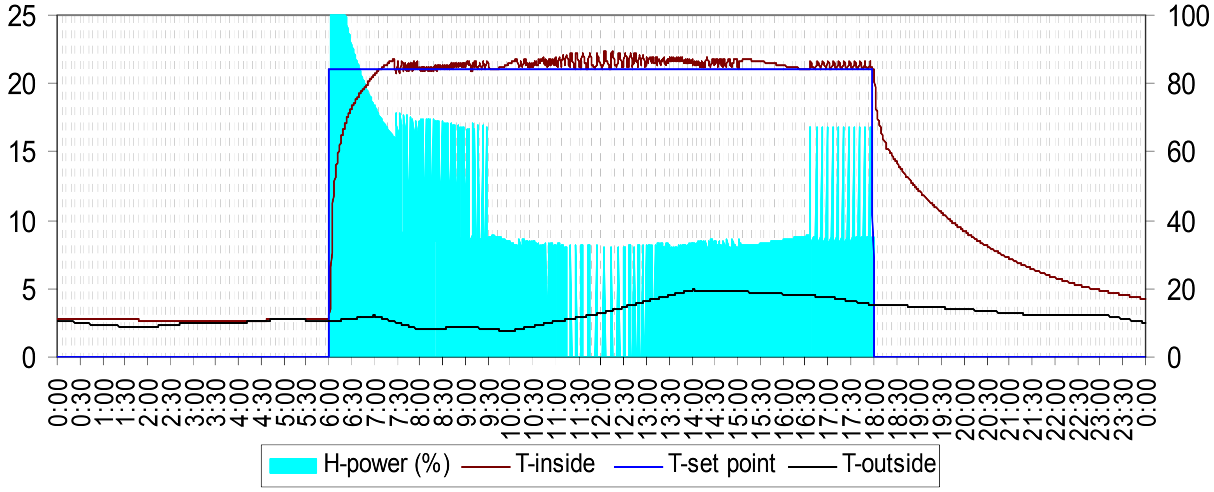

Fig. 5. Simulation results

A detailed comparison between experiments and simulation results shows that there are small changes in both responses of the controller used for the indoor temperature in the test cell. Those changes are due to the climate data that highly influence the temperature inside the test cell. In fact this outside temperature is a disturbance that makes changes over time and the controller designed does not takes action to suppress sensitive input noise, which causes chattering at short intervals of few seconds only. However, the controller designed can filter noises if an estimator is used to operate the actual causes with negative values. Another point in comparison is that the responded signals in both figures (4 and 5) are not very close to each other. This is due to ESP-r, which considers the climate data on an hourly base and probably due to theoretical approximations used sometimes to represent closely practical issues. Nevertheless, the controller designed maintains the indoor temperature controlled within the PMV boundaries of thermal comfort while minimizing energy consumption near optimum.

7. CONCLUSIONS

A mathematical formalism of model-based optimal control for heating mode is proposed by indicating two main factors, of energetic and comfort aspects. These factors are then concerned with improving the indoor environmental quality of buildings. In fact, it may be concluded that corresponding model based control algorithms are possible to be integrated for such purposes. However, the run-time coupling, approach described above can than generates an associated knowledge for wider applicability of advanced control strategies in buildings.

Future work includes a development of LQR control based estimator to filter disturbances.

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PROJECT REVIEW BASED KNOWLEDGE MANAGEMENT PRACTICES

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ABSTRACT: Different barriers prevent current practice of project review for capturing all project knowledge needed and its easy retrieval. The problem centres around the gap between the learning event and the time of conducting the review, the absence of the project related actors and the final format of the review. The studies that have been carried out to tackle these issues attempted to develop alternatives solutions but not to improve the current situations of the project review. Furthermore, no study has been carried out to particularly deal with the knowledge of project management. This paper intends to discuss the shortcoming of the project reviews. The paper also reviews and discusses the academic methodologies used in social science in general and in the construction management discipline in particular. It was found that there is a gap between the methodology that the researchers use in practice and the methodology presented in the research. It concludes that, an acceptable methodology can be generated as groups of combinations between epistemological and ontological assumptions and qualitative and quantitative data collection and analysis. No particular methodology can be the best for all research. The paper also affirms that more than one methodology could be used in one research.

Keywords – Project review, knowledge management, research methods, methodology.

1. INTRODUCTION

The significant value of project history to the management of a current project has drawn the attention of a number of authors. Yet, project reviews are the most effective technique in capturing project knowledge. This paper is an early stage of on-going PhD study. It aims to establish the case for the research and to identify the appropriate research methodology. In order to clearly introduce the case, it was decided to firstly review the current practice of knowledge management in the United Kingdom (UK) construction industry. Then, highlight and discuss the research problem, so as to identify appropriate aims and objectives. A review of relevant research philosophies, methodologies, techniques, will then be presented. In the last section an overall design for the proposed research is presented and explained.

2. CONTEXT

The construction industry accounts for 10 % of the UK's Gross Domestic Product and employs 1.4 million people, and as such can be considered to be a significant player in the UK economy. As complex as it is large, the industry is composed of thousands of companies, ranging from micro to small and medium enterprises (SMEs) to giant multinationals, representing a multitude of different design, engineering, building, manufacturing and management professionals (BSI 2003).

Despite all the efforts that have been put into improving construction development, and despite all the tools and systems developed to allow successful project delivery, the record of construction projects is in point of fact very disappointing (Falqi 2004). However, in the last decade the UK construction industry has witnessed an exceptional improvement. This change was called for in the Latham (1994) and Egan (1998) reports. Both of them criticised the performance of the industry and call for improvement. Other government reports have called for sharing and transferring knowledge within organisation and across the industry. For instance the National Audit Office (NAO 2001) in their report "modernising construction" demonstrated that that these reports identifies the lack of the culture of learning from previous projects or construction industry best practice as a fundamental barrier which needs to be overcome if construction performance is to improve and become more cost effective. The recent report by Egan (2004) dealt with knowledge management (KM) practice. It emphasised the need for capturing lessons learned and the culture of lifelong learning. The government response to the Egan review was the report from the Office of the Deputy Prime Minister (ODPM 2004), which again showed the supports for KM. It expressed the willingness of the government to aid the current programmes with more learning and development programmes. In addition, many organisations have attempted to improve their performance, and KM was one of the areas that some organisation tackled (see later).

3. KM PRACTICE IN THE UK CONSTRUCTION INDUSTRY

The practice of KM is not new as knowledge has been always captured and shared, what is new is considering KM as being central task in organisations. That concept was brought during the last ten years in the literature such as that by Nonaka and Takeuchi (1995), and Leonard-Barton (1995). Evidence of change in a number of organisations adapting KM strategies has been increasing since the mid nineties (Westelius and Mårtensson 2004).

Although "there is a scarcity of studies that analyse and report on what organisations are doing in practice to capture and transfer knowledge" (CIRIA 2004), some studies have been carried out to generally review the level of KM practice in the industry. Egbu (2000) conducted a study based on previous project which was completed in 1998, and aimed at developing a prototype-training simulator that will provide experiential learning of the cultural aspects of the innovation process in organisations. The study involved four case studies from four innovative construction organisations and it showed that KM is not just about the supply side (data and communication technologies). Rather that work showed that it also involved the demand side (business goals, strategy, organisational structure and people issues). In addition, a thorough consideration of the knowledge content, people, processes, culture and technology and their interdependence is vital in any coherent and robust strategy for managing organisational knowledge in construction. In the same year an MSc dissertation examined the current practice of KM in 12 organisations out of the largest 20 construction organisations in the UK according to the business turnover. The study was conducted to develop an academic knowledge management model based on current thinking. It was found that 50% of the organisations understand the meaning of KM and 30% of them have some forms of KM, however, it was generally found that the practice of KM was responding to the survey applied in all of the organisations but in an informal way (Herrington 2000). In another study by Egbu and Botterill (2001) 20 ethnographic interviews were conducted in six diverse project-based construction organisations. That study revealed that organisations could be said to be at different 'stages of maturity' in the management of knowledge and intellectual capital. The study also demonstrated that managing tacit knowledge was difficult and organisations employed different techniques (formal and informal) in their attempt to manage tacit knowledge. A separate empirically based study by Egbu *et al.* (2003) carried out an interview based survey on 12 small and medium enterprises in order to review the current practice of KM. That study came out with the same results as the previously cited work as it concluded that some elements of KM are practiced but in an adhoc fashion. Another recent survey of construction organisations by Carrillo *et al.* (2003), shows that about 40% of the survey's respondents already have a KM strategy and another 41% plan to have a strategy within a year. About 80% also perceived KM as having the potential to provide benefits to their organisations, and some have already appointed a senior person or group of people to implement their KM strategy.

Nonetheless, a number of construction organisations have seriously attempted to establish formal methods for managing their knowledge such as Atelier Ten, Arup, Edward Cullinan architects, WSB group, Penoyre & Prasad and Broadway Malyan. The IT construction forum (see www.itconstructionforum.org.uk/publications/casestudies.asp) which is managed by construction excellence and founded by the department of trade and industry (DTI), has supplied over 12 case studies on KM practice in the UK construction industry. These case studies revealed that there is a well approach that has been adapted in several organisations in order to capture, share and reuse knowledge. Examples of that approach include structural skills network, appraisal system, intranet system, KM group, regularly CPD (Continuing Professional Development) sessions, knowledge bank, stage reports, mentoring, lessons learned.

In a nutshell, the UK construction industry has begun to recognise KM as a central task in its organisations since many of them have already established strategies for managing the intellectual capital. Yet, there is a lack of studies that explore in depth what are the KM processes that are actually used in the practice.

4. THE RESEARCH DESIGN

This section identifies and discusses the nature of the research problem, and identifies the aim and objectives of the proposed research.

4.1. Problem statement

While much attention has been paid to the implementation of KM in project-based organisations, little effort has been made to address the management of knowledge in the projects themselves. However, many studies have indicated that the current practises in relation to project review are poor and involve shortcomings. It was found that no study has taken place to tackle this issue and therefore establish a solution.

The methods of project knowledge capturing offered can be classified in terms of the timing when they are conducted into three types; (i) post project-based (ii) stage-based, and (iii) activity-based. The post project-based method (e.g. post project review and post implementation review) are very effective in capturing knowledge as it represents the experiences and lesson learned from a wide picture, in addition to that, it gives a good opportunity for reviewers to judge project performance after a product (i.e. building) has been delivered and occupied. However, due to the review time conducting (usually two years after the project) a huge amount of project knowledge would possibly become lost (Kamara *et al.* 2003). Also there would be a danger that related people would have moved to other projects (Orange *et al.* 1999).

The stage-based method of capturing project knowledge partly overcomes the problems related to the absence of relevant people indicated above. Yet in practice some parties (whose participation in the capturing processes is important) involved in a part of a phase and then leave the project. Moreover, the time between the start and completion of a stage might be so long to the extent that part of the knowledge would be lost, particularly in complex projects where large amounts of learning events can occur.

Quite a few attempts have been made to overcome these problems. Tserng and Lin (2004) developed an activity-based KM system for contractors during construction phase and Kamara, *et al*. (2005) built up a conceptual framework for live capture and reuse of project knowledge. It is asserted that these concepts can solve all identified problems as long as both of them are based on capturing knowledge instantly after the learning event occurs or after every activity in a project. However if visualising how many activities or how many potential learning events there are in a construction project, then there would be a very large number of activities and more of learning events. Applying any of the above approaches maybe very demanding, and might have an impact on the projects activities. In the case of capturing knowledge after every activity there might be an assigned time for capturing knowledge as a project's activities are supposed to be known in the project schedule; however the authors of this approach did not consider how it would be guaranteed that the activities participants will contribute in capturing knowledge. Conversely, (Kamara *et al*. 2005) identified a project knowledge file should be set up which is agreed on at the onset of a project and all parties are required to contribute to its compilation. Nonetheless, it is difficult (if not impossible) to know when and where all the learning events will occur. Accordingly, there will be no assigned time for capturing knowledge and that will lead us to say again capturing knowledge via this framework will have negative impacts on project activities.

Beside what has been mentioned above, the project review is commonly conducted as check list (OGC (Office of Government Commerce) 2003b, and Schindler and Eppler 2003). That in turns limits the amount of the knowledge to be captured to the elements identified in the check list. In addition, the final format maybe constructed in a way that makes it difficult to reuse the knowledge captured in future projects. Yet, it is widely known in practice that project reviews should be carried out by an external party (Prencipe and Tell 2001, OGC 2003a, and Schindler and Eppler 2003) who is not involved in the project. The external party may not realise the knowledge obtained from the project as much as people who have participated in the project. To make it clear; why has it been very difficult for other vehicle companies to copy the Toyota Production System (TPS), despite that Toyota produced books explained in detailed the process of production in addition to giving tours of its manufacturing facilities? Because "the TPS techniques that visitors see on their tours - the kanban cards, andon cords, and quality circles – represent the surface of TPS but not its soul" (Pfeffer 1998). Therefore, no one can express the know-how as people were in involved in the project processes.

Finally and most importantly, some studies have considered either the knowledge of particular construction phases or the knowledge of the overall project. The focus in both cases were either on the product oriented knowledge (i.e. Fruchter 1996, Koch and Thuesen 2002, Brandon *et al.* 2005, Fruchter 2005) or the project knowledge in general (i.e. Maqsood *et al.* 2003 and 2004, Mohamed and Anumba 2004). Nevertheless, no study was carried out to particularly tackle the knowledge of project management.

4.2. The research questions

To sufficiently address the identified problem, the study would seek to answer the following questions: Is there a need for capturing and retrieving project knowledge? What are the models for capturing and retrieving project knowledge currently used in practice? What are the processes used to deploy these models and what is the extent of their efficiency and effectiveness? How all the amounts of the desired project knowledge can be effectively captured and easily retrieved?

4.3. Aim and objectives

The aim of the research is to develop a reliable decision support framework that can assist in preventing the loss of project knowledge and facilitate the use of project knowledge in other projects. That can be achieved through attaining the following objectives:

4.3.1. Exploring the state of the art in KM in the literature related to construction management and some other project-based industries in terms of capturing and retrieving knowledge.
4.3.2. Exploring both personalisation and codification strategies and their underlying processes of knowledge capturing and retrieving in construction projects in the practice.
4.3.3. Determine the level of organisational maturity of knowledge capture and capability of retrieval in the current practice.

The research will be limited to capturing and retrieving construction project knowledge. The knowledge will be considered is the knowledge that related to the processes of construction project management.

5. RESEARCH METHODOLOGY

Literature shows a lack of consensus regarding the appropriate methodology for use in construction management research (see Betts and Lansley 1993, Seymour *et al.* 1997, Runeson 1997, Seymour *et al.* 1998 and Wing *et al.* 1998). The main problem in the construction management literature regarding the research methodology is that the authors focus on the methods and techniques in general but there is no emphasis on the ontological and epistemological perspectives. Many authors limit the combination between techniques, methods and ontological and epistemological assumptions to two or three methods. In our respect this is very narrow view and has led to less flexible approaches. The next paragraphs intends to discuss these points, starting with the research philosophy moving through the research methodology and techniques, and finally presenting the overall design that will be used in this research.

5.1. Research method

Any research should be carried out to contribute to the existing knowledge that is related to the discipline, otherwise it is useless. Three methodological paradigms were identified in the social sciences to produce such research; positivist, interpretivist, and combined or pragmatic approach. The positivist paradigm is based on realist ontology, objectivist epistemology and usually takes the form of deductive research and makes use of the quantitative technique. On the other hand interpretivist method is based on nominalist ontology, subjectivist epistemology and usually takes the form of in inductive research and makes use of the qualitative technique. The combined or pragmatic research methodology means using both the positivist and interpretivist paradigms in one research. Betts and Lansley (1993) investigated the researches that published in the first ten years in the journal of construction management and economics. It was found that the discipline was lacking in its guidance from and contribution to theory. It was suggested that such a result maybe partly influenced by determining inappropriate research methodology. The question arises here; is there an appropriate methodology that could generate the best results for construction management research? This was the point of debating in the construction management research as well as in the social science in general. While some thought that only quantitative approach should be used to study social science, others were just emphatic that qualitative approach only appropriate (Punch 2005). Regarding the construction management field where is different techniques are employed. Some of the functions are based on, or can be explained by various scientific theories, some of the techniques have a theoretical background (Runeson 1997). Seymour *et al.* (1997) believe that the researchers should pay much attention to the interpretivist approach, as it was clearly stated: "Our suggested alternative is to concentrate upon the interpretative methods that researchers and managers use to make sense of the world. It is our belief that such an account better reflects the realities of construction management as a practice" (p. 198). In fact that means if any research related to construction management was conducted using interpretive methods then it would generate more valuable results. Seymour *et al.* built that principle because of the assumption that in our discipline the ’objects of study’ are people, whereas in many significant studies in construction management the objects are data. That was clearly explained by Wing *et al.* (1998).

On the contrary, Runeson (1997) argues that positivism provides the best insurance against bad research in construction management studies. Runeson asserted that positivist methods of theory building have been sufficiently modified to deal with the special demands of management research. The same author also claimed positivist research methods were the best insurance against bad research. However, adopting Runeson's approach would lose a lot of important knowledge. There are some types of problems that can not be solved using positivist methods alone. For example, if researcher is seeking to know the processes of knowledge capture that were used in an organisation, how it can be known what these processes would be without observing them, or without the explanation of the people involved, and how it would be known what makes that process not working perfect without the views of the experts concerned. The positivist may play important role in reporting how regularly the processes are carried out and how and who are the people involved, but such an approach can never reflect the process as much as the interpretivist approach does. And of course knowing the process of knowledge capture may lead to the building of theory (body of knowledge).

It is believed that the researcher should choose the method that suites the nature of the research. It is not necessary to follow one research paradigm. It is considered that the perception of methodological pluralism that was suggested by Wing *et al.* (1998) to be the most appropriate. The research method used should be appropriate to the objectives of the research and the needs of the particular stage reached and hence the type of knowledge to be discovered. Different approaches can serve different functions in the knowledge discovery process (Wing *et al.* 1998).

In terms of the epistemological and ontological perspective, the vast majority of the researches in the field of construction management neglect to mention them separately, they are content to just indicate it is a positivist or interpretivist approach. And the researches that have talked about it were limited to whether ontological realist epistemological objectivist (positivist paradigm) or ontological nominalist epistemological subjectivist (interpretivist paradigm) dominates. That perhaps because most authors believe ontological realist research can not be epistemological subjectivist at the same time. That maybe due to the restrictive definitions of the ontological and epistemological assumptions that were identified by Burrell and Morgan (1979). However, it is believed that the limitations presented in the researches do not match the research methodology in practice. There are many research conducted by integrating ontological realist with epistemological subjectivist positions. Going back 20 years ago when Johnson *et al.* (1984) identified all the possible ways of integrating ontology and epistemology assumptions. It was affirmed that when objectivism and subjectivism are combined with the two major alternative ontological positions, realism and nominalism, a four-way classification scheme is generated. Empiricism combines a realist ontology with a subjectivist epistemology, substantialism combines a realist ontology with a objectivist epistemology, subjectivism (idealism) combines an nominalist ontology with a subjectivist epistemology, and rationalism combines nominalist ontology with an objectivist epistemology (Johnson *et al.* 1984). Therefore it can be seen that Johnson's classification is more detailed and accurate in presenting the ontological and epistemological combination. However, when looking at the research in our field it would be found that lots of researchers have used empiricism, substantialism, and idealism as the bases of their research methodology. There maybe no problem in applying the appropriate methodology, but there is a problem with the researchers in presenting that methodology in their research. That is very obvious when research see respondents as the best instrument of knowing the facts. For example, if researcher sought to know the tools and strategies of KM in a company. Then the researcher requested a person in charge to fill the questionnaire. In this case the research sees the knowledge that given by the respondent as the reality. That because the respondent is not telling his opinion which might be not the accurate fact. Instead, the respondent is reporting the real practice. Despite that the researcher is taking the reality from people, the reality here is not a product of people mind. This way of dealing with fact combines between the realism ontology and subjectivism epistemology.

5.2. Research technique

Here the research technique means the method of collecting and analysing the research data. These methods can be quantitative or qualitative methods. The research problem, questions, and hypothesis are the elements that can guide the researcher to the appropriate research technique and methodology. Because of the association between technique and methodology many researchers stick on either the positivist or interpretivist methodologies the quantitative and qualitative techniques (Bryman 1984). It should be known that it is not necessary for a positivist methodology to use a quantitative technique and equally an interpretivist research approach should always use the qualitative technique. There maybe some integration between the two extremes. Positivists may use qualitative technique and interpretist may use quantitative technique. Qualitative and quantitative research should never be thought of as opposites but rather as the right tools for performing two different kinds of job (Grainger 1999). The situation today is less quantitative versus qualitative and more how research practices lies somewhere on a continuum between the two (Creswell 2003). Research may use both techniques, and what is appropriate at one stage of the research maybe not appropriate in another. Both quantitative and qualitative techniques can be also combined in one stage as "Many studies mix and match statistical sampling techniques, qualitative data collection, and statistical analysis from the qualitative and quantitative traditions" (Bamberger 2000 p. 9). Qualitative techniques of data collection may be very helpful at the earlier stage of most research as it widens the knowledge of the researcher, while quantitative technique maybe more appropriate during the later stage of some research as the researcher is more confident with the area that has been investigated, so for any work if would be necessary to design an accurate format of the all the aspects required.

5.3. The overall design of the research

The main challenge in planning the research is for the student to consider and explicitly state, the overall design of the study (Remenyi *et al.* 1998). This research may use different methodologies and techniques in different stages as can be seen in figure 1. Nevertheless, the general theme of this study could be scud to be ontologically realist and epistemologically subjectivist and that it would make use of qualitative technique. This approaches appropriate since the study concerns itself with the *processes* of capturing and retrieving project knowledge. Ontologically the research views that the phenomena (e.g. processes of capturing and retrieving project knowledge) as existing fact. Nevertheless, the best way of collecting the data of this phenomenon maybe via the people actually involved in the process. Due to the fact that collecting the data directly from the phenomenon by the researcher may take long time, and that some organisations may not allow the researcher access to collect the data. Furthermore, would assuming that the research is epistemologically objectivist, would that mean that the research will get more accurate data? Of course no, because, in this case the knowledge about the processes maybe taken from the document or directly from the processes, and in both cases the researcher, may not be able to generate much knowledge about the process if it was not taken from the people experiencing it. However in the stage of evaluating the proposed decision support framework, the object of the research may change to be the data that will be obtained from the projects themselves. Here the research design adapts features of a realist ontology and objectivist epistemology.

In terms of research technique, generally the research will take the form of qualitative research. The data need to be collected to differentiate from stage to stage; one of them is the descriptions of different process that the research required. The way of collecting the data at that stage will be by interviewing people participating in these processes. And that almost will be followed by qualitative analysis using the inductive method. The inductive method has been already used when the researcher was looking for an area of interest, but after identifying that area, the research switched to deductive method in order to establish the case for this study. However, there maybe a need of using quantitative technique to collect some data, especially at the next stage of the study which will involve a meta-evaluation ("an evaluation of an evaluation" (Patton 2002). In other words, the next stage will evaluate the data provided in the literature on the tools and techniques used in the industry for capturing and retrieving knowledge. The data in this stage will be quantitatively collected using the close-end questionnaire. And it will be analysed using quantitative technique.

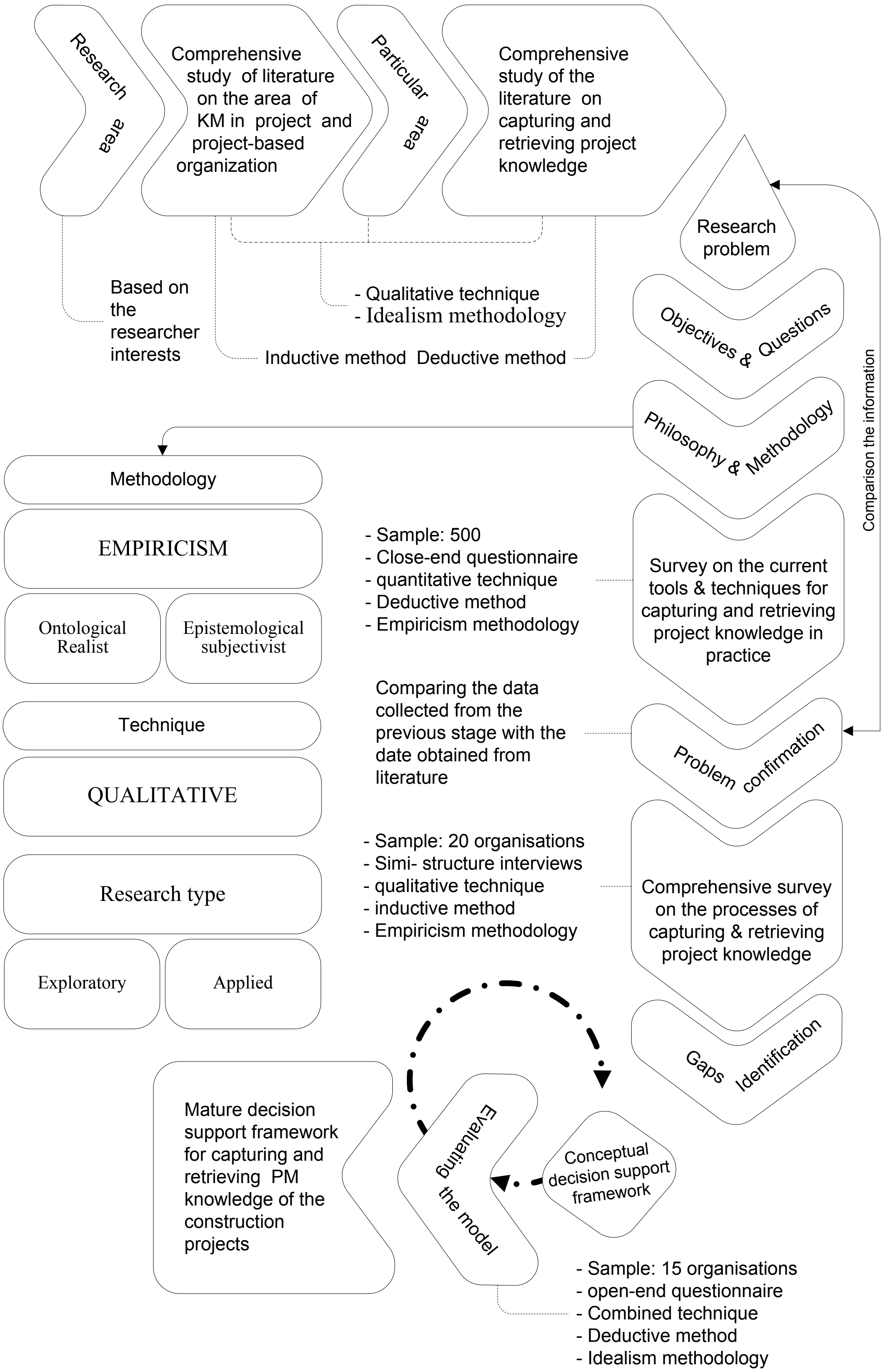

Fig. 1. The overall design of the research

6. CONCLUSION

Project reviews are still the most effective way of capturing project knowledge. Yet it suffers shortcomings in the current practise. Efforts need to be made to improve the performance of project reviews if all desired knowledge needs to be captured and easily retrieved. In order to successfully capture all the desired knowledge, three key points need to be tackled and improved; the conducting time, the involvement of related people, and the method of conducting the project review. Capturing the desired knowledge may not be enough unless it is easy to reach and use it in future stages or projects. Retrieving the project knowledge easily certainly depends on the final format of the project review, the technique used for storing knowledge, and the taxonomy method of the projects knowledge.

Regarding the methodology, it was emphasised that no particular methodology can be the best for all research. What suits one research may not suit another. Research problem, objectives and questions are the guides to the appropriate methodology. Methodology should be flexible as to meet the research requirements. It should be recognised that differing methodologies can be used are not one, two or three. Differing forms of methodologies can be generated as groups of combinations between epistemological and ontological assumptions and qualitative and quantitative data collection and analysis. More than one methodology could be used in one research project and maybe in one stage. The study also showed that empiricism, substantialism (subjectivism), and subjectivism (idealism) are the paradigms that have been used in the construction management field in practice. However, despite many research projects using the empiricism paradigm, it is not considered in many of the research texts currently available.

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A FRAMEWORK FOR KNOWLEDGE MANAGEMENT SYSTEM IMPLEMENTATION WITHIN THE LIBYAN BANKING INDUSTRY

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ABSTRACT: Most of the studies that form the basis of the existing frameworks have been carried out in organisations in Western industries countries where there can be similarities in some of the assumptions about the components of the framework that this research is carrying out. To add a new perspective the study has been conducted in under developing country (Libya). This study affords opportunity to see the differences in the culture and infrastructure provision at the local levels in comparison with the literature review that most of it comes from western perspectives.

This paper highlights the developments of the framework, a comprehensive review of theory, research, and practices on knowledge management (KM) that contrasts existing critical knowledge managemenet system (KMS) implementation areas have included in this framework. The framework explains how can bridge the gap between what should be exist at the Libyan public banks (LPBs) to be able to implement a successful KMS, and what exist in real life. The knowledge management implementation framework for banking industry (KMIFBI) is meant to fill the gaps to successfully build KM systems within the Libyan banking industry. Three versions of this framework were therefore investigated: The first version was based on a number of theories and assumptions; along with resulted from preliminary, secondary research and group sessions, both are referred to as "first draft framework". The second draft is a modified framework based on the results of pre-field investigation "workshop" and is referred to as the "Pre-field investigations framework". The third is based on the results of the empirical investigations "interviews" and is referred to as the "Post-field investigations framework". The first framework is described in detail in this paper.

Key words: frameworks, Libyan banks, KMS implementation, KMIFBI framework

1. INTRODUCTION

Many organisations are embracing KM but few of them are able to implement it successfully to see the benefits. Implementation of KM is a strategic process and needs careful target setting and review. Providing a framework, to the managerial knowledge portfolio, to enable managers to appreciate how knowledge management KM is organisationally important (current) and how it can be related to everyday managerial activity (actionable) (Bailey & Clarke, 2000). According to Robertson (2002) there are many benefits in applying a knowledge management framework or methodology. Also it is argued that Any KM framework should aim to build a KMS that enhance organisational competitiveness through capitalising the potential value of knowledge (Kim, 1999, Wiig, 1997a).

If organisational knowledge is a strategic asset, then the method used to implement a knowledge management system is critical (Bollinger & Smith, 2001). In this understanding (Rubenstein-Montano et al., 2001a) recommend some derives directly for a KM framework these are:

- First, Methods should be based on frameworks; for instance Wiig et al. (1997b) in his methodology is explicitly discussed in terms of an overseeing framework: review, conceptualise, reflect and act.
- Second, a framework provides a set of guiding principles for a discipline, and a methodology can be thought of as a specific, detailed description of how to carry out the ideas and objectives set forth by a framework. Thus, a methodology must be developed within the context of some framework - adopting its ideals and principles; and
- Third, the method must contain sufficient detail to be implementable. Thus, the framework should be presented and described in detail.

In the following section, this paper is going to introduce the requirements of the framework that would increase the likelihood of the success of the KMS implementation within the Libyan banking industry, and will give the Banks in general and the Libyan Banks in particular the ability to determine the level of organisational readiness for an implementation of KMS. This approach should also provide management with effective guidance that contributes to meeting their business objectives and achieving the specified critical knowledge implementation areas (CKIAs). The requirements should set up the foundation for developing a balanced measurement approach which aims at presenting the current/existing organisational status and the expected status for the successful implementation of KMS. By identifying a suitable framework for a knowledge management initiative, Robertson (2002) argues that it is possible to build credibility and provide an appropriate context for meaningful dialogue with leadership. In his view this framework builds an approach to knowledge management that is specifically tailored to the organization's environment, processes, and goals".

The purpose is to present a knowledge management framework for Libyan Public Banks (LPBs) and discuss how to employ it. This research first derives generic elements for effective KMS implementation areas through literature reviews. Then, considering the elements within the LPBs during the preliminary research, next, this research analyses the case of the LPBs throughout secondary research, finally, this research discusses the lessons and implications for knowledge management initiatives throughout the framework presented in this paper.

In order to produce such a framework, a suitable structure should be established and built upon the activities that have been done so far in this study that identify the key KMS components to achieve implementing successful KM system within the LPBs. Theses areas have to be extracted, combined and/or modified accordingly; its generic characteristics that should be considered essentially in designing KM activities and presents a refined framework of KMS implementation. The structure should embrace the main components of KMS implementation (see figure 1). This structure should lead to the development of a measurement model that is able to measure the organisational state of readiness for a KM implementation system in term of CKIAs.

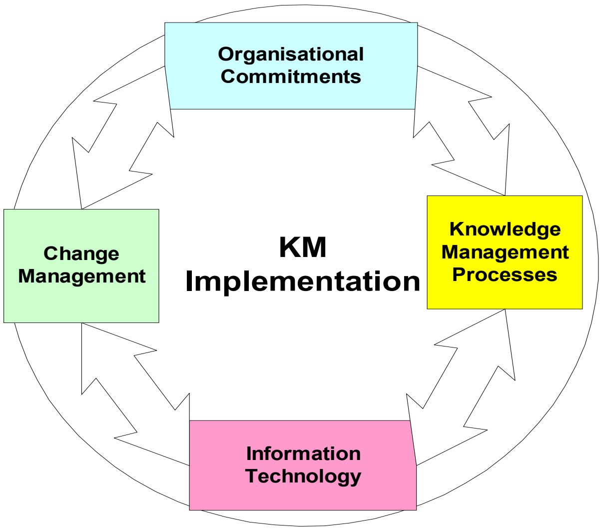

Figure 1: Domains of Readiness

The framework for implementing KMS within the KMIFBI will be introduced. Main focus of KMS implementation may be different, depending on the nature and characteristics of the tasks different organisations pursue. Accordingly, core characteristics of Banks must be considered to recognise main points on which KMS implementation should focus. Thus, a sound KMS implementation framework for Libyan Banks helps to fulfil this need by providing important guiding principles and directions. However, developing such a framework can be a challenging task for managers and practitioners as they may lack the knowledge of what characteristics, areas and constructs should be included in it. Implementation frameworks that do not have the necessary areas in place can paint an incomplete picture of KM and its implementation process, thus providing a suboptimal guidance for conducting KMS is an essential task in this study.

This research uses the Libyan Banking Industry case as the basis for developing the framework to organise the relationships between KMS elements and its implementation; to motivate the need for such a framework and to provide some additional context for this work, the following section revises the developments of the KMIFBI framework. The KM framework has been developed to help Libyan banks in understanding the range of KM options, applications and technologies available to them. It provides a view of the totality and complexity of the various KM theories, tools and techniques presented in the literature. Also, it provides a framework within which management can balance its KM focus and establish and communicate its strategic KM direction.

Thus, general KMS phases are given, along with detailed steps of how to carry out KMS expected outputs. The general phases are: initiate, diagnose, establish, act, and learn.

2. A DESCRIPTION OF THE KMIFBI

The objectives of this research work were focused on providing the Banking Industry with a practical methodology which could be used to translate the conceptual ideas of KMS into a working programme with defined objectives, or deliverables, using terminology that the industry could readily understand. The research highlighted the requirement to develop a supporting analysis methodology to examine employee actions and behaviour in regard to how they can effectively process knowledge and information. This would have the benefit of identifying the main areas on existing KM which could be improved through the application of an appropriate KM strategy as the Knowledge management is still a developing field, and there exist a number of distinctive knowledge management frameworks, each of which is different in focus, scope, components, and approaches from one another.

Therefore, this KM plans should identify the strategic KMS areas that can achieve the knowledge implied goals, as it is believed that knowledge management has to be seen strategically and it is reasonably clear that the Libyan Banks will face difficulties in implementing and communicating the KM initiatives if they not seen it as strategic issues. To do so the case analysis of the Libyan Banks KM which are going to employ this perspective, the critical knowledge implementation areas have been identified and the readiness of the Banks for KMS implementation can be depicted by the use of a model that explains particular requirements in term of four domains, each one classified into four or five CKIAs areas (see figure 2).

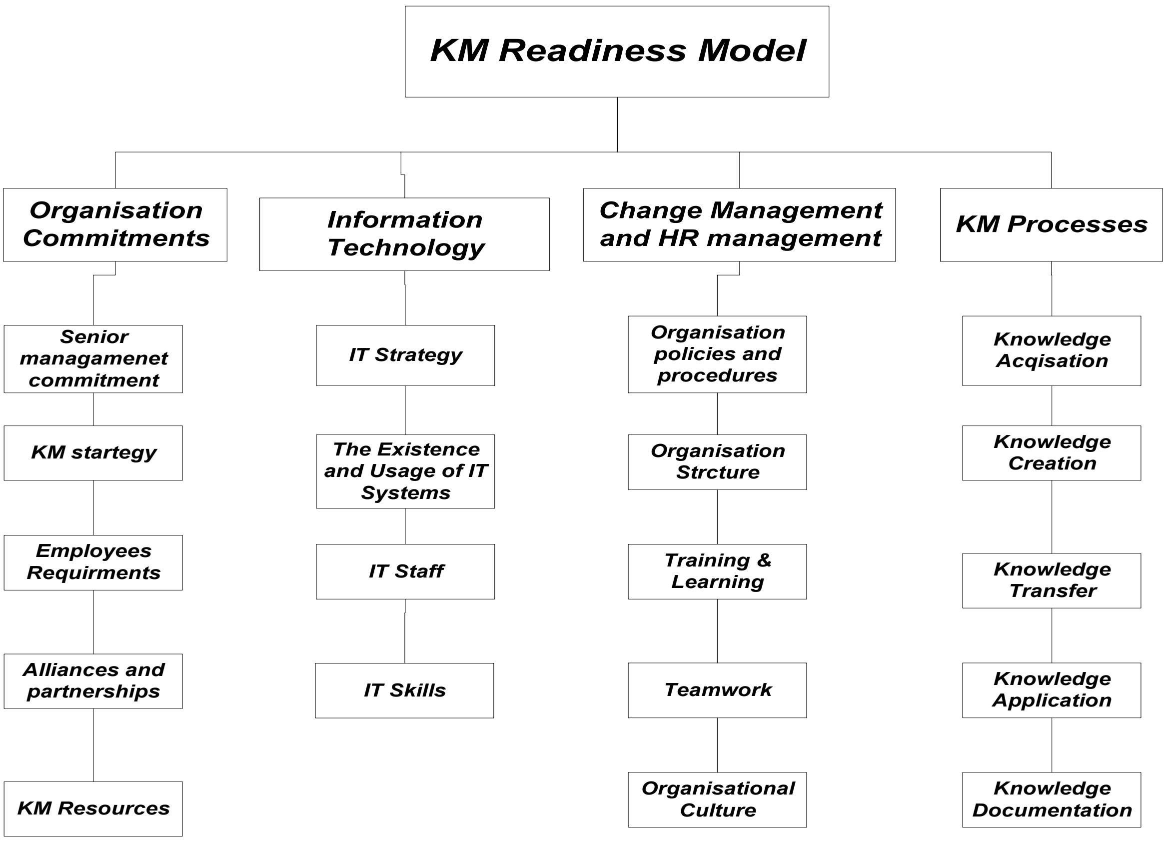

Figure 2: Structure of Readiness Model

Applying the four domains of developing KMIFBI of the individual and the organisation, and the four mean of developing knowledge capabilities of the banks to be able successfully implementing KMS; theses four fields are to bridge the gap between the importance and effectiveness, and to determine knowledge implementation gaps from a organisation, people, technology and process as can be seen in figure 3.

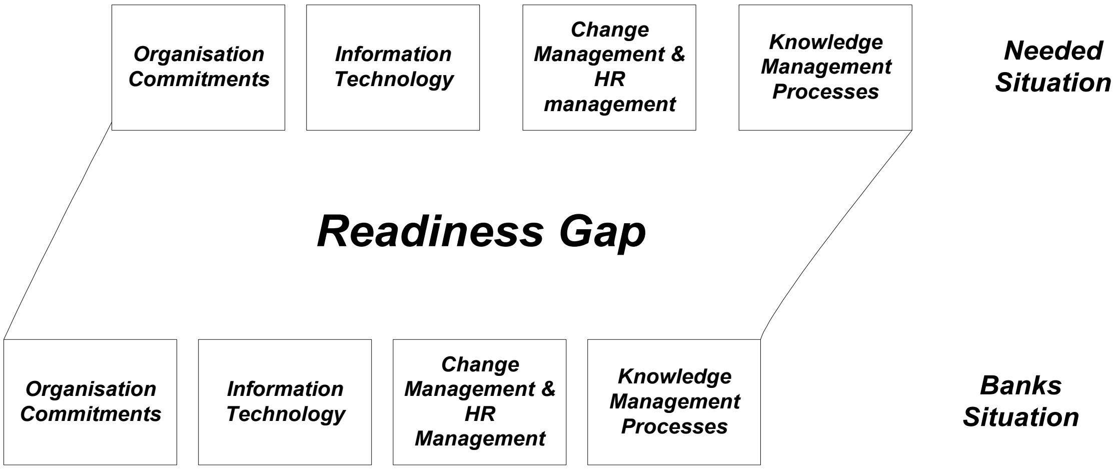

Figure 3: Readiness Gap

The following section describes the domains (OC, CM, IT and KMP) in details using the description of the attributes associated with each of them as they might occur in each of the five maturity levels. Each of the CKIAs describing an attribute comprises an aspect of how the status of the particular attributes should be at different organisational KMS maturity levels. The levels describes by the framework do not intend to make any a judgmental statement of the status of the organisational maturity. Some of the descriptions of the attributes of the early levels might be understood to have a negative notion. This should not be the case. The framework is merely trying to describe, depending on accumulated experiences and pervious research frameworks introduced in the literature which are reviewed in earlier, describe the status of organisation's KMS implementation maturity at each of those levels.

3. THE FIVE STAGES IN KMIFBI

Each of the five fields in the matrix represents a key area for developing knowledge capabilities. While developing each field on its own will also result in greater organisational knowledge capabilities, each one relies substantially on all of these fields; to achieve large and sustainable gains in capabilities all four fields must be addressed and developed on an ongoing basis, as can be seen in the figure 4. It is briefly described some of the specific tools and initiatives which can be used to develop each of fields, as shown in figure 4. The proposed requirements for KMS constitute crucial areas for the design of KMS and provide the building blocks for integrating organisation commitments, change management, information technology and KM processes.

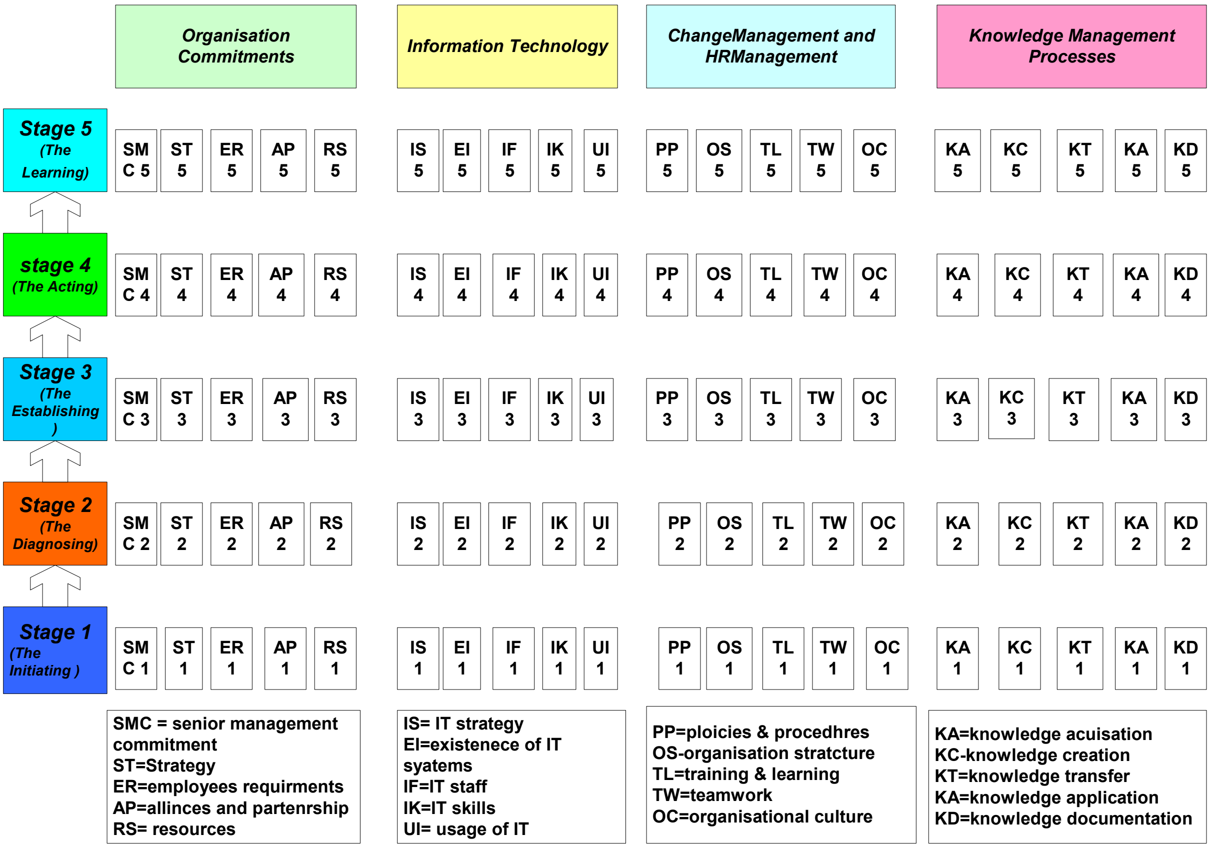

Figure 4: five Stages for Developing KM Capabilities

In doing that, a number of issues arise that need to be addressed in KMS implementation that are explained in details in the five stages below.

Stage 1: Initiating
Provide clear vision and undersatnding to KMS
Initiate a KM strategy
Initiate clear responsibilities and motivation for KMS
Initiate alliances and partnerships
Initiate KM resources.
Initiate the business changes for policy & procedures, structure, training and learning; teamwork and culture) in a strategic context by relating them to KM and strategic objectives and critical success factors.
The organisation need to rethink the way in which intended to manage IT in term of (IT strategy, existence of IT systems, IT staff and IT skills)
Think of implications for the organisational Knowledge base (K. acquisition, creation, transfer, application and documentation) and identify existing knowledge from a process, people and product perspective.

Senior Managemnt Commitment
Change Management
Information Technology
Knowledge Managemnt Processes

Figure 5: the main duties in initiating a KM plan

Stage 2: Diagnosing
Monitoring and reviewing the state of the KMS vision and interest.
Monitoring KM strategy.
Reviewing the motivation systems to meet the employees' requirements as well as providing regulatory and legal requirements to promote knowledge process.
Identifying the opportunities provided by partnering for improving the performance of KM processes and within such a framework in the organisation.
Adjusting the resource levels for new activities/priorities of KM, and how could be managed independently by each organisational unit (e.g. branch, region).
Reviewing organisation's strategy, policy, procedure, and structure to meet knowledge process requirements in a reliable and timely manner.
Scanning the organisation's structure for KM department.
Analysis of training and learning requirement is done using integrated information; managers' skills gaps in KM practices are being analysed.
Reviewing the work distribution in line with individual competencies and preferences of the teamwork.
Scanning the culture barriers that might prevent efficient delivery of KM.
Determining the type of information technology systems required by the organisation to perform KM successfully.
Scanning for the strategic opportunities provided by IT; That can the organisation benefit from some of the conditional commitment
Reviewing the levels of IT skills in all departments, and partial commitment to R&D initiatives may slow down the rate of progress of IT.
Reviewing the existence of IT staff.
Clarify the knowledge dimension of the business problem by identifying the KM processes (K. acquisition, creation, transfer, application and documentation) involved and determine knowledge gap from a process, people and product perspective.

Senior Management Commitment | Change Management | Information Technology | Knowledge Management Process

Figure 6: the main duties in diagnosing KM infrastructures

Stage 3: Establishing
A long term KM plan is established, and is closely aligned with the organisation strategic and business plans and organisation's corporate strategy and shapes the organisation's knowledge culture.
Appointing a Knowledge chief executive whom will be the champion for KM project.
New programs are introduced as appropriate to improve employee satisfaction and assessing members and rewarded them for developing new knowledge and testing new ideas.
Starting partnerships and collaboration which provide the organisation to learn from others, and transfer knowledge to their organisation base.
Re-allocating all resources needed for KM programs based on priorities that reflect results achieved.
Establishing the KM policy and procedures and knowledge standards and cycles, also building KM guidelines for specific operational areas.
Developing the structure of KM department with full KM responsibility for strategy and business.
Developing well and a wide range of training & learning and provide support tools and techniques to be fully understood and used by all staff in term of KM. Learning plans have been developed.
Initiating a strong sense of teamwork across the organisation and linking incentives, rewards, and recognition with teams' contribution.
Initiating a KM supports cultural to shift knowledge -smart workforce and environment. The organisation is truly planning to exploit co-operation culture for improving its position, capabilities and expertise.
Establishing IT strategy for the whole of the organisation.
Establishing strategic IT applications services and networks with inside and outside entities to provide communication services for all individuals and groups in the organisation, and putting plan for providing diverse hardware architecture according to each unit's needs.
" Appointing a high level manager for IT services area, with middle management status.
Initiating core technical skills and some expertise outsourced to plan the strategic exploitation of IT for individual units and the organisation as whole.
Initiating KM acquisition activities such as collecting information needed and wishes of clients, active in an external professional network or association, doing researches (i.e. with universities) to explore future chances/possibilities
Initiating KM creation activities such as openly discussing problems, failure, and doubts in the banks, New ideas and insights lead, if necessary, to redesign of business processes and work methods, providing learning groups.
Initiating KM transferring activities such as starting knowledge sharing methods (KMS/Knowledge Portal), a people-oriented method (Storytelling) and a combination method (Micro articles), informs its members systematically of changes inn procedures, colleagues inform each other regularly about positive experiences and successful projects, Members change jobs regularly, thus distributing their know-how and so on.
Initiating KM application activities such as decision making depend on sufficient knowledge, selling knowledge, products, or services gets explicit attention, experience of clients are used to improve products and services, using existing know-how in a creative manner of new applications, frequently make use of brainstorming sessions to find solutions for problems we meet, failures and successes are evaluated and "lessons learned" are set down.
Initiating KM documentation activities such as having disposal up-to-date handbooks, which are frequently used, having documented all specific knowledge and skills of individual members, having up-to-date knowledge documentation systems.

Senior Management Commitment
Change Management
Information Technology
Knowledge Managamnt Process

Figure 7: the main duties in establishing KM infrastructures

Stage 4: Acting
Involving the senior management in the whole KM presses and implementation through business efficiency to support KM objectives and goals.
Reviewing KM strategies are commonly used by senior managers to ensure the input into strategic and business planning.
Formal mechanisms are in place to survey employees' encouragement and satisfaction regarding to KM on a regular basis, and results are tracked over time; KM initiatives are linked to employees' satisfaction, hence employees are rewards regarding to their knowledge.
The organisation as individual becomes within the industry to prepare themselves for KM at their own discretion.
External and internal resources are provided to all managers and employees; resource planning models are used to estimate resource requirements for KM.
Integrating organisational policies and procedures in practices with KM activities.
Prepare an Action Plan and identify changes required in organisation's structure.
Managers are applying training & learning in their day-to-day operations of KM and seeking and up-grading the quality of training, also seeking to provide all key training and learning in term of KM.
The organisation starts to create a number of teamwork and culture that would support KM initiatives and corporate goals.
Organisations start fostering the culture of continuous learning and participation. Pro-active effort is acting to share new ideas and approaches across the organisation.
Start using and exploiting IT for the banks' strategic opportunities and can be able successfully to perform KM, as well as starting of full involvement of IT users in KM initiatives; IT Reviews are carried out as issues arise.
Select possible tools to support the KM processes identified in the context of your business problem; general communication tools are provided to link senior management with employees.
Existence of organisation-wide network, where all groups are connected, and the central IT staff provides communication services for all individuals and groups in the organisation.
Combining the roles of IT and business to plan the strategic IT for individual groups and the organisation as a whole, where the business IT planners have an experience from working in/with both users and the IT function which makes them cross-disciplinary; some of IT users are involved in KM initiatives.
Producing (creation) mode where the new knowledge is produced by interacting with the things in cognitive domains of the enterprise.
Acquiring mode where the new knowledge is acquired from internal and external sources; externalising mode where the convertible tacit knowledge of the members of the organisation is conceptualised, articulated and externalised; discovering mode where the knowledge hidden in the data sources of the organisation (e.g. databases, data warehouses) is discovered; synthesizing mode where the new knowledge is generated either by integrating the newly generated and validated knowledge with the existing knowledge or by combing the existing knowledge;
People are encouraged to increase interactions oinside and outside and tansfer for efficiencies by providing input and are allowed to make suggestions when changes occur; and are consulted and given opportunity some times to participate in major change initiatives.
Knowledge is used in functions, reviewing and monitoring purposes and shared amongst functions where interrelationships exist.
Knowledge is documented by technology and non-technology tools.

Senior Management Commitment — Change Management — Information Technology — Knowledge Managamnt Process

Figure 8: the main duties in acting KM infrastructures

Stage 5: Learning
Value of KMS in the organisation is measured and tracked over time.
Improvements are created to develop strategic plans to address high priority issues related to KMS. A strong link exists between incentives, rewards, recognition, and teams' contribution.
Incentive, rewards, and recognition systems are constantly being improved, and customised to the needs of the organisation.
The organisation essentially beneficial from partnering in supporting its resources to support KM processes, and therefore require its larger partners in international organisations to show flexibility and adopt formats to accommodate their needs.
The resources allocation culture supports openness and flexibility.
The results of KMS are integrated in organisational policies, procedures, and practices.
The structure of KM department is a fully developed KM responsibility for strategy and business.
Organisation is truly exploiting training & learning for its KM activities.
Strong sense of teamwork exists across the organisation.
The organisation embraces innovation and responsible knowledge -taking; further, results of KM are used to support innovation, learning and continuous improvement.
The organisation is in a position to benefit from the IT culture that has been developed and maintain IT on the urgent agenda of concern of top management.
The organisation appears to be using and exploiting IT for its strategic opportunities and can be able successfully to perform KM. Also IT systems rely heavily on gathering and processing external in addition to internal data through the use of EDI systems with external entities such as customers, government and suppliers, which introduce problems of compatibility between external and internal data.
Existence of organisation-wide network, where all groups are connected, and the central IT staff provides communicat" Full involvement of IT users in KM initiatives, communication is very smooth, with management controlling and not limiting information to employees. ion services for all individuals and groups in the organisation.
High levels of IT skills in all departments and partial commitment to R&D initiatives may slow down the rate of progress of IT in the organisation.
Teams at the organisation are regularly exchanging knowledge and reaches conclusive decisions related to major change.
Information flows freely within functional areas, and is shared between functional areas inside and outside; and people are able to speak out and participate in discussions without fear of reprimand.
Organisation fosters a culture of continuous learning and participation. Pro-active effort is made to share new ideas and approaches across the organisation.
People are empowered to take responsible for KM, and are encouraged to be innovative by using knowledge for what ever and where ever.
The organisation is regularly documented knowledge and retrieves it when needed.

Senior Management Commitment

Change Management

Information Technology

Knowledge Managamnt Process

Figure 9: the main duties in learning KM activities

4. HOW THIS FRAMEWORK WORKS

The aim of Stage 1 "Initiating a KM Plan" is to provide a support by the overall organisation as well as by the senior management to ensure that interest of KM is exists, and that the effort will be pushed forwards. Senior management, which, alone, has overall responsibility for different stages of the process, must lead the banks to a more global approach to KM. A knowledge management strategy also needed to facilitate the transformation of the various types of knowledge within an organisation and to provide an evaluation mechanism to measure the effectiveness and efficiency of any strategy. It also needs to have users support (employees), which can be accomplished by involving users in the development process of KM. The aim of Stage 1 is to provide a structure for formulating a strategic business plan of KMS by identifying the external (business) drivers, defining strategic objectives or goals, identifying critical success factors, and developing measures to analyse the knowledge dimension of the problem. Figure 5 shows a condensed version of the template for developing a KMS plan. These CKIAs (key forces) are the key issues influencing an organisation to achieve or cope with radical future changes in the business environment regarding to KMS implementation. The outcome of Stage 1 is a business improvement plan of KMS with performance targets.

In the Stage 2 "Diagnosing KMS Infrastructures", the diagnosing phase builds upon the initiating phase to develop a more complete understanding of the improvement work. During the diagnosing phase two characterisations of the organisation are developed: the current state of the organisation and the desired future state. These organisational states are used to develop an approach for improving business practice. The goal of the banks scanning initiative is to provide an integrated and organisation-wide capability to develop a successful KMS implementation. The primary goal is to collect, analyse and interpret information from a variety sources. While directed at the needs of senior management, the resulting intelligence from the environmental scanning initiative will be of importance to others steps. As this scanning function develops, it will become more important to ensure that the processes and systems for implementing KM are open to all areas. Moreover, links between these findings and others in the literature will be necessary. The aim of Stage 2 is to clarify the whether the business problem has a knowledge dimension and to develop specific KM initiatives to address the business problem. The outcome of Stage 2 is a KM strategic plan with a set of initiatives and implementation tools to support business improvement. Figure 6 shows a condensed version of the steps involved in identifying the knowledge implications of a business strategy and for developing knowledge management initiatives for business improvement. Moreover, KM mechanisms can only be managed successfully if there is a mutual consensus to forge long-term partnerships and establish centralised KM processes.

Stage 3 "Establishing KMS Infrastructures", the aim of Stage 3 is, therefore, to provide a structured approach for implementing the KM initiatives (see Figure 7). Pan and Scarbrough (1998) report that management and leadership play a critical role in establishing the multi-level context needed for the effective assimilation of KM practices. Also there is a need to have the necessary infrastructure in place and having adequate resources to be able to demonstrate the further processes through a result oriented approach, for instance implementing of IT infrastructure in terms of establishing physical connectivity between people is a very important task. The infrastructure issue is affecting all businesses; today's environment is forcing organisations to obtain all or part of their overall infrastructures such as (IT, training and learning, teamwork, culture etc). The outcome of stage 3 is a KM strategy and an implementation plan with priorities and an appreciation of likely impact of various KM initiatives. This stage is the most challenging, as the justification of KM initiatives depends on the expected establishment of KM infrastructures. The outcome of Stages 1 and 2 of the KMIFBI Framework is a business improvement strategy underpinned by KM.

Step 4 “Acting a KM Infrastructures”, the activities of the acting phase help an organisation implement the work that has been conceptualised and planned in the previous three phases. These activities will typically consume more calendar time and more resources than all of the other phases combined. As the adoption of the KMS grows organically, the management should promote the KMS to people to try to persuade them to use the KM systems and tools. Management should ensure that prospective users are educated and trained to use the KMS effectively, and people are given plenty of opportunities and encouraged to learn and use the KM system. By applying these "actionable" activities in each of the knowledge domains of the managerial knowledge portfolio it can be ensured that KM activities are perceived to be dealing with important managerial concerns and organisational issues. Managers should be focusing their attention on ensuring that there are processes, practices, and people with the appropriate capabilities in place to ensure that knowledge is being managed in each of these critical domains. In applying these KM activities to organisational work, managers are able to see where the value and limitations of certain KM initiatives and tools are. The Figure 8 gives more details of this step’s activities. The out come of this step is a specific business context that creating values, and drawing on people with diverse expertise and knowledge both to enhance existing value chains, and to create new ones. The pace of change in the business environment in acting stage means that strategic plans can no longer be set for a fixed term and then implemented, but must continually evolve in response to management's evolving understanding of the organisation in the context of its environment.

Step 5 “Learning a KM Activities”, the learning phase completes the improvement cycle. One of the goals of the KMIFBI framework is to continuously improve the ability to implement change. In the learning step, the entire KMIFBI experience is reviewed to determine what was accomplished, whether the effort accomplished the intended goals, and how the organisation can implement change more effectively and/or efficiently in the future. The Figure 9 gives more details. The out come of this step is given the importance of a strong organisational learning climate; and senior management needs to take the initiative for sponsorship and support of the efforts in this direction. However, due to the diverse background of the employees, senior management should not assume that cross-functional thinking happens overnight, especially in organisations traditionally characterised by functional isolations, domain dissimilarities and centralised management. One thing managers can do to facilitate learning and the acquisition of new knowledge is to offer continues training to individuals in areas where knowledge is needed or desired. Learning in organisations takes place when the experiential awareness traverses across departmental boundaries and results in leveraging the strategically valuable knowledge to improve goods and services. Francis and Mazany (1996) concluded that to become a learning organisation, an organisation must develop a wide range of knowledge, skills and characteristics. However, the beginning step is to develop the necessary structures to assist those within the organisation, as well as the organisation itself, to learn and to change. And finally any KM approach is always an ongoing communicative learning process that enables periodical revising of corporate strategies in the light of current business environment (Masini and Vasquez, 2003; Millett and Randles, 1986; Schwartz, 1996; van der Heijden et al., 2002). Therefore organisations adopting KMS have to carry on all KM activities and increase interaction between their infrastructures as well as having a long-term understanding of KM planning in order to plan new concepts sooner.

5. HOW TO READ THE KMIFBI FRAMEWORK

The success or failure of an organisation's KMS implementation rests more heavily on the organisation's ability to manage and combine between organisation commitments, change management, information technology and knowledge management processes. An organisation and its managers have to use a variety of approaches to combine, sort, and process the environmental knowledge to produce timely and relevant knowledge for forming, monitoring, evaluating, and modifying organisation’s goals and objectives. This variety should reach a high integration level in order to be possible to obtain a strategic KMS. The banks have to follow five stages in Capability Maturity Model (CMM) format, whereas the banks can’t move to the next stage unless finished the first one. Each step and its component are interconnected and build upon each other as shown in Figure 4 above. A balance of these elements must remain flexible in order to fit the business strategy and to adapt to a turbulent and ever-changing environment.

The out comes of the first stage are a securing senior management commitments and support; a developed business strategy of KMS implementation with an organisation clear vision and understanding of KM, In the second stage the out come is a model of the current knowledge infrastructure, reflection involves an analysis of strong and weak points, and determining where opportunities for improvement to the knowledge infrastructure lie, so a record of the current status CKIAs will be available.

The out comes of third stage are organisation and senior management establish and implement a knowledge infrastructure and support system that enhances and facilitates the knowledge processes (acquisition, creation, transfer, application and documentation) of at the appropriate levels.

The act step (forth) consists of the actual consolidation, integration, development, and distribution of knowledge. The outcome for the act stage is the actual implementation of a new knowledge infrastructure. The fourth step of the knowledge management process cycle is the review of the results of actions taken, using assessment criteria. Criteria should consider whether the infrastructure contains the right knowledge, whether the knowledge infrastructure is stable or susceptible to change, whether it is in a form that permits easy use, and whether the people who need the knowledge can easily access it.

In stage five (learning), however before conceptualisation can occur, an organisation must have experience. It can be suggested that the knowledge management process cycle is actually a reflection of the cycle of organisational learning whereby knowledge is created through the transformation of experience can also be applied to organisations.

6. CONCLUSION

This paper has described the process and analyses under which the KMIFBI framework is developed to improve the LPBs strategic capabilities relatively to knowledge management processes and implementation. Since the dynamic aspect of knowledge management processes depends largely on individual and organisational commitments, IT systems, skills and behaviours, these areas that the framework has developed specifically in order to build a high degree of responsiveness, and a willingness to re-examine continually the knowledge processes. The KMIFBI Framework has to be validated in the next step. This validation could be with the potential adopters and of professionals they already have a KMS in place.

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ASSESSING THE ROLE OF ORGANISATIONAL COMMITMENT IN KNOWLEDGE MANAGEMENT IMPLEMENTATION: AN APPLICATION OF THE CAPABILITY MATURITY MODEL TO THE LIBYAN BANKING SECTOR

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ABSTRACT: It is widely acknowledged that senior management commitment, information technology, change management, human resource management, and knowledge management processes (in terms of knowledge management implementation) are essential considerations for organisations wishing to exploit and manage their holistic knowledge assets. This paper presents research undertaken within the Libyan banking industry using the Capability Maturity Model concept as a context for knowledge management implementation. The paper explains the involvement of senior mangers in supporting the knowledge capturing process vis-à-vis understanding the user-requirements, planning for KM strategy, have enough alliances and partnerships; providing KM resources and knowledge management implementation within the Libyan banking industry. Key findings suggest that gap analysis should be undertaken in four key areas prior to implementation of knowledge management system.

Keywords: capability maturity models, change management, human resource management, information technology, knowledge management.

1. INTRODUCTION

Knowledge is an essential and critical function needed in order to obtain and facilitate competitive advantage in modern organisations. Hence, today's organisations are increasingly paying more attention in the initiation of knowledge management (KM) activities for building their assets (intellectual capital) and knowledge-based systems (processes) in order to maximise results. However, there are numerous issues concerning the promoters and dissenters of knowledge management implementation, for example, factors related to: organisation commitment (OC), information technology (IT) focus, change management (CM) procedures, and KM processes. The difficulty for many organisations arises from the fact that the 'implementation' component of the KM initiatives often faces barriers, especially no logical framework and methodology is adopted to support it (Kridan and Goulding, 2005).

The continuous process of change often places considerable demands on organisations, which naturally embrace change through the norms and values of stakeholder positions. This change process can often cause friction, as 'cultural identity' usually takes a long time to learn, develop, be accepted, and mature; and can be exacerbated where employees and managers are culturally divided, or where a dichotomy exists between views and expectations e.g. change and 'hidden' agenda. This obviously impedes the KM implementation process.

KM strategies must do more than just outline high-level goals such as 'become a knowledge-enabled organisation'. The strategy must identify the key needs and issues within the organisation, and provide a framework for addressing these issues as well as providing assessment techniques to evaluate the effectiveness and efficiency of this strategy (to be able to successfully measure the impact of KM initiatives on an organisation's capability). Furthermore, KM initiatives have to be incorporated with an organisation's strategic goals and objectives (Carrillo et al, 2003; Robertson, 2004).

The success of KM initiatives depends upon people's motivation, their willingness, and their ability to share knowledge and use the knowledge of others. Barriers therefore need to be identified and removed. Existing enablers also need to be enhanced and additional ones created. This is often where the greatest KM challenges lie (Cong and Pandya, 2003).

2. THEORETICAL FOUNDATIONS

Various authors have specifically investigated the relationship between commitment and knowledge processes (for instance: (Hislop, 2002; Scarbrough & Swan, 1999; Smith & McKeen, 2002). Studies concerning this subject have identified various dimensions of organisation commitment (Mowday et al., 1982; Reichers, 1985). In this paper five organisation commitments are considered to be affective to knowledge management implementation, these are:

3. THE IMPORTANCE OF SENIOR MANAGEMENT COMMITMENT

KM requires senior managers to think differently about organisational work and KM activities require managers to change how they invest their effort and time – costs. For senior management to add value to its organisation they first need to develop a clear vision of strategic potential of KMS. Senior management are in charge with ensuring organisational survival. They are uniquely positioned to develop and exploit strategic potential ideas and to set conditions for the flow of knowledge around the business to ensure that managerial decisions are taken effectively to address continual change requirements (Bollinger & Smith, 2001).

In addition, Bailey and Clarke (2001) state that senior management to add value need to leverage external knowledge that others are not party to, make informed judgements about trends in the uncertain future in order that they can create clarity of direction. They then need to communicate well and widely what is fundamentally and critically important to organisational success. What this highlights for senior mangers is the need to step up from managing to leading - using their organisational visibility to convey what is strategically important and the focus of their activities to create a knowledge valuing, creating, sharing and exploiting culture.

To gain and sustain commitment to valuing KMS, it is believed that senior managers should have the motivations to invest in organisational resource and personal reputation to create favourable conditions for KMS by changing culture in the business. This in turn highlights the need to have sufficient grasp of the external business and industry environment to spot the trends and sufficient grasp of the capability and contribution potential within the organisation. And of course this clear vision can only be built and exploited if senior managers devote time to communicating it well in terms that are relevant to those round the organisation who are best placed to implement it.

4. THE IMPORTANCE OF KM STRATEGY

An analysis of KM failures reveals that many organisations who failed did not determine their goals and strategy before implementing any KMS Further, the success or failure of KMS is dependent on its integration into the goals and strategy of the organisation (Doz & Schlegelmilch, 1999; Hansen et al., 1999). In fact, 50 to 60 percent of KM deployments failed because organisations did not have a good KM deployment methodology or process (Lawton, 2001). The most important managerial context for investing in and promoting the use of KM is the organisation's strategy. That is, KM efforts must not be divorced from strategy planning and execution. In other words, an organisation's KM strategy must be driven by a clear sense of what its competitive strategy is. However, in many KM projects that disappoint, strategy is not even a key evaluation criterion or motivating factor (See for example, the empirical studies of 24 organisations in Davenport et al., (1998b), and that of 431 organisations in Ruggles (1998)).

According to Hansen et al., (1999), when an organisation considers developing a KM strategy it must know its market and must also find an answer to three important questions:

What does the market want?;
What are the driving forces?; and
How may the organisation be able to best provide answers?

Soliman and Spooner (2000) state that a good knowledge strategy needs to delineate clearly the resources to be dedicated to tacit and explicit KM. A recent study (Price Waterhouse Coopers, 1999) suggests that in order to harness and increase the know-how experience and expertise of employees, organisations should implement the following strategy:

- Focus only on what the business needs to know, i.e. become knowledge focused;
- Make important knowledge visible, i.e. become knowledge visible (e.g. create and make explicit pathways to the experts and important wisdom within the company);
- Pay attention to the vocabulary of knowledge, i.e. become knowledge defined (e.g. customers' needs versus customer feedback);
- Go beyond the company to tap knowledge from customers, suppliers and competitors, i.e. become a knowledge seeker;
- Make it clear to employees that knowledge sharing is a core value for the company, i.e. become a knowledge culture;
- Measure the results of the implementation of the knowledge management program, i.e. become a knowledge assessor;
- Reward the sharing of expertise and intelligence, i.e. become knowledge exemplified.

The above strategy could also assist as a checklist to ensure that the KMS covers all key elements of the organisation. A KM strategy should be linked to what the organisation is attempting to achieve (Gronhaug & Nordhaug, 1992; Teece, 1998). It is also important to articulate the purpose of the KM strategy. What benefits does the organisation expect to gain from their work with KM? How will it affect the employees' work?, (Klaila, 2000). Moreover, Gopal and Gagnon (1995) put it concisely “effective KM starts with a strategy”. Within a KM strategy, knowledge is recognised as an organisation's most valuable and under-used resource and places the intellectual capital at the centre of what an organisation does (Ash, 1998). To start to create a KM strategy, an organisation needs to build systems for capturing and transferring internal knowledge and best practices (Allerton, 1998).

Based on the discussion points above Wiig (1997b) has identified five strategies that are used by organisations to implement KM systems. Some pursue knowledge as a business strategy, where the focus is on knowledge creation, capture, organisation, renewal, sharing, and use at each point of action. Second is the focus on intellectual asset management such as patents, technologies, structural knowledge assets, customer relations, operations, and management practices. A third method is to focus on a personal knowledge asset accountability strategy. Here, each employee is responsible for his/her own knowledge-related investments, renewal of knowledge, and sharing of knowledge assets within the employee's area of accountability. A fourth strategy is the knowledge creation strategy, with a focus on organisational learning, research and development, and employee motivation to innovate and learn. The fifth strategy is the knowledge transfer strategy. Here the emphasis is on systemic approaches to transferring knowledge, such as acquisition, organisation, restructuring, warehousing, and repackaging for distribution to the point of use. The specific method selected by an organisation differs based on the individual business and its unique needs.

Finally, survival strategies rely on the effective utilisation of existing assets and resources, including the existing level of knowledge (Lang, 2001).This latter aim is supported by Von Krogh et al. (2000) who claim that strategy will ultimately determine the areas an organisation will do business in and to what extent it will be successful in competing in those areas. Knowledge will be vital for an organisation's long run strategy and it will be important to envision future knowledge needs.

5. THE IMPORTANCE OF MEETING EMPLOYEES’ REQUIREMENTS

Several authors argued that the introduction of a reward system or changes in compensation incentive policies rarely have an effect on the KM processes it enhance long-term KM process because the process needs to be natural (Ellis, 2001; Finerty, 1997; McDermott, 1999; O'Dell & Grayson, 1998). One of the most important issues when working on a KM strategy is to create the right incentives for people to share and apply knowledge (The Banker, 1997). The personal reward systems must support the culture of sharing knowledge (Keeler, 2000; Mayo, 1998). To improve this process it is crucial to reward employees that contribute their expertise and to make sure employees understand the benefits of KM (Cole-Gomolski, 1997b). Traditional compensation, reward and pay systems are under attack for being neither cost-effective nor motivational (Despres & Hiltrop, 1995). Non-monetary rewards become important, as in a knowledge-intensive environment employees are potentially more motivated by intrinsic career considerations. A study undertaken by Fish and Wood (1997) showed that intrinsic career considerations were more important than monetary rewards in motivating employees to take on international assignments. It is also suggested that once a reward system has been instituted, the quantity of knowledge shared is likely to increase, but the quality may decrease (Scheraga, 1998). In addition, Michailova and Husted (2003) argued that the use of encouragement, stimulation or incentives is inadequate in hostile sharing environments, suggesting that any kind of rewards evaporate quickly and do not increase motivation for knowledge sharing.

Organisational rules or systems are explicit means of motivation or coercion to stimulate KM activities among the organisational members. Reward and incentive systems may be popular examples of such organisational system (Lai & Chu, 2000). Therefore, a motivating organisation culture is especially important for the running of the KM activities. Stemming from the competitive instincts of human nature, incentives are one method of optimising employee performance and corporate results. In these understanding organisations that welling to implement a successful KMS; have to set a dynamic compensation system for enhancement of employees' abilities to process knowledge and gain from it.

6. THE IMPORTANCE OF ALLIANCES AND PARTNERSHIPS

Long-term partnerships and collaboration can help the organisation to learn from others, and transfer knowledge to their organisation base. It has been argued that partnering can provide opportunity for improving the performance of KM processes (Rycroft & Kash, 1999), and within such a framework, it then becomes possible for individual organisations within the industry to prepare themselves for KM at their own discretion (Siemieniuch & Sinclair, 1999a, 1999b, 2000). Partnering can be essentially beneficial to organisations that may not have the resources to support KM processes, and therefore may require their larger partners in international organisations to show flexibility and adopt formats to accommodate their needs.

Managers in modern organisations usually seek the knowledge they lack from external sources because of the complexity of the environment, sophisticated in modern technologies, new customer needs and so on. The answer to these central issues will determine the strategy to explore new knowledge sources or to exploit a knowledge base with network partners (Grant, 1996). In summary, an integrated knowledge management framework cannot be complete without any of the two perspectives (i.e. internal and external). The internal knowledge base of an organisation must be complemented with partnering practices and the involvement of other knowledge network members. The uniqueness of each organisation's networking configuration is expected to shape organisation core competencies and, ultimately, to determine business profitability in the long run.

7. IMPORTANCE OF KM RESOURCES

Knowledge resources include internal and external human resources, data and documents of various forms, customers, and associate organisations or partners (Bierly & Chakrabarti, 1996; Chesbrough & Teece, 1996; Cohen & Levinthal, 1990; Grant, 1996; Lai & Chu, 2000). Moreover Davenport (1997) emphasised the importance of financial resources to KM practices, which in many cases can be expensive. A 2001 survey conducted by supportindustry.com and STI Knowledge reveals that 31 of 49 companies (63 percent) reporting a KM initiative spent between \$100,000 and \$249,000; 16 percent (eight of 49) spent \$250,000 to 499,999; three of 49 spent between \$500,000 and \$749,999; one of 49 spent between \$750,000 and

$999,999; four of 49 spent between $1,000,000 and $1,999,999; and 2 of 49 spent between $2,000,000 and $4,999,999 (CRMindustry.com, 2001).

Despite inability to evaluate their most important knowledge resources this, it is important to parameterise the value variable, so that managers may estimate resource value when making strategic decisions about accessing or developing knowledge resources (Sveiby, 1997). From a KM perspective, managers make choices about knowledge resources leading to organisation heterogeneity and sustainable advantage. Valuable knowledge resources are then combined to create superior capabilities leading to effective KM processes (Massingham, 2004).

Through human and related task, knowledge resources are exploited for KM activities, such as knowledge acquisition, storage, sharing, and utilisation. Hence, adequate resources to support knowledge flows and collaboration need to be allocated. According to Barney, resource based logic can help managers "more completely understand the kinds of resources that can generate sustained strategic advantages" (Barney, 2001). He adds that this assists managers to "identify ... the most critical resources controlled by the organisation ... and to nurture and maintain these resources." To be a strategic asset, the resource must possess four characteristics which are: valuable; rare; inimitable; and non-substitutable.

8. RESEARCH METHODOLOGY

The first step in any process improvement endeavour is to determine the baseline state. As the KM concept is still relatively new, the immaturity of this field makes it necessary for this research first to determine the critical areas the (variables) which require attention while planning the KMS, and discuss what is important and what is not; generally this is an effective solution for organisations that are still beginners in process improvement. For organisations with little KM process capabilities, a better choice is to begin with a self-assessment. In an organisation where process maturity is a new concept, a self-assessment (questionnaire) offers an easy entree to the world of process improvement. As the term implies, self-assessment is a means by which an organisation assesses compliance with a selected reference model or module without requiring a formal method. Self-assessment helps organisations find gaps between their current practices and those identified in the KMS. The results of the self-assessment can also be used to educate the organisation about the acquisition module as well as about the requirements of the formal appraisal method. The mechanics of a self-assessment are simple and can be done by use of a questionnaire administered by a face-to-face interview, requiring managers and employees to respond to a series of questions based on their understanding of how work is performed in their organisation. To encourage candour in the responses, the researcher should administer the questionnaire confidentially. The individual responses are then aggregated, averaged, and presented for discussion and further action (Blanchette, and Keeler 2005).

Any KM strategy must identify the key needs and issues within the organisation, assess them and provide a framework for addressing these areas. This creates the need for instruments and a process that can be used to evaluate an organisation’s current status relative to the critical knowledge implementation areas (CKIAs). A quantitative method has been developed for assessing and evaluating Libyan banks’ current status relative to the CKIAs because of the importance of understanding in detail, how banks work, and because the lack of literature on KM in the banking requires the use of case studies during this explorative stage (Yin, 1994). Also, Bell (1993) refers to the case-study approach as "… particularly appropriate for individual researchers because it gives an opportunity for one aspect of a problem to be studied in some depth within a limited time scale".

The literature on KM poses questions about knowledge and suggests a number of design principles for its implementation (Stebbins and Shani, 1995, Ware, 1997). The questions are generated as a result of an expansive review of several streams of literature, a pilot study and preliminary research. In this paper only OC questions are dealt with:

Research Question: Do the Libyan banks promote and support the implementation of KMS? This question has sub-questions which are:

- Do the senior managers at the Libyan banks have a clear vision and support for the KMS implementation?
- Do the Libyan Banks have enough strategies for KMS implementation?
- Do the Libyan Banks promote and motivate their employees for KMS implementation?
- Do the Libyan banks have enough alliances and partnerships with the international banks to enable the implementation of KMS?
- Do the Libyan Banks have enough resources for successful KMS implementation?

As indicated, the methodology involved using a quantitative case study method, supported by face-to-face interviews, where the interviewees responded to a series of questions based on their understanding of how work is performed in their organisation. The individual responses were then aggregated, ranked, and presented in tables. These results will be considered in combination with the other questionnaire results (questionnaire of CM, IT and KMP) to provide a full assessment that would have many more questions covering all the process areas described in the KMS implementation.

Many organisations have turned to the Capability Maturity Model (CMM) developed by the Software Engineering Institute (SEI) to improve their software engineering processes by setting goals to achieve higher SEI levels (Paulk et al, 1993). In this paper CMM will be used as guideline to implement a knowledge management system within the banking industry.

Each CMM level has several associated key process areas. The instrument allows for the determination of the score associated with the KM level, which the bank should try to achieve. Each key process area contains several key activities. the scoring guidelines for measuring how well an organisation implements a specific key activity, basing them on several common KM themes (CKIAs), and the activities were then expanded and grouped under three primary evaluation dimensions, using criteria which we also developed, for evaluating them (see Table 1, 2, 3, 4, 5).

Table 1: Senior Management Commitment

Category	Interpretation
Category "A" SMC satisfactory/ best practice	• Senior management have created a climate wherein creativity and responsible risk taking are encouraged, barriers are broken down between functions, and business decisions are challenged. ▪ Senior management have established a forward-looking approach to knowledge management practices to assess department's capacity to sustain desired performance levels in the future. ▪ Senior management are recognised amongst peers for leadership in implementing knowledge management practices. ▪ Senior managers have the motivations to invest in organisational resource and personal reputation to create favourable conditions for KMS. ▪ Senior management have a primary focus on establishing a culture that respects KM processes.
Category "B" SMC further improvement possible	• Senior management currently have a clear vision and goals about KMS, • Senior management provide adequate support to the core knowledge management programs. • Senior management commitment involved in whole of KM processes. • Senior management is linked organisation's corporate goals and objectives to knowledge management initiatives. • Senior managers are integrated KM in the organisation's corporate strategy and shapes the organisation's knowledge culture.
Category "C" SMC requiring more attention	• Senior management still suffering from some confusion exists within the understanding, visions, and responsibilities of managing knowledge. • The level of senior manager's participation in the formulation of overall KMS is still very low. • Senior management has developed a short -term plan to improve knowledge management practices, • Senior management still reviewing its plan for supporting KM activities and services to assess where KM is appropriate, • Senior management is recognised the need for change in organisational culture.
Category "D" SMC urgently requiring attention	• Little or no overlap exists in understanding, visions, and responsibilities for KMS among senior managers. • Little or no effort is made to reconcile the KMS initiatives by senior management. • Senior management has limited involvement in KM processes, • Senior managers have a little motivation in providing KMS infrastructures to support the operations of the KM function. • Senior management is not highly committed to support organisational culture for knowledge management practices.
Category "E" SMC not Applicable	• No senior management commitments dedicated for implementing KM.

Table 2: KM Strategy

Category	Interpretation
Category "A" KMST satisfactory/ best practice	• KM strategies are clearly defined by senior management and in each management level, and are well understood throughout the organisation. • The organisation's corporate goals and objectives are fully linked to KM strategy. • The KM strategy is established with the continual KM policy and procedures. • Review results play a major role in redirecting focus of KM design, and in determining the type of risks that might face the performance of KMS.
Category "B" KMST further improvement possible	• Integrated KM strategy is embedded in the organisation's corporate strategy. • KM strategy supports KM objectives through business efficiency. • A long term KM plan is in place, and is closely aligned with the organisation policy and procedures. • Review KM strategy is included the risks of change management and human resources in internal and external relationships.
Category "C" KMST Category requiring more attention	• The corporate goals and objectives of the KM strategy are not well defined and cleared at the organisation. • The relations between KM strategy and organisation's goals and objectives are indirectly addressed through its supportive role. • Very low level of the participation of KM strategy in the formulation of overall KMS in the organisation. • Only the some issues are reviewed by KM strategy, some risks are partially reflected in KMS plans.
Category "D" KMST urgently requiring attention	• KM strategies are completely separate entities from organisation's strategy. • There is no conjunction between the corporate goals, objectives, policies and procedures and KM strategy, • No involvement of the senior management practical in the formulation and processes of KM strategy, • Limited attention has been given to evaluate the KMS risks.
Category "E" KMST not Applicable	• No KM strategy dedicated for implementing KMS.

Table 3: Employees' Requirements

Category	Interpretation
Category "A" AP satisfactory/ best practice	▪ The organisation has a long-term partnerships and collaboration which provide the organisation to learn from others, and transfer knowledge to their organisation base. ▪ The organisation essentially beneficial from partnering in supporting its resources to support KM processes, and it is a larger partners in the international organisations.
Category "B" AP further improvement possible	▪ Med-term partnerships and collaboration with other organisations that help the organisation to learn from others, it becomes a partner within the only a part of its industry, and it requires to be a larger partners in the international organisations; it shows flexibility and adopt formats to accommodate its needs. ▪ Partnering is benefiting the organisation and supporting KM processes.
Category AP "C" Category requiring more attention	▪ Short-term partnerships and collaboration with national and international organisations just started recently; the organisation began to prepare for partnership within the industry for KM interaction. ▪ Only some benefits can be realised at the organisation by partnering.
Category "D" AP urgently requiring attention	▪ Only season-term partnerships and collaboration are provided at the organisation, as a result no clear opportunities provided by partnering or relationships in term of KM improvement. ▪ Benefits from Partnering are not clear yet.
Category "E" AP not Applicable	▪ No Alliances or partnerships dedicated for implementing KMS.

Table 4: Alliances and Partnerships

Category	Interpretation
Category "A" ER satisfactory/ best practice	▪ Senior management is committed to communicate the importance of meeting employees as well as providing regulatory and legal requirements to promote knowledge process. ▪ Incentive, rewards, and recognition systems are constantly being improved and customised to the social and money bases needs. ▪ Knowledgeable people are fully rewarded at the organisation, and all further carrier steps is depended on the accumulation and the application of knowledge. ▪ Value of human capital in the organisation is measured and tracked over time.
Category "B" ER further improvement possible	▪ General communication tools are provided to link senior management with employees. ▪ Formal mechanisms are in place to survey employees' encouragement and satisfaction regarding to KM on a regular basis, and results are tracked over time. ▪ Improvements are created to develop plans to address high priority issues such as incentive, rewards for knowledgeable employees, ▪ Employees' role in KM is a key consideration in the employees' performance measurements.
Category "C" ER Category requiring more attention	▪ No formal mechanisms exist for senior management to manage its relationship with employees, or to measure the extent of the communication benefits. ▪ Only some arrangements for surveying employee encouragement and satisfaction exist across the organisation. ▪ Indirect linkage between KMS and employees incentives and rewards. ▪ Limited monitoring, measurements, and analysis of results of the accumulation of the knowledge by employees, and they are on a trend basis in term of motivation systems.
Category "D" ER urgently requiring attention	▪ Communication tends to be downward, with management controlling and limiting information to employees. ▪ Information on employee satisfaction is collected on an informal and ad hoc basis. ▪ Confusion exists in accountabilities for achieving and reporting results regarding to employees satisfaction and motivation. ▪ No formal measurement to the level of knowledge accumulation and no link to the employees' performance measurement.
Category "E" ER not Applicable	▪ No motivation system provided for implementing KMS.

Table 5: Knowledge Management Resources

Category	Interpretation
Category "A" KMR satisfactory/ best practice	▪ Resources are re-allocated between KM programs based on priorities and results achieved. ▪ All management levels are highly committed and supportive to, and participate actively in the resource allocation process for KM. ▪ External and internal resources are provided to all managers and employees ▪ The resources allocation culture supports openness and flexibility to all the staff and be coded for positions. ▪ KM resources are reviewed continuously in term of KM.
Category "B" KMR further improvement possible	▪ Resource planning models are used to estimate resource requirements for KM only. ▪ Senior managers are the only responsible for resources allocation. ▪ Organisation is more interesting in internal resources as provided mechanisms to facilitate resource re-allocations between branches/regions. ▪ Only managers have the access to the knowledge resources. ▪ KM resources are reviewed in term of KM every five years.
Category "C" KMR Category requiring more attention	▪ Resource levels are adjusted for new activities/priorities only in term of KM, and are managed independently by each organisational unit (e.g. branch, region). ▪ KM resources are managed by low managerial level. ▪ No formal mechanisms are in place to facilitate resource re-allocations between branches/regions or other organisations. ▪ The top management provide time and resource only when required. ▪ KM resources are reviewed in term of KM every three years.
Category "D" KMR urgently requiring attention	▪ No systematic/formal approach or process to resource allocation for KM. ▪ Roles and responsibilities as they pertain to identifying and providing strategy resources for KM are generally not well understood. ▪ No mechanisms exist for the organisation to manage its resources for KM. ▪ Information on the KM resources is mainly anecdotal. ▪ KM resources do not seem to be reviewed in term of KM every five years.
Category "E" KMR not Applicable	▪ No KM resources allocated for implementing KMS.

Every analysis in this area was based on CO literature, and 21 questions were used that seek important information about the development, procurement, and exploitation of OC in the context of KM. Each question was accompanied by a grid containing five possible answers (in scenario format as extracted from Martensson, 2000 and IT strategic health check questionnaire)), and respondents were asked to indicate their extent of agreement. The questions were designed to establish:, if KM related issues were used as a strategic tool (satisfactory/best practice), if they were used as an operational tool (further improvement possible), if they had some value (requiring more attention), if they had a little value (urgently requiring attention) and if they had no value and the organisations would not use them theoretically (not applicable). The grid for assessment used the letters E = "not applicable" (N/A) = 1 ; D = "urgently requiring attention" (URA) = 2 ; C = "requiring more attention" (RMA) = 3 ; B = "further improvement possible" (FIP) = 4 ; and A = "satisfactory/best practice" (BP) = 5. Before any interview was conducted, it was important to explain to all participants the exact aim and objective of this questionnaire.

To encourage candour in the responses, the researcher administered the questionnaire confidentially with an assistant from the bank in question. They were used in three banks as a tool for gathering information regarding the overall use, application, and maturity of OC in the Libyan public banks, and conducted with five core members in each bank. The details can be seen in Table 6.

Table 6: Category of Interviews

Position in the Bank	Total No. of interviews
Senior Manger (Head of the Bank or Deputy)	3
Executive (Head of IT, HR, Department)	3
Managerial (Head of Information, Training Division)	3
Technical (Structural Engineer, Programmer)	3
Administrative or Supportive (Secretary, Accountant)	3
Total	**15**

Each question was carefully explained because of the ambiguity of the concept of KM. To improve the data reliability all results were recorded anonymously. The data collected was analysed using the SPSS software and standard statistical analysis techniques, e.g.:

Frequency tables to present numbers and percentages of categorical questions.

Descriptive measures such as mean, median, mode, and standard deviation

Measure of strength (MS) = (mean-1)*25.

The formula maps a scale from (1-5) to a scale of (0-100) (percentage of strength) for example: mean = 3.98 MS= (3.98-1)* 25= 74.50%.

The descriptive measures for the effectiveness of the CKIAs related to OC in the all three banks, and the raw results from this questionnaire summarises the content of the 21 questions, shown in Table 7 below.

Table 7: The Questionnaire-Raw Data

No	CKIAs	Mean	Std. Deviation	MS %
1	Doest he senior management currently have a clear vision and goals about KM?	2.73	1.033	43.25
2	Does the senior management in your bank provide adequate support to the core knowledge management programs?	2.47	.834	36.75
3	Does the senior management commitment in your bank involved in whole of KM processes?	2.87	.990	46.75
4	Do the senior managers have the motivations to invest in organisational resource and personal reputation to create favourable conditions for KM?	2.80	.676	45.00
5	The senior management have a primary focus on establishing a culture that respects KM processes?	2.87	1.125	46.75
6	How would you describe the relation between your bank's strategies and KM strategy?	2.40	1.056	35.00
7	Does your bank committed to see KM as strategic level and deliver all KM strategies to all its employees?	2.47	1.356	36.75
8	How does your bank intend to manage KM in future?	2.33	.816	33.25
9	Does your bank handle any consider risks associated with the implementation of knowledge management?	2.93	1.100	48.25
10	Does your bank committed to meet employees' requirements in term of KM?	2.00	1.000	25.00
11	Does your bank provide adequate help to the employees to win work?	2.07	.884	26.75
12	How much does your bank encourage employees to create and share their knowledge?	2.53	1.187	38.25
13	What is the level of the compensation system regarding to knowledge management implementation in your bank?	2.53	.990	38.25
14	Do you think your bank is motivated the employees according to their knowledge?	2.13	.834	28.25
15	How are alliances and partnerships used as a part of your KM strategy?	2.13	1.246	28.25
16	How can describe the involvement of employees in external relationships in term of knowledge management?	2.07	.799	26.75
17	Considering your bank's commitment, what the level of providing budget and sources for KM programs?	1.73	.704	18.25
18	How much does your bank provide time and resources to take part in the learning and sharing exercises?	2.67	1.113	41.75
19	Does your bank provide enough technologies, policies and procedures for generating, sharing and storing knowledge?	2.53	.915	38.25
20	Does your bank eliminate any existing and future rules that are likely to obstruct the continuous of resources providing?	2.33	.900	33.25
21	The bank reviews the organisation resources regarding to KM?	2.27	.799	31.75

In Table 8 these 21 questions were categorised into five dimensions as can be seen in table 8, the descriptive measures for the overall effectiveness of the CKIAs related to OC in all the three banks. The mean scores are between (2.10) alliances and partnerships and the highest (2.75) senior management commitments.

Table 8: Descriptive analysis Overall effectiveness factors

No	Item	Mean	Rank	MS%
1	Senior management Commitments	2.75	1	43.75
2	KM strategy	2.53	2	38.25
3	Employees' requirements	2.25	4	31.25
4	Alliance and partnership	2.10	5	27.50
5	KM Resources	2.31	3	32.75

Thereafter these results were applied to a matrix to help identify the exact status of OC support in the all banks. Five outcomes in each area are presented as can be seen in table 9.

Table 9: The Comparison Guideline

Relevant Category	E	D	C	B	A
If the Mean	0-0.99	1-1.99	2-2.99	3-3.99	4-5
If the MS	0	0-25%	25-50%	50-75%	75-100%

Although the guidelines are generic, the assessor can easily use them to determine the level of each specific key activity. This progress-assessment process is not intended as a replacement for any formal assessment instruments developed by the SEI, but rather as an internal tool to help banks prepare for a successful implementation of KMS.

The precise interpretation based on the literature review of each of these categories (see table 1,2,3,4, and 5), are combined with the interviews results as follows:

9. SUMMARY OF FINDINGS

9.1 Senior Management Commitments

Although the earlier preliminary research findings indicate the importance of this area, the secondary research reveals a weakness with a mean of 2.75 and MS of 43.75%, in comparison of these results with the conceptual framework (see table 1), these results are in adaptation with the category C (a mean between 2 and 3 and MS between 25-50%), therefore the interpretation of these results mean that still there is confusion exists at the LPBs in term of KM vision, interest and responsibility, furthermore it is that the relation between SMC and KM strategy is indirectly addressed through its supportive role, also some overlap in the roles and responsibilities among managers are exist, as a result, the corporate goals and objectives of KMS are not well linked to the banks' business strategy.

9.2 Knowledge Management Strategy

The mean and MS of this area in the secondary research show very low level of KM strategy (a mean of 2.53 and MS of 38.25%), comparing these results with the interpretation conceptual framework (see table 2), these results are relevant to category (C), which mean that no clear KM strategy exist at the LPBs recently, and the relationships between KM strategy and organisation's goals and objectives are indirectly addressed through its supportive role. Furthermore, these results mean that very low level of the participation of KM strategy in the formulation of overall KMS. In term of reviewing the risks that might face the LPBs when implementing KMS, it is that no full action is made to prevent the KM activities. Therefore, these banks may face misguided and confusion for achieving KMS if they don't have a clear and effective KM strategy in place.

9.3 Employees' Requirements

The secondary research indicate a very low level of employees' support and encouragement by the banks and the senior management in term of KMS implementation with a mean of (2.25) and MS of (31.25%), these results in comparison with the interpretation work (see table 3), mean that no formal mechanisms exist form the senior management to manage their relationships with their employees, or to measure the extent of the communication benefits between them as well as only some arrangements for surveying employees' encouragements and satisfactions are exist across the banks. Furthermore these results mean there is indirect linkage between KMS and employees' incentives and rewards, limited monitoring, measurements, and analysis to the results of the level of the knowledge accumulation by the banks' employees.

9.4 Alliances and Partnerships

The analysis of this area in the secondary research shows very weakness to the alliances and partnerships that have been made at the LPBs so far with a mean of (2.25) and MS of (31.25), further interpretations to these results (see table 4), it can be said that Short-term partnerships and collaboration with national and international organisations just started recently; the LPBs just began to prepare for partnership within the industry (public and private banks) for KM interaction. Therefore, only some benefits are gained at the LPBs by partnering with some of the international organisations and might be the organisations that the LPBs have some shares in them.

9.5 Knowledge Management Resources

In the secondary research the results show that very weak KMR for KMS implementation with a mean of (2.31) and MS of 32.75%. To interpret these results with the conceptual framework (see table 5) it is that no systematic/formal approach or process to resource allocation, budgeting or forecasting to resource allocation for KM activities, also the roles and responsibilities from senior managers at the LPBs as they pertain to identifying and providing strategy resources for KM are generally not well understood. Furthermore, no mechanisms exist for the LPBs to manage its resources for KMS implementation and the information on the KM resources is mainly anecdotal.

9.6 Discussion

The analysis resulted to that senior managers at the LPBs still could support the implementation of KMS, but it might be also that the importance and the potential benefits of a KMS may not have been full realised by the SMC at the LPBs. since the KMS is quite a new concept, and this also has an impact on the organisation's decision to adopt and implement a KMS (Grover & Goslar, 1993; Sarvary, 1999)., Moreover KM strategy is not well developed at the LPBs and its readiness has not been assessed against the reform needed.

Also the results show that KM resources is not available at the LPBs as any organisation adopting KMS needs some organisational resources to manage its knowledge strategically e.g. internal and external information, budget so on, these resources should be growing in popularity as (Xu & Quaddus, 2005a). Furthermore, the alliances and partnerships at the LPBs with the national and international banking community are still in the low manner, as a result of the UN and USA sanctions. In term of meeting employees' requirements it can be said that still there are a low level of the motivation and reward systems at the LPBs. regarding to KM initiatives as indicated by (Xu & Quaddus, 2005a) if people do not commit to and support the KMS, it will not succeed.

Overall, the LPBs are not fully promoted and supported the implementation of KMS, and still need a comprehensive method and plan contains a KM strategy, motivation systems, Alliances and partnerships as well as adequate KM resources. From the information gathered through these surveys, it can be understood that the Libyan banks attach a very low level of priority to knowledge implementation. This issue is partly related to the lack of an adequate budget to this kind of development, which could if instituted; benefit the aggregate of employees at their diverse levels. These benefits could be translated into a continuous learning cycle to further create a culture that supports innovation, and knowledge sharing in order to change the culture among its employees and help in their adoption of change; It was also observed that the majority of employees tended to keep their knowledge secret, rather than sharing it with one another in order to eliminate any source of competition towards their position and to further protect their own interests within the banks.

10. CONCLUSION

As the banking industry has its own needs, knowledge management in banking should be developed to improve business efficiency. Therefore, it is essential to develop a framework which describes the fundamental problems facing the Libyan banking industry in the implementation of knowledge management system. Such a framework of "Knowledge Management" must embrace the SMC, IT, CM, HR, and KMP gaps that often occur when implementing knowledge management system, and provide several fundamental approaches to avoid these gaps e.g. a mitigation strategy. The preliminary framework should be taken as a basis for data collection and analysis, and further validity of the framework that refers to the extent to which data collection instruments are used. Through the definition of these four gaps, banks can assess their weaknesses before implementing their knowledge management initiatives. Furthermore, through the evaluation of the knowledge management gap, banks can make corrections and adjustments accordingly in order to enhance their chances of success of the implementation of knowledge management initiatives.

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THE NEED FOR AN EFFECTIVE KNOWLEDGE MANAGEMENT FRAMEWORK FOR CONSTRUCTION SITE MANAGEMENT

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ABSTRACT: There has been significant growth in implementing knowledge management (KM) in construction organisations in recent years. The primary objectives are to deliver construction projects of the highest possible quality, avoid mistakes, prevent the 're-invention of the wheel' and improve project performance. In a site management context, problems often arise and may lead to costly defects if not resolved quickly and effectively. The greatest challenge facing construction managers today are: to find the most efficient way of managing the construction site, to select the best method of resolving problems, and to make decisions in real time. A problem-solving KM process is the vehicle for connecting knowledge and performance; knowledge gains economic value when it is used to solve problems, explore opportunities and make decisions that improve production performance. A viable framework for the enhancement of construction site management practices through an integration of knowledge management processes, underpinned by case study findings from constructions organisation that have implemented KM in their organisations, is discussed and presented. An integrated framework that reflects the specific context of site management practices, and which makes provision for both explicit and tacit knowledge is therefore proposed. The integrated framework contains two main components. Firstly, a proactive approach, to take KM measures to avoid problem occurring. Secondly, reactive approach, to tackle a specific problem with a KM dimensions. The potential benefits of the integrated KM framework are also discussed.

Keywords - Construction, Site Management Practices, Knowledge Management, Conceptual Framework

1. INTRODUCTION

In today's competitive environment, the survival of engineering and construction organisations very much depends on knowledge and innovation. It is now widely recognised that knowledge of construction practices and construction processes is an important component of constructors' core competence. It is also now being recognised that some of the intellectual assets (knowledge) of construction organisations or contractors are entrenched deep into site management practices. Unfortunately, construction organisations still do not have any systematic methods for the creation, capture, storage, sharing and reuse of a professional's domain knowledge of products, people and processes (Robinson *et al.*, 2001). More specifically, there is much scope for making site management practices more competitive through better knowledge management. An improvement in the management of construction sites can be achieved by implementing management forms, which emphasize co-operation, delegation, continuous learning and the use of information technology. Knowledge management (KM) is central to this as it facilitates continuous improvement through project learning and innovation (Robinson *et al.*, 2001). Sheehan *et al.* (2005) argued that an effective knowledge management approach towards capturing knowledge on tall building at EC Harris provides easily accessible nuggets of knowledge relating to cost and construction issues, reducing wheel reinvention and improving effectiveness. It is particularly important, however, to examine failed knowledge management initiatives in other organisations. Storey and Barnett (2000) have identified three main causes of failed knowledge management initiatives in an organisation. These causes are as follows:

- Top management are 'committed' only up to a point;
- The KM initiative was undermined by divisions and differences in perspectives between diverse functional 'camps'; and
- A pilot for the KM initiative had been tried in one part of the company rather than planning for a total company-wide lunch.

However, the competitive business environment has prompted construction organisations to rethink the nature of the resources and capabilities that generate advantage. One of the drivers is because clients are becoming more sophisticated, insisting on better value for money and demanding more units of construction for less units of expenditure. This paper focuses on the development of a framework to promote a concept of problem-solving knowledge management process within site management practices. In order to overcome and reduce the problems faced by site managers, an integrated knowledge management framework is proposed. It concentrates on developing systematic methods for managing knowledge on the construction site. The framework has been developed based on an analysis of literature review and case study results. This paper starts with reviewing the role of knowledge on the construction site. The need for knowledge management integration is discussed. The main findings of the five case studies undertaken are then presented and the variations between organisation knowledge management approaches and strategies explored. The paper then discusses the conceptual framework development for integrating KM into site management practices. The proactive and reactive knowledge management approaches for integrating site management practices with KM processes are also presented. The paper concludes with a suggestion on the role of KM in solving site management problems and the usefulness of the framework presented.

2. THE ROLE OF KNOWLEDGE ON THE CONSTRUCTION SITE

The Project Management Institute (PMI, 2004) defines knowledge as 'knowing something with the familiarity gained through experience, education, observation, or investigation, it is understanding a process, practice, or technique, or how to use a tool'. Knowledge can be classified as either explicit or tacit (Nonaka and Takeuchi, 1995). Explicit knowledge refers to the knowledge that is transmittable in formal, systematic language. It is rooted in the form of hard data, scientific formulas, manuals, computer files, documents, patents, and standardised procedures that can easily be transferred or spread. Tacit knowledge, on the other hand, is mainly personal, context-specific, and therefore hard to formalise and communicate. It is mainly located in people's minds, thus there should be ways of recording who has what experience, on past projects for example, and ways of getting these people together with others who need that knowledge (Sun and Howard, 2004).

In construction organisations, knowledge often becomes embedded, not only in documents and repositories, but also in organisational routines, processes, practices and norms. Knowledge can be considered as a production resource with a specific economic value and it needs to be managed in a professional manner (Nonaka and Takeuchi, 1995; Schaefer, 1993). It is recognised that an accumulation of experience and knowledge on the nature of projects assists the site manager to clearly understand the site management problems and related issues. In solving site management problems, a great deal of a site managers' efforts is directed at understanding the problems in order to recognise the similarities of the problems at hand with previously solved problems. From a construction management context, there is a need to develop a robust KM framework that can be embedded into site management practices. This will enable the site manager to capture, store, share, and reuse the different types of knowledge, whether tacit or explicit knowledge. Nevertheless, knowledge in the construction organisations is by no means always easily captured or effectively shared amongst industry players (Bresnen and Marshall, 2001). On the other hand, Construct IT (1996) categorises site management practices into six sub-processes and its basic purpose is to provide a framework for carrying out work on any construction site. These are as follows:

- *Management, supervision and administration of sites*: Including correspondence, minutes, RFIs, labour allocations, payroll, progress reporting, notices/claims, instruction, drawing register and technical information;
- *Commercial management*: This covers estimating, valuations, sub-contractor, payment, variations, dayworks, cost-value reconciliation, final accounts and cash flow;
- *Legal, health and safety*: Management of legal, health and safety requirements on sites. This considers safety policy; COSHH and CDM regulations, insurance, building regulations, British Standards and Codes of Practices;
- *Planning, monitoring and control*: This covers all activities associated with project planning and scheduling, typically the production of Gantt-chart, network analyses, method statements, resource levelling, progress reports and exception reports;
- *Delivery and materials' handling*: The activities associated with the management of deliveries and the subsequent handlings of materials on site are covered including requisitions, purchase orders, material call of, GRNs and plant returns; and
- *Production on-site and off-site*: This considers activities supporting production, for instance QA plans and reports, contract terms drawings, specifications, setting-out and measurements.

An assessment of the knowledge that resides in these sub-processes is crucial for the efficient performance of site management functions. However, the nature and problems of the construction process, also present challenges for the integration of knowledge management within the site management context. These problems can be addressed by the development of an effective framework for integrating applicable knowledge management processes (Bolloju *et al.*, 2002; Breis and Bejar, 2000) into site management practices. There are several aspects to be considered in this regard. In particular, it is important to identify the most significant site problems and KM issues associated with the problems, develop appropriate KM initiatives, and then establish an action plan for implementation. Most importantly, the integration of KM processes and site management practices appears to be a promising means of minimising current site management problems and improving construction site operation and management.

3. CASE STUDY FINDINGS

To obtain more insight into the applicability of KM processes to improve existing site management practices, a five-step descriptive case studies approach (that incorporates qualitative comparators with observations made within five construction sites) was adopted. Five construction sites suggested by organisations involved in previous KM studies at Loughborough were used for the case studies. To ensure comparability, the selected construction sites had similarities in competitive environment, value chains and communication approach, which suggested greater consistency in industry context across competing organisations (King and Zeithaml, 2003). Background information about the construction sites investigated and project personnel interviewed are presented in Table 1.

Table 1. Details of site organisations involved in case studies

Case	Type of site	Project Personnel	Construction Experience	Cost (£)	Procurement Method
A	Pharmaceutical building	Project Manager	35 years	16 million	Design and Build
B	Hospital (PFI)	Design Manager	16 years	82 million	PFI
C	Water works	Design Manager	17 years	6 million	Fast Track
D	Swimming pool and fitness centre	Site Manager	40 years	7 million	Traditional
E	Retail store and service apartment	Project Manager	27 years	22 million	Design and Build

This study was based principally on semi-structured interviews with one site-based project personnel in each of the companies. Interviews lasted from 2 hours to 4 hours 30 minutes. The interviewees under study were all experienced construction professionals who had from 16 years to 40 years experience in managing a construction site. This study was designed to seek variation in construction size and procurement method, which plays an important role in industry rivalry and profitability (Harris and McCaffer, 2001). These differences provide the opportunity for exploring variation in knowledge resources within and across construction site management contexts. The aim of the case study was to understand the key problems of site management practices and to observe existing practice in managing knowledge on the construction site. It also sought to identify how KM processes could improve current site management practices. A summary of the key findings is presented below:

a. Problems on the construction site

It was observed that managing a construction site offers a wide range of interesting engineering and management problems to be solved. Poor communication, poor information and inaccurate planning were identified as major problems that occur. These problems are introduced by the many types of project being undertaken, the types of materials and plant, their varied location and the changing nature of the project as it progresses. For problem solving, it can be concluded that the site management uses two methods to address site management problems. These are: (a) structured methods – these include quality control procedures and health and safety procedures and (b) informal methods – these include previous experience, discussion or informal meetings and reference to experts.

b. Proportion of construction knowledge

The case studies showed that all project managers in the case study organisations rely on tacit knowledge in managing construction sites. Although the interviewees gave different figures on the percentages of tacit and explicit knowledge involved in construction work, they indicated that most construction knowledge is embedded in the minds of workers. Therefore, it is important to find a method to acknowledge and capture tacit knowledge on the construction site. It is also equally important to classify types of construction work that depend on tacit knowledge (e.g. brickworks, carpentry works, plastering works and etc.)

c. Approach taken when a mistake is made

Basically, workers make the same mistakes and repeat the same errors while carrying out construction work. The case studies showed that all the site management teams have used traditional management methods for capturing mistakes and lessons learned. There are two main stages: firstly, discussion and informal meetings and secondly, documentation in the project file. Most case study organisations have used an intranet system to disseminate the report to the people on site and off site. However, one out of the five case study organisations shares and disseminates the report via a knowledge management system built on their intranet system.

d. Knowledge sharing mechanisms

Meetings are the most effective mechanisms to share knowledge on the construction site. There are many types of meeting: some are relatively informal and organised on an ad hoc basis, while others are formal and scheduled in accordance with contractual demands. Three out of the five site management teams have used construction forums and best practice seminars to share knowledge between people in the organisation. They have a structured approach and are serious about sharing best practices and lessons learned. In contrast, informal meetings have also been used in sharing construction knowledge. For example, two site organisations conducted ad hoc meetings (informal meetings), which sought to demonstrate a particular job on the construction site to the workers.

e. IT tools and software used

The implementation of knowledge management strategies in the case study organisations is supported by numerous information technology (IT) tools. The IT tools can be divided into several categories: (a) an e-mail system - for knowledge sharing, (b) expert system - for knowledge capturing of a worker in limited domains of knowledge (c) an Intranet – to collect and deliver certain knowledge and making organisational knowledge available to geographically dispersed staff members, and (d) an electronic process base document management system - for importing and exporting knowledge using an electronic system. The majority of the sites have an e-mail system, with two of the five site organisations having implemented a data store project file on the intranet.

f. Role of intranet

The intranet systems in all the cases are used to store knowledge (procedures, quality system, method of statement, best practices etc.), to provide a vehicle for people to request knowledge and as a directory for each member of staff to share particular skills, experience and areas of interest (e.g. concrete works, brickworks, earthworks and etc.). However, the content and structure of the systems are slightly different. Two of the site organisations have a well-structured and appropriate intranet system. However, one organisation has developed a knowledge management system and shared knowledge via the intranet system. However, the knowledge management system developed is complicated to use and too much information is generated by the system. The collaborative and knowledge sharing features of intranets, combined with their low cost, have made them attractive alternatives to proprietary groupware for collaborative work, especially among small and medium size organisations. For simple tasks, such as sharing documents or document publishing, an intranet generally is less expensive to build and maintain than applications based on commercial groupware products, which require proprietary software and client or server networks.

4. CONCEPTUAL FRAMEWORK DEVELOPMENT

4.1 Overview of the framework

The case study findings revealed that the case study organisations have numerous mechanisms for managing their knowledge, although the label of KM is often not used. Nonetheless, the site management team can have difficulties with regard to resolving site management problems. They often wait until late in the project, when many problems start occurring, before tackling such problems and related issues. An integrated framework that reflects the specific context of site management practices, and which makes provision for both explicit and tacit knowledge is therefore proposed. The integrated framework contains two main components:

- Proactive approach – involves taking measures to avoid problem occurring
- Reactive approach – involves tackling specific problems that have a KM dimension

The proactive and reactive KM framework can be used to solve site management problems for any construction site sub-processes (planning, commercial management, material management etc.). It also can be used as a management tool to minimise the number of problems that occur on the construction site and reduce their impact (Mohamed and Anumba, 2005).

4.2 Proactive and reactive knowledge management approach

The framework is designed to be a structured approach in managing and acknowledging construction knowledge that is entrenched in site management processes. Figure 1 shows the main stages of the knowledge management framework to be implemented on the construction site and indicates the approach to be taken to tackle a specific problem (reactive approach) and the approach to be followed to avoid potential problems (proactive approach). The particular approach used depend on the context and the stage at which the Site Manager wishes to explore the use of KM. Reactive KM approach is a nine-stage methodology for identifying the knowledge gap that has led to a given site management problem and recommend measures to tackle the problem. The first decision point (second box in Figure 1) involves the site manager deciding, on how to respond to problems. It may be useful to view construction problem solving as a community activity: problem solvers do not operate within a vacuum but adopt and adapt solutions and method practiced and learned in previous cases (Li and Love, 1998). If there is a KM dimension to the problem, the site manager needs to use the reactive approach in the framework to address the problem. If there is no KM dimension for the problem, the site manager needs to select possible solution. In contrast, a proactive KM approach is aimed to support the institution of KM initiatives that will prevent the most common site management problems from occurring and to reduce the impact of problems if they do occur.

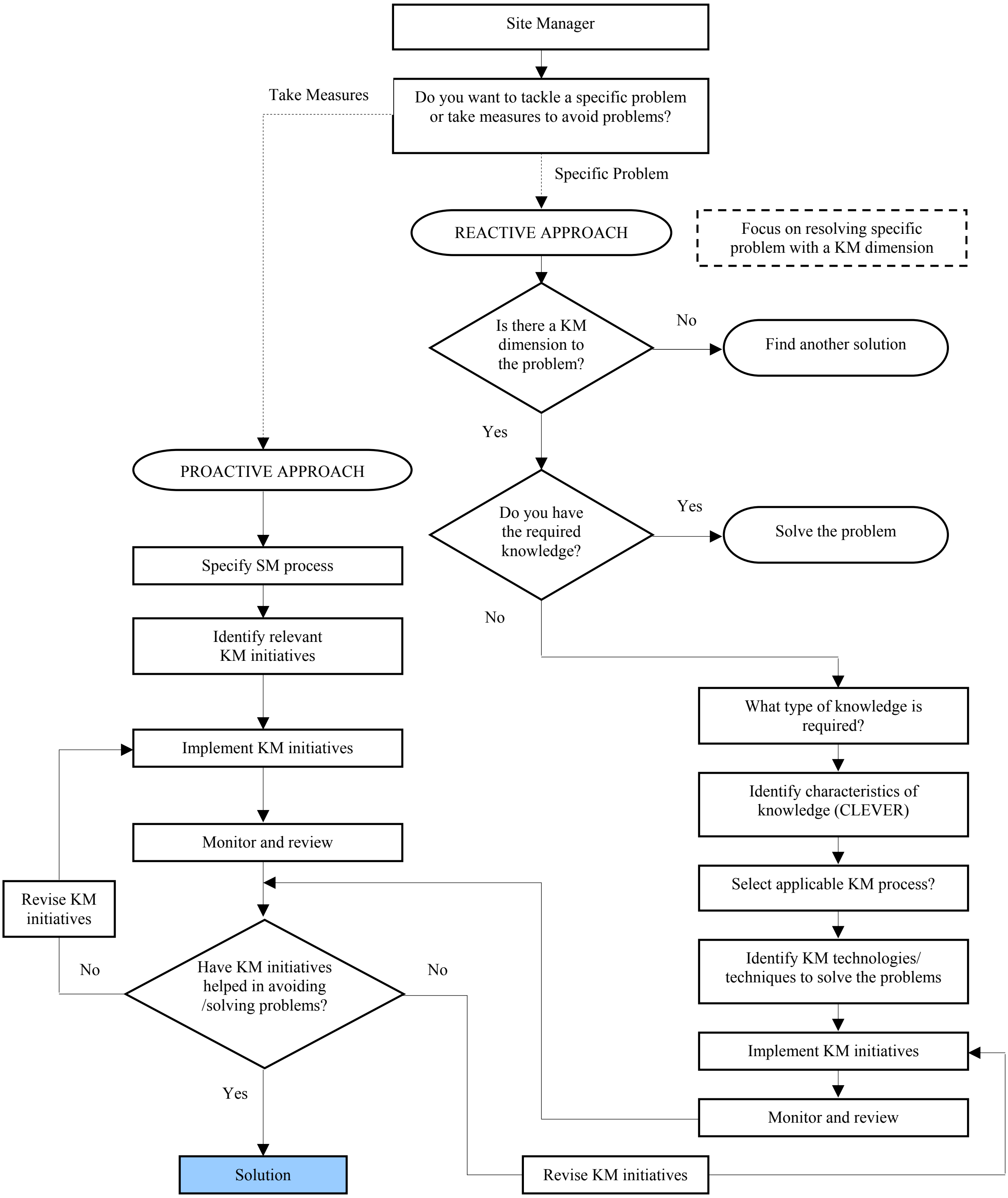

Figure 1. Proactive and reactive knowledge management framework

These aims formed the five main stages of proactive KM approach as illustrated in Table 2. The main element of this approach is a set of alternative solution to resolve a specific site management problem. Table 2 summarises the key stages of the proactive and reactive KM framework to be integrated in the site management practices. While the actual implementation may be organisation-specific, the framework is appropriate to be completed by site manager. Alternatively, the framework can be used collectively in a site management team, with site manager acting as a facilitator. When using a framework, it is helpful to consider one site management problem with a KM dimension at a time. This will provide a central focus for all stages in the framework. These key stages provide a clear and workable framework to integrate KM processes into site management practices.

Table 2. Stages in the proactive and reactive KM framework

Stage A (Proactive Approach)	**Aim**	**Outcomes**
A1. Specify SM process	To specify construction site management processes that the site manager wishes to focus on	• Clarification of problem area (site management processes)
A2. Identify relevant KM initiatives	To identify available solutions potential problems for the site manager to improve current practices	• Set an alternative solution to resolve a specific problem
A3. Implement KM initiatives	To take measures to avoid problems and to reduce the impact of problems if they do occur	• Measures to solve problem for each site management problem
A4. Monitor and review	To assess the effectiveness of the measures taken	• Monitor and review strategy for evaluating the impact of measures on the construction site
A5. Revise KM initiatives	To modify an existing measures so as to improve their effectiveness	• Improvement plan with measurable indicators to identify ineffective action plan
Stage B (Reactive Approach)	**Aim**	**Outcomes**
B1. Identify KM dimension	To identify whether problem is knowledge based or not	• Clarification of the KM dimension in each specific problem
B2. Determine if required knowledge is available	To discover if the knowledge to solve a given problem is available	• Determination of the site manager's level of knowledge to solve a given problem
B3. Identify the type(s) of knowledge required	To identify the type of knowledge required to solve the site management problem	• Specific knowledge type(s) for typical site management problems
B4. Identify the characteristics of knowledge	To identify the characteristics of the knowledge required. Use 'CLEVER' framework to support this stage (Anumba *et al.*, 2005)	• Set of characteristics of the required knowledge
B5. Select applicable KM processes	To facilitate the selection of the applicable KM processes	• Appropriate KM processes for addressing a particular problem
B6. Identify KM technologies and techniques	To identify KM technologies and techniques for the selected KM processes. Use 'SeLEKT' framework to support this stage (Al-Ghassani *et al.*, 2005)	• Set of applicable KM technologies and techniques
B7. Implement KM initiatives	To implement KM initiatives to assist the site manager in resolving site management problems	• Implemented KM initiatives
B8. Monitoring and review	To assess the effect of the KM initiatives in relation to what was meant to achieve	• Report on effectiveness of implemented KM initiatives
B9. Revise KM initiatives	To modify existing KM initiatives so as to improve their effectiveness	• Revised KM initiatives and action plan

As such, this framework incorporated a part of the CLEVER (Cross Sectoral Learning in the Virtual Enterprise) framework; thus it has the capability to identify the characteristics of the knowledge required in an organisation. The CLEVER framework is a well-established KM framework developed at Loughborough University, which focuses on the definition and analysis of a knowledge problem in order to facilitate the selection of an appropriate strategy for solving the KM problem within an organisation (Anumba *et al.*, 2005). Meanwhile, the framework also adopted a part of the SeLEKT (Searching and Locating Effective Knowledge Tools) framework which aims to identify critical criteria (KM dimension) required for selecting KM techniques and technologies that can support the implementation of knowledge management initiatives (Al-Ghassani *et al.*, 2005).

The rationale underpinning an integrated KM approach is based on a number of issues arising from the literature review and semi-structured interviews with site managers on the construction site. According to Bennett (2000), the best way of dealing with issues and site management problems is to anticipate them, and get teams to practice and rehearse solutions. Also, rehearsal often means that a ready-made answer or solution already exists. Emmitt and Gorse (2003) assert that site management teams should highlight potential problems at the earliest opportunity and work with the organisation to resolve them. It is believed therefore, that the proposed framework is capable of acting as a structured approach in capturing, storing, sharing and disseminating construction knowledge that is entrenched deep in the construction site processes. Further development of the framework involves:

- Developing an evaluation strategy for the KM framework;
- Automating and implementing the framework as a computer-based prototype system; and
- Evaluating the resulting prototype system to determine its potential in improving construction site management practices.

5.CONCLUSIONS

This paper has described an attempt to integrate knowledge management processes into site management practices. Five construction sites that implemented KM in construction site organisation were used as case studies. The study demonstrated variations between construction site knowledge management strategies and practices. Its was discovered that case study organisations used conventional approaches (meeting and actual observation) to resolve management and engineering problems on the construction site. The study also revealed that site management teams still do not have any systematic methods for managing knowledge on the construction site. Therefore, it is important to develop problem oriented KM framework rather than technology oriented domain on the construction site environment. The proposed framework provides a platform to make past solutions and standard procedures to solving problems easily accessible (explicit knowledge to solve site management problems). It can also increase the ability of the site manager to learn from his/her environment and to incorporate knowledge into site management practices. The two-stage framework (proactive and reactive approach) can prevent the site management team from repeating past errors by capturing best practices, lessons learnt, and especially the solutions to problems that arise on site. The framework provides site managers with access to standard procedures and a selection of supporting KM technologies and techniques to manage their knowledge in a reusable format. The framework will also help site managers to reduce the number of problems that occur on the construction site and minimise the negative impact of unpredictable problems on site.

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MANAGING CONSTRUCTION WORKERS AND THEIR TACIT KNOWLEDGE IN A KNOWLEDGE ENVIRONMENT: A CONCEPTUAL FRAMEWORK

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ABSTRACT: Within the construction industry, it is increasingly being acknowledged that knowledge management can bring about the much needed innovation and improved performance the industry requires. Nevertheless, sufficient attention is still to be received for the concept of the knowledge worker and their tacit knowledge within construction industry. Yet, proper understanding and management of this resource is of immense importance for the achievement of better organisational performance. Hence, this paper aims to devise a theoretical framework for managing construction knowledge worker and their tacit knowledge based on review and synthesis of literature. Paper stresses the importance of construction knowledge worker and tacit knowledge through review of literature and highlights prevailing gap due to lack of attention and recognition given to the tacit knowledge in the construction industry. Based on identified gap research aim, objectives and hypotheses are devised. As the specific research methodology, the social constructionism stance in terms of epistemological undertakings and idealistic approach under the ontological assumptions with value laden purposes are suggested. Further, it recommends the deployment of multiple exploratory case studies approach with triangulation techniques.

Keywords – Construction Industry, Knowledge Worker, Knowledge Management, Tacit Knowledge

1. BACKGROUND

There has been a surge of interest in managing knowledge during last few decades, leading to considerable changes in the business environment. As a consequence, there is increasing concern in organisations' efforts to deliberately manage knowledge in a systematic manner. Work by Polanyi (1958), Nonaka and Takeuchi (1995), divided knowledge into tacit; which is stored in people's heads and is acquired through experience, and explicit knowledge; which could be documented and therefore physically stored. Accordingly, Knowledge Management (KM) discussion has focused into two principal camps. One is rooted in the Information Technology (IT) perspective (Explicit knowledge) where authors focus on IT tools to deliver KM solutions (Bair and O'Connor, 1998; Gottschalk, 2000; O'Leary, 2001), and the other on the human resource (Tacit knowledge) perspective that relies on the people aspect to provide KM solutions (Harman and Brelade, 2000; Egbu et al., 2001). Yet, human resource perspective of KM still considered to be relatively unexplored and not fully understood (Zack, 1999) compared to work on IT perspective (Leonard and Sensiper, 1998; Holtshouse, 1998).

It is argued (Egbu et al, 1999, Carrillo et al, 2000; Kamara et al, 2003) that the main drivers behind the increased interest in KM amongst organisations operating in the UK construction industry are the Government's prerequisite to achieve industry-wide improvements and the desire of individual organisations to seek competitive advantage. This has been further emphasised in a survey by Management of Knowledge and Innovation Research Unit (Egbu et al, 2003) of the Open University, which highlighted the move towards the change initiated by the Latham (1994) and the Egan (1998) reports as the mostly cited driving force behind KM within the UK construction industry. Yet, the term 'Knowledge Management' is relatively new to construction organisations (Carrillo et al, 2000), nevertheless, a growing number of organisations within construction industry (Kamara et al, 2003) now perceive KM as an integral part of their competitive strategy for providing long term benefits for the organisation. The emphasis on KM reflects the growing realisation that it is a core business concern, particularly in the context of the emerging knowledge economy, where know-how of a company is becoming more important than the traditional sources (capital, land etc) of economic power (Drucker, 1992; Scarbrough et al, 1999).

However, despite the interest and the effort put into KM by many leading companies, the discipline is still in its infancy in the construction industry and is at an embryonic stage in UK construction (Robinson et al., 2001; Carrillo, 2004). This is evident with dearth of academic research and inadequate empirical studies done on KM in construction industry and even the limited number of studies that have been conducted, focused heavily or solely on explicit knowledge (Egbu et al, 2003) and on the role of IT (Carrillo et al, 2000). However, any KM approach that is purely based on IT is bound to be less successful because people issues, which are not readily solved by IT systems, would need to be resolved (Kamara et al, 2002). Further, in the context of the knowledge economy, what people do with their knowledge, termed as tacit knowledge, is considered to be the real driver for the performance of the industry (Quintas, 2005). As such, the people-centred view of KM is increasingly being viewed as of critical importance for organisations wishing to retain competitive advantage and to achieve better performance. Hence, as a labour intensive knowledge based industry, there is an emerging importance placed on effectively managing the construction knowledge worker and their tacit knowledge to achieve best value for the industry.

In this context, the paper discusses the theoretical framework developed to manage knowledge worker and their tacit knowledge to achieve better performance within the construction industry. The paper is broadly divided into five sections. Initially, it discusses the importance of knowledge worker and their tacit knowledge with specific to the construction industry. Secondly, paper explores the theoretical basis of managing tacit knowledge and its link to organisational performance. Aim, objectives, research questions and hypotheses are explained within section three and section four introduces the conceptual framework of the study. Finally, paper concludes with discussion of the specific research methodology for this study.

2. IMPORTANCE OF KNOWLEDGE WORKER IN CONSTRUCTION

It is argued (Robinson et al, 2001: Egbu & Robinson, 2005) that the construction industry, although known for its highly tangible products such as buildings and other structures, is increasingly now recognised as a provider of services, placing more emphasis on knowledge. Hence, construction industry has already entered into a knowledge economy where it is perceived as one of the knowledge based value creating sectors of the economy [Refer Pathirage et al (2005a) for a complete synthesis]. Moreover, people are known to be the key to success in a knowledge economy, whom are termed as knowledge workers. There are a wide range of professionals involved in construction industry, working as an inter-disciplinary team in delivering the construction products. People are recognised as possessing knowledge, skills and know-how, having the ability to create knowledge and value, and collectively retaining organisational memory. What people do with their knowledge is the real driver for competitive advantage in the knowledge economy (Quintas, 2005). As highlighted by the UK Government's Competitiveness White Paper (DTI, 1998), one of the two distinct tasks envisaged for organisations within the knowledge driven economy is to encourage and support employees in developing their skills and qualifications on a continuous basis. The UK construction industry employed 19,130 workers per £1 billion output (total of 1,599,000 workers) in 2003 (Green et al, 2004), hence considered to be one of the labour intensive sectors of the economy. People are an organisation's most valuable asset and this is especially true in relatively low-tech, labour intensive industries such as construction.

The increased awareness of the importance of employees' knowledge coincided also with a popularisation of the idea of the 'knowledge worker'. This is based on the notion that certain types of work are more knowledge intensive than others, and it is this knowledge intensive work that is growing within the economy (Quintas, 2005). The importance of the construction worker is highlighted by the fact that industry relies on skill and on the capacity to bring different skills together effectively (Drucker & White, 1996), thereby the concept of the knowledge worker has long been important to construction organisations (Green et al, 2004). In recent years, with the growth of the service sector, this emphasis placed on the construction knowledge worker has gradually increased. Further, construction employs an extremely diverse range of people from a wide array of occupational cultures and backgrounds, including people in unskilled, craft, managerial and professional positions, which makes it difficult to manage knowledge workers effectively to ensure organisational success. Much of this individual knowledge is unknown to others and unmapped and unrecorded. As Sheehan et al (2005) asserts in construction;

- Some 80% of the useful knowledge is tacit and cannot be written down
- The CI is characterised by a wealth of experiential knowledge, yet employees retire or leave the organisation, potentially taking tacit knowledge and a potential source of competitive advantage with them

As Rezgui (2001) cited, there are few key reasons that limit current approaches of KM in the construction industry. Among the key factors for these limitations are;

- Much construction knowledge, by necessity, resides in the minds of the individual working within the domain.
- The intent behind the decisions is often not recorded or documented.
- The individuals who have knowledge about the project are likely to left for another project at the end of the construction stage; hence their input is not captured.

All these three limitations indicate the direct correlation with the human factor in the construction industry and stress the importance of the concept of knowledge worker which has long been central to construction industry performance. Further, both Sheehan et al (2005) and Rezgui (2001) stress the point that much knowledge possessed by construction knowledge workers are considered to be tacit in nature. Accordingly, the following section outlines the importance of the tacit knowledge and its presence in construction as a knowledge based industry.

3. TACIT KNOWLEDGE IN CONSTRUCTION

Within construction, the type of knowledge varies considerably, yet tacit knowledge attracts an increase concern as a labour intensive industry. In the context of construction, examples of tacit knowledge include estimating and tendering skills acquired over time through hands-on experience of preparing bids, understanding the construction process, interaction with clients/ customers and project team members in the construction supply chain, as well as understanding tender markets (Egbu & Robinson, 2005). Specially, Engineers, Architects and other professionals within the construction industry are not in a position to 'cut and paste' best practice (Kamara et al, 2003) from the past due to the unique and the complex nature of the construction projects. They have to draw on the past to find solutions for the future. Tacit knowledge evolves from these shared practices and experience which need to be managed for the project and the organisational success. According to Wetherill et al (2002), knowledge in construction domain can be classified into three categories as illustrated in Table 1, which further highlights the emphasis placed on knowledge worker and tacit knowledge.

Table 1: Classification of Knowledge in construction domain (Wetherill et al, 2002)

Domain Knowledge	The information available to all companies and is partly stored in electronic data bases
Organisational Knowledge	Company specific and intellectual capital of the firm which also comprises knowledge about the personal skills, project experiences of the employees
Project knowledge	Which includes both project records and the recorded and unrecorded, memory of processes, problems and solutions

By taking a different stance Stahle (1999) suggests organisations into three-dimensional system i.e. mechanistic, organic and dynamic nature, depending on the different challenges presented for management of knowledge. Mechanistic part deals more with explicit knowledge whilst organic nature helps the organisation to work flexibly with a people-centred orientation and involves the management of tacit knowledge. The dynamic nature facilitates continuous improvement and innovation. Wetherill et al's classification reflects the organisational hierarchy and when one moves from domain knowledge to project knowledge the concentration on knowledge too moves from explicit to tacit nature, which further highlights the knowledge worker concept in construction. Stahle's suggestion indicates both the management and the production of the knowledge. In a similar sense Moodley et al (2001) contend that the tacit knowledge is developed through the individual or project teams, while the explicit knowledge is created through process, procedures and other routines that can be codified. Whatever the classification, tacit knowledge of the workers has been highlighted in much research carried out in the construction industry. A research carried out within structural design firms (Al-Ghassani, 2003) showed that about 80% of knowledge used during concept design stage is tacit compared to about 20% of explicit knowledge. As such, managing tacit knowledge more effectively offers construction organisations a possible mechanism for improving their performance in times of greater competition. Having discussed the importance of construction knowledge worker and their tacit knowledge, succeeding section explores more into tacit knowledge and its management.

4. TACIT KNOWLEDGE MANAGEMENT

Several researchers (e.g. Nonaka and Takeuchi, 1995; Stahle, 1999) consider that success of an organisation is formed by the interaction between individuals and several types of knowledge. However, as highlighted by Koskinen (2003), in many organisations the bipartite nature of knowledge, i.e. tacit and explicit, has probably not yet been sufficiently understood. Thus, one organisation might need more tacit knowledge than another, yet more attention is often directed on codified material only. Thereby, the fact that a great deal of the know-how required in implementation of a task is tied to knowledge that is not written but realised through understanding of the personnel, is not taken into consideration as a whole (Koskinen, 2003). Tacit knowledge is the unarticulated knowledge that resides in human beings, which is obtained by internal individual processes like experience, reflection, internalisation or individual talents (Herrgard, 2000). Therefore it cannot be managed and taught in the same manner as explicit knowledge. An organisation's core competency is more than the explicit knowledge of 'know-what'; it requires the more tacit 'know-how' to put 'know-what' into practice (Brown & Duguid, 1998). Even if coded knowledge is easier to diffuse, the role of tacit knowledge is often essential for being able to use coded knowledge. Yet, an understanding of what constitute 'tacit knowledge' is central to its effective management. Hence, the succeeding section introduces the nature of tacit knowledge and factors which effects its utilisation.

4.1. Tacit Knowledge & Its Utilisation

As Herrgard (2000) and Empson (1999, 2001) contended, organisations' knowledge resources can be described as an iceberg. The structured, explicit knowledge is the visible top of the iceberg, which is easy to find and recognise and therefore also easier to share. Beneath the surface, invisible and hard to express, is a momentous part of the iceberg. This hidden part applies to tacit knowledge resources in organisations. Individuals are the primary repositories of tacit knowledge that due to its transparent characteristics is difficult to communicate. While highlighting the importance of tacit knowledge, Tiwana (2000) defines it as know-how that is stored in people's heads which is personal, acquired mainly through education, training and experience. In a similar sense, Saint-Onge (1998) describes tacit knowledge as an individual's intuition, beliefs, assumptions and values, formed as a result of experience. It is from these beliefs and assumptions, which make up an individual mindset that decisions are made and patterns of behaviour developed. Thereby, in working life one can easily find many examples of tacit knowledge such as intuition, rule-of-thumb, gut feeling and personal skills, all based on individual experiences. When synthesised, tacit knowledge could be classified into two dimensions knowingly the technical and the cognitive dimension (Herrgard, 2000, Hussi, 2004). The technical dimension encompasses information and expertise in relation to 'know-how' and the cognitive dimension consists of mental models, beliefs and values (Gore and Gore, 1999), in short conception of reality.

Nevertheless, the factors which affect the utilisation of tacit knowledge in organisations can be categorised into internal and external factors. Internal factors are either possessed or under control of an individual which influences both technical and cognitive dimension of tacit knowledge. As suggested by Koskinen (2003) the internal factors can be further categorised into different groups which are called memory, communication, and motivational systems. Memory systems include experience, mental models, and intuition, in other words factors which function as constructs and manifestations of memory (and tacit knowledge) of an individual. Communication systems include interaction, language, and proximity, in other words factors which affect the communication of data, which is then interpreted to become knowledge. Motivational systems include commitment and trust. Commitment is a manifestation of the motivation of an individual, and the trust between the people involved motivates them to share and receive tacit knowledge. In a similar sense, Butcher et al (1997), introduced the term "Meta Abilities" defined as personal, acquired abilities that underpin and determine how and when knowledge will be practiced within the organisation. Meta abilities introduced by Butcher et al (1997) underpinned the very similar factors suggested by Koskinen (2003) under the internal factors. The external factors are called situational systems and they include leadership style and organisational culture, which defines the situation in which tacit knowledge is utilised. Thereby, this highlights that management of tacit knowledge is intrinsically concerned with both internal and external factors. Thus, tacit knowledge management strategy of an organisation should address both these facets to be effective. The following section further explores this issue.

4.2. Management Strategy

As Harman and Brelade (2000) contended, KM to be effective, must encapsulate the idea that it is through the acquisition of knowledge by individuals and their willingness to apply their knowledge for the benefit of the organisation that competitive advantage is achieved. Davenport (1998) further highlights this issue by asserting "the most dramatic improvements in KM capability in the next ten years will be human and managerial". Invariably, the management of tacit knowledge is intrinsically linked to the management of people (Egbu et al., 2001) and to the processes that facilitate knowledge generation, distribution and sharing between related individuals and workgroups. As highlighted in internal and external factors of tacit knowledge utilisation, this further stresses very similar two aspects or dimensions in tacit knowledge management;

- Recognising and managing people or the knowledge workers with the right human resource policies (Internal factors)
- Ensuring knowledge supportive and conducive environment or culture within the organisation to support knowledge processes (external factors)

An increase number of individuals do work which is knowledge based and the concept of knowledge worker needs to embrace these individuals who can be found at the all levels within organisations. A major aspect of managing tacit knowledge in a knowledge-based economy is giving to knowledge worker the power that arises from the ability to solve the critical contingencies facing the organisation. It means that knowledge worker will increasingly be able to determine that they are managed in ways acceptable to them. As suggested by Tyson (1995), for managers this will involve a paradigm shift to see themselves as facilitators rather than controllers. This highlights the necessity of managing knowledge worker with flexible, employee centred approaches based on consensual models (Harman and Brelade, 2000). Yet, Construction as an industry which has a reputation for its dominant culture of command and controls consistently emphasises and correlates with the hard model of human resource management. Also the culture of subcontracting and self employment marginalises the importance of people management and thereby reflects and reinforces the dominant industry receipt of hard human resource management. The ignorance of the knowledge worker within the construction context has contributed to a great extent to the under performance of the industry as lamented by many authors (Cooke-Davies, 2001; Nesan & Holt, 1999). As Egan (1998) asserted;

> "*….much of construction does not yet recognise that its people are its greatest asset and treat them as such. Too much talent is simply wasted, particularly through failure to recognise the significant contribution …… We understand the difficulties posed by the fragmented structure of the industry, but construction cannot afford not to get the best from the people ……*" (para 17: 14).

Soft human resource management policies based on empowerment and commitment are much more prevalent within organisations orientated towards creativity (Green et al, 2004). As such it is an urgent matter for the construction industry to move towards the softer approach based teamwork from hard model of human resource management to enhance the collective efforts. The second facet of the management strategy is concerned with creating a proper knowledge supportive culture with appropriate techniques for knowledge processes. This will be discussed further in the next section.

4.3. Processes and Techniques

Processes like knowledge production, dissemination and sharing are considered to be important facets of a knowledge economy (Egbu & Robinson, 2005). Hence, the KM environment needs to reinforce the acquisition, use and sharing of individual tacit knowledge. Therefore, significant effort should be directed towards exploiting non-IT techniques such as communities of practices, brain storming sessions, action learning, post project reviews etc to facilitate person-to-person and person-to-organisation interactions. Several authors (Augier and Vendelo, 1999; Koskinen, 2003) have repeatedly highlighted the importance of interaction, integration and involvement of knowledge workers through social networking within an organisation. Social interaction of employees cultivates a knowledge sharing culture based on shared interest, thus encouraging continuous knowledge generation through the evolution of a community of practice. Within the community of practice, tacit knowledge may be shared in non-codified forms (Brown & Duguid, 1998). According to Koskinen (2003), in such kind of knowledge environment manager could support the acquisition and sharing of knowledge and expertise by;

- Encouraging individuals to use their knowledge and expertise
- Facilitating innovation and creativity and encourage new ideas
- Representing the interests of the individual/ team to the organisation

This will involve an understanding of individuals and teams and a willingness to be open to new ideas and personal development. As such, managing tacit knowledge in a knowledge environment, corporately through right human resource policies and techniques will be judged by its ability to encourage and enable individuals to apply their knowledge for the benefit of the organisation.

4.4. Organisational Performance

The determination and the establishment of benefits and the impact on the organisational performance are of utmost importance for a business to justify the implementation of KM initiatives. As Grant (1996) asserts in his knowledge-based theory of strategy, the source of competitive advantage in dynamic environments is not knowledge that is proprietary to the organisation (explicit knowledge), because the value of such knowledge erodes quickly due to obsolescence and imitation. Rather, sustained superior performance is determined by non-proprietary knowledge in the form of tacit individual knowledge. Tacit knowledge can form the basis of competitive advantage because it is both unique and relatively immobile. Yet, because that knowledge is possessed by individuals and not the organisation, a critical element of sustained competitive advantage is the ability to integrate the specialised and tacit skills of the individuals, as highlighted in the previous section. Grant's approach can be considered as an outgrowth of resource based thinking and indicates the importance of tacit knowledge towards organisational performance and in achieving competitive advantage when developed and managed properly. Having established the theoretical basis for managing tacit knowledge, following section describes the aim, objectives, questions and hypotheses devised for this study.

5. AIM, OBJECTIVES AND HYPOTHESES OF THE STUDY

As emerged from previous sections, the main aim of this study is to explore and investigate into tacit knowledge management in the construction industry and its relationship to organisational performance. Justification for the study is done through highlighting the importance and its necessity to manage tacit knowledge in construction industry and due to dearth of published literature and inadequate empirical work done [Refer Pathirage et al (2005b) for a complete argument]. The broad aim stated above will be achieved by four objectives. First: by exploring into current KM practices and usage of business performance models within construction organisations. Second: by determining the role and the importance of tacit knowledge and factors which influences the generation and utilisations of tacit knowledge. Third: by investigating the strategy and techniques to be followed in managing tacit knowledge. Finally: by exploring the relationship between tacit knowledge management and organisational performance in the construction industry. Based on the understanding gained from the literature review and synthesis, hypotheses and research questions are developed as explained below.

RQ1: What are the current KM practices and business performance models used within the construction organisations?
H1: There is a lack of attention given to tacit knowledge management within the construction organisations, when compared with emphasis given to management of explicit knowledge within the industry.

RQ2: What are the key factors which determine the generation and utilisation of tacit knowledge for construction knowledge workers?
H2: The tacit knowledge generation and utilisation processes are very complex involving internal cognitive processes of human beings, rather than simple, due to various internal individual factors and external, group, organisational and industry factors.

RQ3: What is the most appropriate strategy for managing tacit knowledge within construction industry?
H3: Tacit knowledge management strategy should encourage managing knowledge workers with trust and commitment than command and control, and should ensure knowledge supportive environment with non IT techniques than Information Technologies, and should address both these aspects than any one of them.

RQ4: How tacit knowledge can be shared and disseminated among construction knowledge workers?
H4: Tacit knowledge could be shared and disseminated, through interaction, integration and involvement by use of techniques like communities of practices, brain storming sessions and action learning, than through coding by use of Information Technologies.

RQ5: What is the impact towards constructional organisational performance when tacit knowledge is managed?
H5: When factors effecting tacit knowledge generation and utilisation are identified, knowledge workers are managed with trust and commitment, and through interaction by use of non IT techniques, there will be a positive impact towards the organisational performance than a negative impact.

These hypotheses are shown in the conceptual model as described next.

6. CONCEPTUAL FRAMEWORK

The conceptual model (Refer Figure 1) shows the process of managing tacit knowledge and its constituent parts based on the theoretical understanding gained from review and synthesis of literature. The core of the model represents the tacit knowledge generation process i.e. cognitive process within human beings. This generation process and the utilisation of the tacit knowledge are influenced by several internal and external factors as represented in four layers. Internal factors are at the individual layer which influences the generation process and utilisation of tacit knowledge. External factors will be at group, organisational and industry level. The second layer represents the group level which is influenced by group factors. The third layer denotes the organisational level, which is influenced by Organisational factors and the final outer layer represents the industry level which is influenced by industry factors (Indicates with H2). These factors in terms of four layers are denoted within the model by use of a triangular which also shows the direction of impact. Arrows which crosses four layers indicates different categories of tacit knowledge.

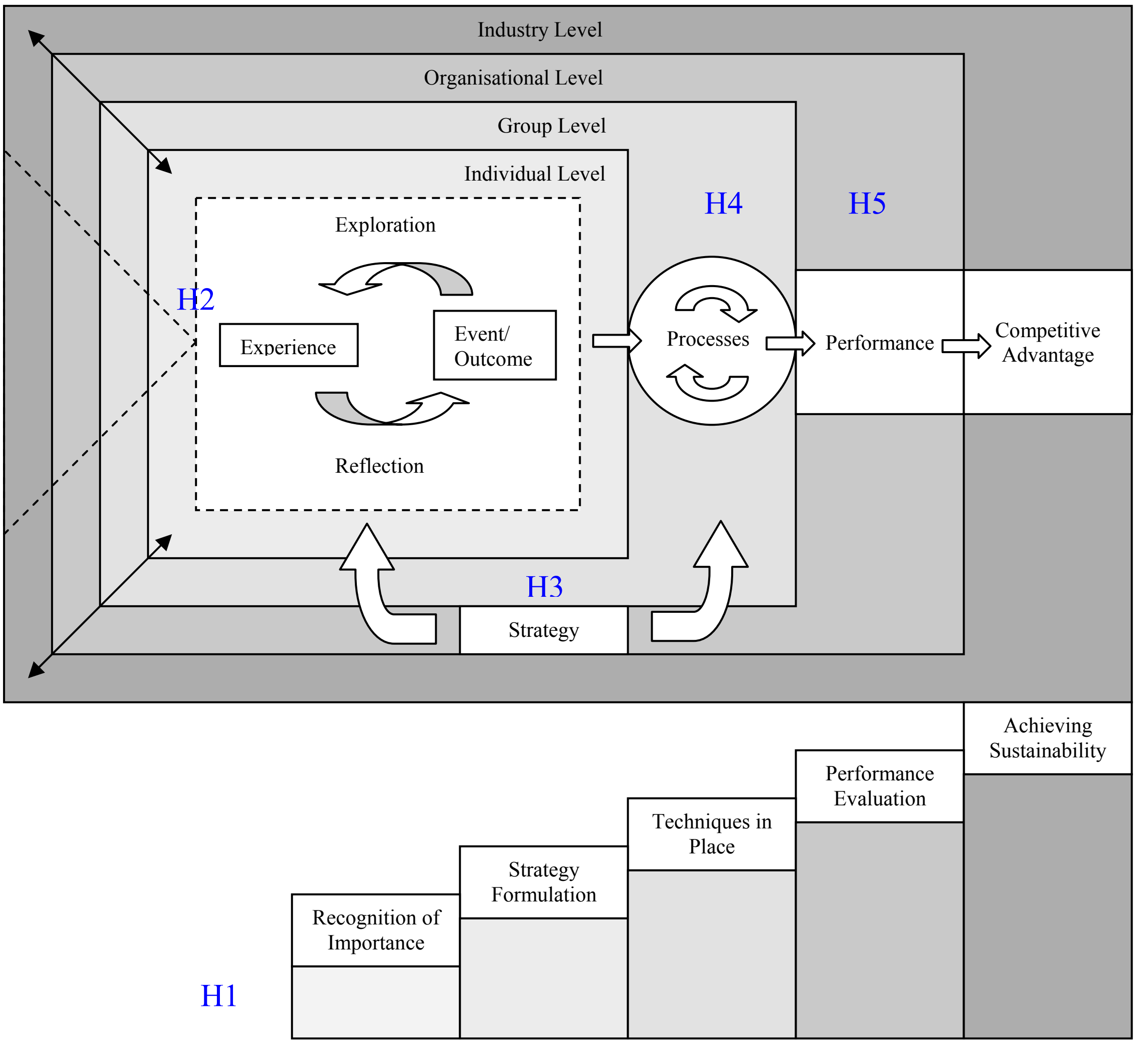

Figure 1: Tacit Knowledge Management Model (Conceptual Framework)

This tacit knowledge needs to be shared and disseminated, through interaction, integration and involvement by use of techniques like communities of practices, brain storming sessions and action learning which is represented at group level (Indicates with H4).

Hence, tacit knowledge management strategy needs to address both, factors which influence the tacit knowledge generation and utilisation, and group level techniques (Indicates with H3). Outcome of this process is linked with the performance at the organisational level and in achieving competitive advantage which is at the industry level (Indicates with H5). Finally, this total process of tacit knowledge management is reflected in five maturity levels, which indicates the stepwise progress to achieve sustainable competitive advantage within the industry. Further, this maturity stages will map out the position of an organisation in term of tacit knowledge management progress, which highlights the attention given by a particular organisation (indicates with H1). Having identified the aim, objectives, hypotheses and the conceptual framework to be used for this study, succeeding section explores the summary of the specific research methodology proposed for empirical data collection and analysis.

7. RESEARCH METHODOLOGY

This study uses the 'nested approach' (Kagioglou et al, 1998) which nests the philosophy, approach and techniques of the research. Figure 2 depicts the intended deployment of each of these elements in this study and succeeding discussions will explore the application of these philosophical paradigms, approaches and techniques for this research [Refer Pathirage et al (2005c) for a complete analysis of research methodology].

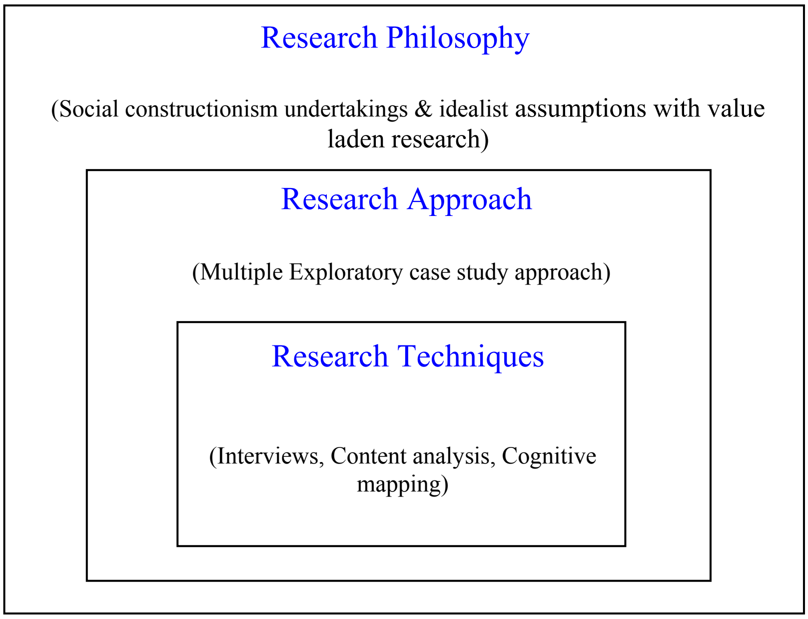

Figure 2: Nested Approach (Kagioglou et al, 1998)

As this study attempts to explore the tacit knowledge mainly grounded in knowledge workers, which gains its orientation from the management research paradigm, it disproves the likeliness of comfortably fitting to the positivist paradigm. Hence, based on the capability of a socially constructed reality in building up the understanding of the phenomenon, social constructionism stance is preferred as the underpinning epistemological undertaking in this research. Further, as the nature of the problem being investigated in this study is of explorative type and due to the unstructured character of the subject being examined, this research closely resembles with the idealist assumption in terms of ontological positioning. Also it is expected that different observers to come up with different view points, due to the subjective, value laden nature of the researcher, which highlights the axiological purposes of the research. Hence, in summary research is mainly driven towards social constructionism stance in terms of epistemological undertakings whilst taking an idealistic stance in positioning under the ontological assumptions with value laden purposes in terms of axiological endeavours.

Further, in terms of research approach, the necessity for a descriptive, context specific research without the researcher's intervention together with the exploratory type research questions defined, justifies the case study approach for this research. As aim and objectives of this research are more of exploratory with 'What', 'How' questions, explorative case studies were favoured. Since, the phenomenon in study is not a critical, unique, typical or a rare case (Yin, 2003), multiple cases were preferred. The use of multiple cases in this research underlines the complexity of the topic under study and develops the empirical evidence to support the theory building.

Data will be mainly gathered via interviews, direct observations and through document reviews. Interviews will be carried out at three different levels of staff in construction organisations i.e. senior manager (strategic level), middle manager and worker level. Open-ended key informant interviews will be carried out with senior managers, whilst semi-structured focused interviews are preferred with middle managers, following a certain set of questions derived from the case study protocol. Interviews with construction workers will entail more structured questions, alone the lines of a formal survey. As this study deals with the tacit knowledge of the intellectuals, analysis of documentation will be of very limited use. Yet, direct observations and review of documentation will be done in view of gaining a clear understanding of the context and the phenomenon of the case being studied.

Several techniques can be employed to analyse data in case studies to improve the rigour in analysis. This study is mainly driven towards theoretical propositions, as reflected in research objectives, questions and hypotheses of the study. Yet, rival explanations too will be sought out with the aid of intended theoretical replication logic. In terms of specific data analysis techniques, to enable the rigor of structuring, organising and analysis of multiple sources data, and to maintain the richness of data, the study undertakes cognitive mapping and content analysis approaches. Also several software packages like Decision Explorer and NVivo will be used to analyse and codify qualitative data, which belong to the domain of Computer Aided Qualitative Data Analysis (CAQDAS). Hence, open ended and semi-structured interviews will be analysed using these content analysis and cognitive mapping techniques. The results from the structured survey will be examined using factor analysis and correlation analysis to further validate the findings from cognitive analysis. Finally, outcome of data analysis will either verify or falsify the hypothesised phenomenon of this research.

8. CONCLUSION

The early focus on knowledge management resulted in technological solutions with a bias towards the use of Information Technology, however, many of these were not successful because they ignored the people required to make them work in construction. More recent work has focused on the importance of human resource in knowledge management, but these have yet to be developed in terms of concepts and frameworks. Hence, this paper introduced a conceptual framework to manage construction knowledge worker and their tacit knowledge based on review and synthesis of literature. Further, it highlighted the importance of the concept of knowledge worker and tacit knowledge within construction and set out research aim, objectives and hypotheses based on the identified gaps from the literature. A specific research methodology for the empirical stage was identified based on the nested approach which suggested social constructionism stance in terms of epistemological undertakings and idealistic approach under the ontological assumptions with value laden purposes are suggested together with the deployment of multiple exploratory case studies approach and triangulation techniques.

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CHALLENGING PROBLEMS
FOR A NEW GENERATION OF DEMONSTRATION PROJECTS

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ABSTRACT: This paper argues that demonstration projects are an arena for implementation and development of sustainable building as technological change and innovation. The aim of the paper is to discuss a theoretical framework to specify demonstration projects in their context. Knowledge and learning processes seem to stop in the parcelled organisation of the construction process. The management of innovation in construction is a complex, theoretically weak and often ill-defined problem due to the contingency and heterogeneity of all parts and variables involved. This paper explores the possibilities to identify challenging problems following different models for co-operation between developers and design, engineering and construction firms. The discussion is based on six real case-projects. Findings show the need for 1) a better conceptual understanding of the project-based production of knowledge, with its characteristic amount of 'practitioner-research', and 2) for new practices able to link knowledge innovations and project managing processes creating the basis for the dissemination of knowledge and information in wider networks.

Keywords – Demonstration projects, innovation, 'heterogeneous engineering', sustainable building.

1. INTRODUCTION

The aim of this study is to implement the issues of sustainable development in the field of construction using demonstration projects as strategies for gaining understanding and for improving the innovation of knowledge that is needed for mainstreaming sustainable building.

What we call sustainable building is depending on a complex, multidimensional, context-dependent knowledge. Therefore this research is challenged by the aim to describe and gain a deeper understanding of the heterogeneous contexts in which a project for a construction with clear requirements of environmental performances develops. One purpose of the study is to catch the practical, theoretical and empirical hindrances that seem to stop the process of innovation due to changes taking place inside the building sector.

This study has its point of departure in four fundamental concepts: sustainability, sustainable building, knowledge and innovations. They could be seen as the four special ingredients that, oscillating between qualitative and quantitative perspectives, give us a complex view of a *demonstration project for sustainable building*, the objective of the study. Innovation theories, social construction of technology and power knowledge are the filters used to find understandings beyond words, in the practice of people.

After having described the research project as to its background, its purpose and its design in section 1, this paper will give an exposition of the complex theoretical matter needed to frame the study. In section 2, the implementation of sustainable building is first presented within a general description of sustainability, then in a social constructivist perspective as a technological change and finally as an innovation process in search for more complex models of analysis. In section 3, follows a re-definition of the research problems as a consequence of the theoretical framing, highlighting the need for a further understanding of the different kinds of knowledge involved in construction and in the communication of its processes. Some research findings and preliminary interpretations are presented in section 4 and finally some remarks with indications for future development of the study conclude the paper

1.1 Background

The need for a vision for a global transition to sustainable development was formulated already in 1972 during the United Nations Environmental Conference that took place in Stockholm. Twenty years later, in the Rio Declaration signed in 1992 by 120 governments (UNCED 1992) the four dimensions of 'sustainable development' were defined and declared to be insolvably intertwined: the social, the economical, the political and the environmental.

An era of a more complex way of thinking was started and the implementation of a global collaboration for a sustainable development was propagated in the action programme Agenda 21. This strategic programme emphasized the need for democratic citizen participation of citizens at a local plan, managed by municipalities with the back up of strategies on the national plan. The implementation of sustainability became mostly the responsibility of governments.

The local and organisational management of the complex issues of sustainable development has found hindrances on the way. Especially in the building sector there have been major obstacles in promoting and implementing innovative practices in this direction. The whole sector must contribute to reduce the consumption of natural resources, especially energy, water and materials. It is of vital importance to strive for a sustainable built environment on both local and international levels. The European Construction Technology Platform has newly underlined the necessity for a common effort to challenge and change Europe's built environment (ECTP, 2005). In actual fact the last decade has seen a dramatic increase of energy consumption in urban areas and buildings, instead of an already required radical reduction. It is time to develop a new generation of energy "highly efficient buildings" and at the same time find strategies and solutions to upgrade the existing built environment to a high level of energy efficiency. Low political commitment (lack of rules and of incitements) and generally a low acceptance of energy efficiency by the owners are argued to be the major causes of the lack of positive results during the last decades (Gann, 1998; Dalenbäck, 2005). This study argues that other barriers must be identified in the building sector and that knowledge must be rooted inside the practice of construction in order to avoid the dependency on political decision-making.

1.2 Purpose of this study

The whole building sector today should be concerned about creating a built environment that respects the principles of a transition to a sustainable development. At the same time a general call for an innovation of the sector is expressed as a necessity in order to adapt all the activities involved to changed economic, social, political and environmental conditions (Kemp, 1994; Hansson et al, 2005). But the terms of this innovation and of the change that is required are still ill-defined.

This research must be considered as a contribution in that direction. More specifically the ultimate aim of this study is to identify where in the process of construction hindrances are to be found, what kind of hindrances, and what can be done in order to remove barriers to innovation. The investigation mostly moves within the first stages of projects: in fact, fundamental decisions are made during this phase, conditioning the final outcomes of a project. Environmental requirements tend to be neglected depending on these initial conditions. More specifically we seek knowledge about what happens within a project-team when the gap between existing knowledge and what the team needs to know at the end of the project is too big. Learning is a fundamental aspect of innovation processes and in this perspective the project-based firms working in construction are considered as both barriers and potentials for change (Gann and Salter, 2000; Prencipe and Tell, 2001). A need to gain more understanding of the individuals involved in the specific context of each project has been leading the investigation until now. The aim of this paper is to discuss a theoretical framework to specify projects and processes in their contexts.

1.3 General description of the research study

We are looking for some kind of circulation that collects a common experience of the new. An actor's approach seems to be appropriate to our aim of gaining an understanding dependent on the individuals involved. At the same time we want to gain an understanding of what factors are important in order to reach a *closure* (see section 2.2) in a technological change, within an innovation of construction in general.

This study is looking for a method to increase our ability to let the actors build their own space for learning and interacting. The method assumed will directly act for

- making research and praxis become nearer, expanding networks
- formulating measures for mainstreaming sustainable building
- being involved in the initial discussions in a demonstration project
- by means of interviews transform the personal experience of practicing professionals into conscious knowledge capable of changing organisations from the inside
- making knowledge available and the possibility to discuss and develop through meetings and publications, and changing any trends towards isolation and lack of communication

The problem areas taken as points of departure are continuously reviewed. Their appropriateness has to be verified. New aims and new results come out of experience: different descriptions and maybe new concepts move our attention to other problem areas and make us develop other measures to get closer to the goal.

It is only because of experience with cases that one may move inside the learning process and assimilate different skills and modes that allow one to move outside the limitations of analytical rationality. The projects/cases evolving during the study can be regarded as *tools* as well as *products.* They are tools for the researcher in order to gain understanding, and products of a learning process in which new problems have been solved and new knowledge has been applied, within a project team. At the same time the creation of a meeting between these evolving cases gives a platform, an arena, for discussion between researchers and practitioners about the change of individual practice. Learning may take place in the interplay between search and discovery (Dubois and Gadde, 2002) for all parties involved and the study has the purpose to reveal more about the process of how we learn, to the participants and to further readers.

1.4 Research design. Six real cases.

The empirical material of the study consists of six real cases (projects for housing, offices and light industry) that evolved during the research process. Located in the region of Gothenburg, Sweden, these projects have been monitored during one year. The practitioners involved have been invited to meetings and confrontations in seminars, workshops and small conferences in order to share the content of their experiences, not only with those with similar roles but with others, researchers, experts, managers, users. In addition, individual interviews have been carried out with practitioners and owners involved in the evolving cases in order to check their individual views, their perspective of the meaning of their practice, their relationships regarding consensus and the lines of conflict existing between them and other parties involved.

The project assumes the participation of the actors (developers, designers, technical consultants and constructors) involved in the six projects as a starting point.

Apart from the meetings and the interviews, the research project has comprised of the following different sections:

- A trial to identify and involve institutional *change agencies* supposed to carry out the dissemination of information and knowledge about demonstration projects in different networks
- Seminars are organised on specific questions opened to a wider participation from actors working in the building sector
- Analyses of the interviews in a social constructivist perspective (see section 2.2)
- Identification of Relevant Social Groups in a social constructivist perspective and finally of a number of Technical Frames (see section 2.2) giving us the possibility to understand the relations of power within the project-teams and in the big group present at the workshop.
- The identification and analysis of 'areas of consensus' and 'lines of conflict' between the Technical Frames help us understand the differences in the management of innovation and the antagonisms existing in traditional processes
- The mapping of the need for different arguments for sustainability and the uses that the individuals make of them in decision-making situations
- Analyses of the learning processes and knowledge production modes characteristic for each Relevant Social Group, looking almost at identifying the *codified, the articulated and the tacit knowledge* at work.

Studying evolving cases gives the chance of coming very near the reality of practice and at the same time of mapping step by step the ways of individual learning, when new knowledge is on play. This is the core of the research project, with one basic difficulty: every project is contingent and context-dependent and for that reason does not give any chance for generalizations.

1.5 Demonstration projects as a method

Previous studies (Edén and Jönsson, 2002; Edén et al 2005; Femenias, 2004) have contributed to the definition of 'demonstration projects' as a strategy for developing sustainable building practices. This study may be considered as a development of those previous findings.

Demonstration projects are widely used as tools for introducing and testing new policies or new technologies and have even been propagated as being tools for supporting sustainable building. Considerable efforts are made for supporting demonstration projects for sustainable building with special incentives and by disseminating results. Ideas and innovations are put to practical use and efforts are made for measuring results. Hence the outcomes of these projects are difficult to catch and a tendency to negative results is noticed (Femenias, 2004). Numeric measures do not say enough, and the environmental performance of the building becomes relevant when referred in the life cycle perspective of the use of the building. Even results of implementation of new technologies are difficult to define separated from a slow time perspective and a slow internal process of innovation of knowledge. This research study, developing the results brought out by Femenias (2004) and answering to the general call to link research and practice, focuses on the *practice of demonstration projects* as *a method* to implement sustainable building and as an important link in an innovation process.

2. MULTIPLE AND EVOLVING THEORETICAL FRAMEWORK

Former investigations have studied sustainable building focusing on technical and numeric results. The focus of this investigation is on the individuals, firms and organisations involved in the change: their visions, the kind of knowledge they represent and how they learn.

The aim of this study mirrors the calls for new forms of practice and research in construction emerging in the international scientific arena (Bresnen et al, 2003; Bresnen and Goussevskaja, 2005). A number of articles call for a rethinking of theories and practices that may allow an opening "to take greater account of the social complex arrangements and processes involved in the organization and management of projects in the construction industry" (Bresnen and Goussevskaja, 2005).

Conflicts and separation of knowledge have been argued to exist between construction management and mainstream organization on the one hand and management theory and research on the other. Social science thinking has favoured the attempts to understand project-based organisations and management in the construction sector. "However, social science-theory has, arguably, rarely been taken to constitute the basic ingredients of the recipe in approaching construction management research" (Bresnen and Goussevskaja, 2005). At that point all studies usually turn back to the more scientific and classical principles influenced by engineering, production and operations of scientific management.

The gap between theory and practice is generally accepted to be huge in the construction sector. The transition to the more complex thinking regarding sustainability is needed to bridge this gap. The theoretical framework within which we move for understanding our topic is multiple and evolving, or better "loose and emergent" (Dubois and Gadde, 2002). Complex matters need complex theories to be understood. The conceptual definitions of sustainable building presented below have been guidelines when entering the empirical world and constitute a *theoretical triangulation* of the topic at this stage of the study.

2.1 Sustainable Building as a concern for the real world.

Sustainability is the dynamic complex questioning that leads these studies. Working for sustainable building challenges the possibility of quantities to become qualities. In terms of *scientific sustainability* the increase of efficiency is the goal of all technology, now considered as *the environmental impact per unit of good*.

Sustainability is referred to in terms of abstract words and intangible outcomes, although it is not a theory. It gives an ontological linkage to the real world and to real contexts, denying models and abstract predictive analyses, defining problems and always revisiting the definitions. Sustainability leads us to some kind of research in action because knowledge without practice does not exist in its domain.

Building is a key sector of the general commitment about the transition to sustainable development (ECTP, 2005). The goals for sustainable building focus on the importance of a *maximal differentiation of solutions*, adaptation to the local context and to global tasks, to the local complexity of the *real world*, inside which the built environment is transformed.

The building sector contributes considerably to the degradation of the natural environment, consuming a big amount of non-renewable natural resources. The main areas of concern for sustainable building are then the optimisation of the use of energy in building, aiming at limiting and finally ending the use of fossil energy resources, together with a broad rejection of hazardous substances in building materials and the reduction of building-waste through recycling and reuse. The qualities of the building are defined as goals strategically to be reached during the whole life cycle of the artefact. They are matters of quality of life, *matters of concern* and no longer *matters of fact,* borrowing two terms from Bruno Latour (Latour, 2004)

Still the general conception of sustainable building is that it is too normative and technical, "performance based and independent" (Femenias, 2004). This study assumes that sustainable building is a question of technological changes going on since the 70s and not the opposition of a small amount of 'green buildings' against the great normal mass. Inside the change we see the need to highlight the role of each individual practicing this change. Barriers may exist inside the social organisation of the process.

2.2 Sustainable Building as a Social Construction

Existing established methods for social enquiries are borrowed as tools. Assuming that sustainable building is an ongoing technological change, the theory of Social Construction of Technology (SCOT) (Bijker, 1987) has been positively employed during an intermediate stage of this study because of its characteristic analyses of technological developments.

SCOT has been developed as a tool for the analyses of the interactions between social factors and technology (Bijker and Law, 1992). The social constructivists dismiss the concept of technological determinism by revealing that technology is always socially constructed and thus subject to demands and changes imposed on it by societal groups. In the sense of SCOT, technological artefacts comprise of both objects as activities and processes; this means both *what* people do and *how* they do it. Demonstration projects for sustainable buildings can, thus, be considered as concretised manifestations of environmental knowledge combined with planning technical expertise.

Moreover we learn from SCOT that there is not only one way of looking at an artefact. Different actors in society have different views on a specific artefact. Therefore it is important to identify these views and the social groups sharing them. A Relevant Social Group (RSG) shares the same view and acts the same way in relation to the artefact. The interpretation and the frame of understanding of the particular artefact shared by all the members of a RSG constitute a Technological Frame (TF). The identification of the different technological frames interacting with each other is an essential element of the SCOT approach.

"[…] technological artefacts are culturally constructed and interpreted. By this we mean not only that there is flexibility in how people think of or interpret artefacts, but also that there is flexibility in how artefacts are designed. There is neither one possible way nor one best way of designing an artefact" (Bijker, 1987). This interpretative flexibility diminishes as the RSGs gradually reach an agreement on a common interpretation of the artefact. Some variants of the artefact's design die out, leaving a dominant surviving 'design' behind. In the SCOT terminology this is called *closure* and *stabilisation.*

The good examples of energy efficient housing still constitute many variables on this path. An agreement about how to interpret these buildings has still not been achieved, but the more the social groups (RSG) interact and try to find common languages to talk about the "environmental sounds" of buildings (Damman, 2005) the more examples will be built and ultimately the nearer the closure will be. This kind of interaction (shaping new knowledge), along with the competitive elaboration of solutions inside each different Technological Frame, constitutes the motor of the innovative process from the SCOT point of view.

2.3 Sustainable Building as an Innovation Process

A technological change deals with innovation processes. These have largely been studied as material for innovation theories, as tools to understand innovations in the manufacturing of products. Hence theoretical models are difficult to apply to construction. The fragmented complexity of the building process has been described as a "hindrance" for the application of general models normally developed for the manufacturing industry. Innovation theories have struggled with the different contexts of construction, compared with manufacturing (Koskela and Vrijhoef, 2001). Former attempts to rationalize and control the building process have resulted in limited pilot projects lacking durability.

Many definitions give the sense of the complexity of innovations. Innovation is implementing a new idea inside an organisation and an innovation process becomes apparent when an act, as well as an idea, begins to impact on its environment.

Innovations are normally considered incremental rather than revolutionary, a question of strategic planning. The *management* of innovation processes has been more and more highlighted and a *strong leadership* is considered to be a precondition for a successful outcome of the process. In opposition to this line of thinking others justify the superiority of soft human-centred approaches underlining the importance of *collaboration, participation and dialogue* in business as in private life. Hence, there are many claims of empirical validation for both perspectives (Fonseca, 2001; Stacey et al, 2003)

All studies seem to agree on one point: real innovation leads to new ways of doing things. At the same time all perspectives have a common assumption that innovation is a phenomenon that can be subjected to human control. "It is taken for granted that humans can purposefully design, in advance, the conditions under which innovation will occur" (Fonseca, 2001). Fonseca argues that this assumption of controllability is the distinguishing feature of mainstream thinking about innovation, based on an abstraction of human practice. He proposes a different understanding of innovations as "the emergent continuity and transformation of patterns of human interaction, understood as ongoing, *ordinary complex responsive processes of human relating* in local situations in the living present. It is in such patterns of interactions that meanings emerge" (Fonseca, 2001).

From this point of view the demonstration project approach, assumed in this study, focuses the attention on "the on-going self-organizing process of communicative interaction in which the products of innovation emerge" (Fonseca, 2001). These processes are not controllable, difficult to catch and describe. In fact the innovations of processes in design methods are *invisible*. In this perspective the request for innovation is challenging all the entities involved in the technological change. It is no more only a question of *strong leadership*; the *collective* plays a central role transforming new knowledge into practice, controlling the real circumstances in which the new is realised.

Trying to define sustainable building as a technological change, so as it is analysed by social constructivism, many minor inventions, new skills, new assumptions, the converging of goals from different social groups, the commitment of a scientific-knowledge group in making tools and knowledge systems accessible to the largest number of people, all these factors and others unpredictable ones, created during the process by the interactions with the contingencies of contexts, participate to the innovation process. This need for complex models along with the need for a deeper understanding of innovation in the building sector, find response in current literature about innovations in the construction sector (Gann and Salter, 2000; Koskela and Vrijhoef, 2001).

We claim that the consideration of the environmental impact of building as a *performance requirement* is the main common denominator for the actual innovation in the building sector. Solving all the new problems arising during the process is a challenging task for all, architects, clients, consultants, constructors, manufacturers of components, facility managers and ultimately the users. The client may recognize the need for innovation under the pressure of regulations, of user-demand or/and of a political mandate. Architects may implement learning of new knowledge and inspire the clients. Furthermore, architects may not be able to bridge this change without co-operating with consultants and these have to share the common responsibility of energy efficiency, for example. All of these parts should be supposed to pay a part of the transaction cost of technical innovation. Competitiveness, co-operation, survival, but even inventions and pure new solutions are different ways of what we previously called 'human control of innovations'.

The final feedback is provided by generations of users who are going to cohabit with the *new* until it becomes ordinary and *old* again and a new generation of ideas will change the performance of the built environment still increasing its efficiency.

3. REDEFINING THE RESEARCH PROBLEMS

Framing the empirical material within the three above-mentioned theoretical domains, that of sustainability in construction, that of a social construction of technology and that of different innovation theories, three new main aspects emerge. These are discussed as follows:
1) Demonstration projects have to be investigated as processes of innovation of learning concerning all the parties involved in a project.
2) It is important to investigate the 'heterogeneous engineering' acting inside a process of technological change, not limiting the attention to only actors and their networks
3) New kinds of good examples may arise from these projects when moving the focus of attention from the final product to the innovative process involved.

3.1 Demonstration projects as innovation processes – still using tacit knowledge

Though the contexts of innovations are generally so different, still *motivation, time and money* are by all researchers considered three necessary factors in order to achieve innovation, regardless of the model. All are necessary but may come in to a different extent. An infinite amount of time and money will not achieve anything if there is no motivation. Time and motivation seem to be more fundamental (Widén, 2002). That is why the demonstration project method we propose builds on two principles: *time for learning* and *strategies for the growth of motivation*.

The six evolving cases linked to the research study from the very start have all had the common goal of giving "good examples for the future". Some of them consider themselves as being demonstration projects, others do not. However within the research project they all become *demonstrative.* The practitioners participating in meetings and seminars develop common strategies for understanding and improving the new challenging problems they are working with. It is a question of developing a method for the internal implementation of sustainable building through an increased exchange of knowledge between practitioners, academic researchers and experts. The research points at the importance of an arena for face-to-face communication and for a widening of networks in order to implement the innovation of knowledge. The interviews with the actors involved tell us about many different ways of working with sustainable building in demonstration projects, of a change taking place in the horizon of meaning regarding individual practices, existing networks, ongoing learning processes inside the firms and organisations and environmental knowledge that begins to be spread with the change of generation.

3.2 Sustainable Building as 'heterogeneous engineering' – articulating knowledge

This study assumes that signs of a technological change are emerging in the transition from isolated green housing to sustainable building. These signs appear as 'heterogeneous engineering', using a term introduced by John Law (Bjiker and Law, 1992). The assumption of this term gives us the impulse to look for all the factors that are needed for a successful implementation of an idea throughout a process in time. 'Heterogeneous engineering' seeks to associate entities that range from people and skills, to artefacts and natural phenomena.

In fact looking only at actors and networks interactions can result in a restrictive description, traditionally focusing on the tacit assumption that it is possible to control innovation by human action and management of organisations (see section 2.3). What John Law (Bjiker, 1987) maintains is that, for a real innovative technical change to succeed, a non-linear combination of interacting casualties is needed. From this point of view sustainable building will succeed in increasing its energy efficiency when it will become *a network of artefacts and skills* converting small quantities of energy into allied in the struggle to master the power of climate.

Law (Bjiker, 1987) suggests that 'heterogeneous engineering' seem to need the three following stages:

1. Stage 1 is in *the process,* shaping technologies (as solar panels), applications and inventions (as environmentally adapted houses and 'passive' houses) and scientific knowledge (i.e. about ecosystems, energy balance calculation, indicators, LCA, LCC, assessment tools etc.).
2. Stage 2 is involving a kind of *social engineering*, i.e. the construction of a network of practices that when associated with the instruments and in order to broaden the fields of contextual applications, would lead to a necessary transformation of solar energy and climate into allied forces. Three stages can be identified in typical examples: a) the State convokes a "scientific commission" with the purpose of converting *esoteric scientific knowledge* into a widely applicable practice; b) the commission produces a set of rules for the calculation of X by semi-educated practitioners. A manual of rules for the use and the application of X is published; c) the new method is adapted and makes further scientific mapping of contexts and a new "metrics" necessary (KWh/m2/year). The new method surely sounds to be too difficult to apply for most practitioners. Only the most up-to-date and competitive attempt to practice it. It seems clearly that in the attempt to create a stable network of elements it is important to identify the *weakest links* (these may in our case be the users or the builders at the construction site).
3. Stage 3, the success of the project must have a *point of return*. All decision-making during the process may not be possible without a scale of reference. *Technological testing* implies the construction of a background against which to measure success.

This points out for our attention the need for more general systems of measurement against which the local adequacy of particular solutions and decisions might be measured. The question is if it is possible to identify the main entities of a *heterogeneous engineering* in a perspective way? Which are the *challenging antagonisms or common goals* John Law is talking about?

3.3 The power of good examples – codifying knowledge

Innovations point towards a goal. During the process, examples emerge adjusting the definition of the goal. In this sense the energy efficiency of building must become the primary goal for the whole construction sector, without exception. But demonstration projects become good examples as we consider them as processes. The energy efficiency goal is adjusted during the period of use and may not solely be considered as a goal for the building phase.

The implicit and tacit type of production and communication of knowledge in the building sector is a hinder when trying to analyse the outcome of projects. How do we communicate these examples focused on processes? A new and clear formulation of goals is needed, as we want to measure the performance of a building with regard to its environmental impact and sustainability. We can start with the numeric measures of performances; this is possible only when we are in control of a situation and when goals and results call for the same kind of outcomes. 45 KWh/m2/year represents a kind of numeric quantity that can become a common goal for all parts involved in the construction sector. But the quality and the *how much learning* of the changed design process that is needed to reach that result can, on the contrary, be difficult to estimate.

A life-cycle perspective on every new and renewal building-project can be required in order to make them into *good example*s, not only as products, but even as learning processes. The more variables in play, the more complex becomes the design process and the management of knowledge it implies.

Different forms of collaboration in order to reach energy efficiency can also become parts of the new common goals to be formulated. Partnering solutions of co-operation in project-group are seen as a means to challenge the increasing complexity of the design-process when more variables are on play. Partnering is said to be the best form for implementing innovation as a learning process (Widen, 2002; Kadefors, 2004). *Investments in partnering* are generally regarded as the responsibility of the developer/client. Within the perspective of the competitiveness of implementing innovations as learning processes inside the firms and organisations, it should be regarded as a *common responsibility* and a common investment between all the parties involved. Innovation of learning and increase of motivation can be the intangible dynamic results constituting the power of these demonstrative examples. The power of examples resides within the practice.

4. RESEARCH FINDINGS AND INTERPRETATIONS

4.1 The practice of sustainable building (new ways of doing thing)

Skilled professionals, with hundreds of concrete cases in their areas of expertise, admit the need for a change in their practices when dealing with special requirements of environmental performances. They express a demand for learning that they claim can only be satisfied inside the 'knowledge environment' they are familiar with, this means inside a 'project' as a context of application of knowledge. Because of their experience with cases they move inside the learning process step-by-step, assimilating new skills and modes that later allow them to move outside the limitations of analytical rationality.

From our meetings with these professionals it clearly results that working for the first time in co-operation with others, no longer playing the "who's cheating who" game, with more time at disposal for discussing solutions, gives plenty of motivation to continue searching. Solutions are founded within the team together with the conscience that technique is seldom used like in the instructions. Calculation tools are tested in reality. Every single project-team constitutes a new context for decision-making: the technical strategies and the choice of systems result from the discussions. This depends on the group's interactions, not on the adoption of general solutions. An engineer expressed it as follows: "Nothing goes straight. You find out that so many are working with things they don't know in detail. This is astonishing but all are more satisfying than in the normal parcelled project management. Even if we, in this case, have more time to sit in general meetings, I still do not think the time requested is more than usual".

The direct experience of buildings is expressed by all the interviewees as the best way of learning something about what they are working with. Articles in magazines seldom give the knowledge they are searching for. The chance of sharing the 'new' with others is almost always provided by being a part of a project-team. New co-operation models are well-known and almost everyone wants the possibility to work in longer, more continuous design processes: not only because the product may become better (you never have assurances of this kind) but mostly because you learn much more working in dynamic co-operation. Not one of these projects has adopted 'functional contracts' or 'partnering solutions' formally, but all of them enjoy some kind of public support for more meetings and evaluations.

It stands clear that knowledge associated with "know-why" and "know-what" tends to be codified, while knowledge associated with "know-who" and to some extent "know-how" tends to be un-codified, or tacit. Tacit knowledge is extremely important in this environment (Gann and Salter, 2000).

4.2 DEMONSTRATION PROJECTS AS SOCIAL ENGINEERING OF SUSTAINABLE BUILDING

Already at this early stage of our study it seems possible to talk about 'social engineering' in demonstration projects, as being an important factor determining *how much learning* a project may produce.

The material provides opportunities to consider the important competitive role played by what Gann and Salter (2000) call 'project-based firms' in design, engineering and construction along with the considerable amount of practitioner-research involved in project-teams. A nearer investigation of the potential for innovation of this characteristic organisation in construction is still lacking in the theoretical studies about the sector. Hence our empirical material confirms relevant emergent characteristics. In the reality of the informal conduction of innovations, research and development of expertise in the course of projects, a relevant 'practitioner-research' activity emerges that is often unplanned within project-teams (Gann and Salter, 2000). The analysis of Gann and Salter is confirmed even as to the lines of conflict, within bigger firms, between senior central actors having a poor understanding of these activities. Big differences even result when comparing the views about innovation management by representatives of the institutional national organizations of the building sector and by the professionals involved in projects. These easily become 'lines of conflict' creating hindrances in the learning process.

In this sense the *demonstration project method* creates consensus and legitimacy about novelties in management and processes and provides strength for new argumentations in official contexts.

5. CONCLUSION

A tentative conclusion at this early stage of the study is that we should be able to consider buildings for sustainability as a more complex kind in need of *a more complex model of analysis*. The empirical part of the research has been leading the choice of possible theoretical tools in order to gain a deeper understanding of the possibility of using demonstration projects. The tension existing between the different innovation theories opened the question of the importance of the learning processes going on inside the organisations and inside the project teams when different co-operation forms are chosen. Beside that SCOT did reveal fundamental resources in order to analyse the social engineering of sustainable building. The investigation of the heterogeneous engineering working for the closure of a technological change has to be developed, as it revealed interesting features in order to access a more complex model of analyses.

We are forced to take a necessary distance from the analyses of quantities and numerical results, concentrating on processes and learning imbedded in practice. As a consequence of this a demonstration project may be considered as the result that measures a distinction between what has been done before and what may be done afterwards focusing on how things are done before and after. The change in practice they produce is what makes them demonstrative while the change of knowledge they produce is too complex to be described.

The other perspective that has been introduced is *how much learning they produce*. We see that some innovations are concerned with internal processes and that some Social Relevant Groups are especially demanding regarding the innovation of knowledge inside organisations. New co-operating models have shown to be effective innovative learning strategies notwithstanding the wish expressed by consultants to work inside new structures. Demonstration projects may then become a method for new internal learning processes.

The future developments of this study will be to access problems concerning knowledge management and learning that still need to be addressed; especially the relationship between learning by individuals, project-based teams and organisations have to be studied.

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AN INVESTIGATION INTO CURRENT COST ESTIMATING PRACTICE OF SPECIALIST TRADE CONTRACTORS

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ABSTRACT: Although extensive research has been undertaken on cost estimating processes of contractors for construction projects, very little research has considered the cost estimating practice within specialist construction contractors.

The objective of this paper is to gain an understanding on current cost estimating practice of specialist mechanical and electrical contractors for construction projects.

The paper reports upon semi-structured interviews and a questionnaire survey of mechanical and electrical contractors that was undertaken in Jun 2005.The respondents were classified into five groups based on annual turnover, namely: very small, small, medium, large, very large.

The data analysis indicated that the main cost estimating method being used by electrical and mechanical contractors was: the unit rate method, followed by comparison with similar past projects based on documented facts, comparison with similar past projects based on personal experience, parametric estimating, and then operational estimating.

The study showed that almost half of the respondents surveyed (48%) do not routinely utilize and rely upon historical cost data provided as site feedback when producing estimates. The reasons revealed by the survey were: unique characteristics of each project, unstructured site feedback, lack of confidence in data provided; incompatibility of information for future estimating needs. The data analysis also showed that the main causes of inaccuracy in cost estimating are: insufficient time for estimating, inadequate specifications, and then incomplete drawings.

The paper sets out a framework for research into the development of a cost estimating model/technique in order to improve the prediction of specialist resources productivity.

Key words: accuracy, cost information, estimating, site feedback, and specialist contractors.

1. INTRODUCTION

The code of estimating practice produced by the Chartered Institute of Building (CIOB, 1997, P. xiii), in addition to many other authors (Kwakye, 1994; Brook, 2004; Ashworth, 2002) define estimating as "the technical process or function undertaken to assess and predict the total cost of executing an item(s) of work in a given time using all available project information and resources". Therefore, for a construction company to thrive, it must have the ability to forecast the likely cost of proposed construction work, and thus at least be able to establish a baseline figure from which a price can be quoted to the client.

Cost estimating methods have been developed for preparing estimates of various types and for various purposes (Daschbach and Apgar, 1988). Many standard textbooks on cost estimating (e.g. Bentley, 1987; Buchan *et al.,* 1991; Kwaky, 1994; Smith, 1995; Brook, 2004 and Ashworth, 2002) are readily available. In this regard, Akintoye and Fitzgerald (2000) in their study of UK current cost estimating practices reported that the main method used by construction organisations is the standard estimating procedure, followed by comparison with similar projects based on documented facts, and comparison with projects based on personal experience. Such commonly applied methods do not differ from traditional ways of estimating, where costs of construction elements (labour, materials, plant, sub-contractor, and preliminary) are established and to which allowance for profit, overhead, and risk is added.

In this regard Curran (1989) has argued that these "conventional or traditional" methods of estimating often fail to cope with the realities of today's world, which involves elements of uncertainty. Bryan (1991), argued that estimating a construction project is time consuming and often tedious. To improve the quality of estimating, he advocates the use of an assembly pricing technique (also called work module pricing, system pricing, rapid pricing or aggregate pricing). Uman (1990) contends that it is difficult to develop a standard process from which to develop a cost estimating system for construction, due to such factors as extreme diversity in building systems, methods, projects, suppliers, contractors and workforce.

However, such methods rely upon judgment and estimator's experience, and are within the domain of what Ntuen and Mallik (1987) called experience-based models. Hegazy and Moselhi (1995) argued these methods are often inaccurate and unstructured and are based solely on contractors' own experiences and the general-purpose procedures dictated by the software systems they use. Law (1994) outlined a general procedure for building contractor cost estimating. However, he reckoned that in practice, contractors devise their own methods for cost estimating and bidding. Skitmore and Wilcock (1994) investigated estimating processes of smaller builders based on an experiment conducted with eight practicing builders' estimators. The work investigated the process of estimating rather than the practice of cost estimating, by looking at methods that estimators used to price selected items from bills of quantities and the variability associated with the outcomes. The results showed that just over half of the items were rated by the detailed methods prescribed in the standard texts. The remaining items were rated mainly by experience.

Although extensive research has been undertaken on cost estimating processes of contractors for construction projects, very little research has considered the cost estimating practice within specialist trade contractors.

This paper reports upon an investigation of current cost estimating practice for mechanical and electrical construction organisations, and sets out a framework for research into the development of a cost estimating model/technique in order to improve the prediction of specialist resources productivity.

2. METHODOLOGY AND RESEARCH FRAMEWORK

A two-phase mixed design strategy is adopted. The mixed method approach has been successfully used in number of recent studies (Fortune, 1999; Hall, 1999; Ross 2005). It has its roots partly in the construct of triangulation, in increasing the validity of a study by considering data from different sources, gathered under different conditions, and using different data gathering instruments. Triangulation has been identified by Denzin and Lincoln (2003) and Yin (1994) as having four aspects: data source triangulation- where the data are considered to be similar in different context, investigator triangulation- when several investigators consider the same phenomenon, theory triangulation- when investigators with differing perspectives investigate the same phenomenon and methodological triangulation- where one approach is used to inform a second approach that takes a different methodological stance. In this study triangulation is from both data source and methodological approaches.

The first phase of the study adopted a quantitative approach to the collection and analysis of the data. It used the results of a comprehensive literature review to inform the theoretical selection of a number of informants to be interviewed using a semi-structured interviews approach. The results of the data collected from the semi-structured interviews were used to design a measuring instrument that was administrated to a sample population. Multivariate statistical analysis techniques were used on the resultant data set; the results will then be used to inform the second phase of the study.

The second phase of the study will adopt an in-depth case study approach in order to explain the results obtained from the first phase. The resultant data from the two phases will then be used in developing a cost estimating model/technique in order to improve the prediction of specialist resources productivity using historical productivity data provided as site feedback.

3. SEMI-STRUCTURED INTERVIEWS

3.1 Semi-structured Interviews Design and Sample Selection

It was decided that the most appropriate approach was to carry out semi-structure interviews with a number of senior estimators in order to get a better understanding of current estimating practice within mechanical and electrical construction organisations prior to the development of the operationalised constructs for the study.

A covering letter was sent to the chief estimator of selected organisations. The letter indicated the objectives of the research and requested that the interviewee should be a staff member responsible for cost estimating activities in the organization. A two-page in length protocol with 19 questions was prepared based on a combination of an extensive review of the literature dealing with cost estimating practice in the United Kingdom.

The covering letter was mailed to 14 mechanical and electrical construction organizations based in the North West of England. Organisations were randomly selected from available lists of mechanical and electrical construction organisations in the Directory of Members of Heating and Ventilating Contractors' Association (HVCA). Five organisations were returned with one firm has no estimating department.

The semi-structured interviews schedule also sought information regarding the following areas:

1. Characteristics of responding organisations in term of annual turnover, typical sizes of projects undertaken, total number of craftsmen, and percentage of work sub-contracted;
2. Factors affecting accuracy of cost estimating;
3. Difficulties that estimators face when estimating typical project cost;
4. Suggestions regarding any improvements required in estimating.

The subsequent semi-structured interviews were conducted in each of the participant's office and lasted for 30 to 40 minutes each. The interview protocol was given to the participants and their permission was sought to tape record the interviews for further analysis. The option was given for confidentiality; however, none of the participant requested that their transcripts remained confidential.

Table 1: Schedule of organisations' characteristics

Organisation	Annual Turnover	Typical Project Size Range	Number of Craftsmen	% of work Sub-contracted
Organisation 1	£20m	Up to £15m	50	30%
Organisation 2	£144m	Up to £24m	Unknown	60%
Organisation 3	£15m	Up to £2m	120	25% to 30%
Organisation 4	£69m	Up to £4m	25	Unknown

3.2 Semi-Structured Interview Data Collection

The interview protocol was considered carefully, as effective in-depth interviewing requires considerable skill in order to yield meaningful data. Descriptive questions were used, such questions were useful to encourage the participants to describe their experiences and approaches to particular issues, however, it was found that directly asking for a rationale i.e. using "why" was seen as being a little to interrogative and led to a loss of rapport. It was found as well that the use of clarification questions was particularly useful to open up areas for further explanation. The interviews were recorded and transcribed.

The phrasing of the questions was refined as the interviews proceeded from case to case and to ensure clarity and reliability of the questions the interviewer took care to avoid the use of statement that may have biased the collected data.

3.3 Semi-Structured Interview Data Analysis

The analysis of semi-structured interviews showed that the main method being used by mechanical and electrical construction organisations in predicting the likely costs of a typical project was the unit rate method of estimating, which was found in most estimating text books, where costs of labour, materials, plant, subcontractors and preliminaries are established and to which allowances for profits, overhead and risk is added.

It was also identified in the analysis of the data collected in the semi-structured interviews that estimators relied upon judgment when assessing productivity rates for labour, plant and sub-contractors. The interviewees were asked about difficulties they face when estimating a typical project cost, which also have been considered as causes of inaccurate cost estimates. The main difficulty being identified by all interviewees was insufficient time for estimating. The interviewees were asked about their opinion in the areas of estimating that require more improvement. Three of the interviewees indicated that the improvement is required in the quality of the data provided to estimators as site feedback. The fourth interviewee had no answer.

4. QUESTIONNAIRE

4.1 Questionnaire Design

The questionnaire survey was undertaken to determine the opinion of mechanical and electrical construction organisations regarding the current practice on cost estimating in the UK. The questionnaire was designed to be as attractive as possible; a columnar format was used with colours highlighting the questions. The header of the questionnaire indicated the logos of the HVCA and Liverpool John Moores University. The questionnaire was four pages in length with 21 questions. The questionnaire design was based on a contribution of an extensive literature review and the results obtained from the semi-structured interviews that had been conducted. The final questionnaire was developed with the aid of a series of pilot questionnaires involving estimating departments of mechanical and electrical construction organisations.

The questions were collected together to ensure that the informant kept the research construct to mind when answering the questions and also to ensure the questionnaire was considered trustworthy, and covered the following sections:

Section one: organisational information, annual turnover, staff volume, business sector, and client type.

Section two: project size, tendering and procurement approaches

Section three: estimating practice, techniques being used, factors affecting accuracy, role of site feedback.

Section four: personal information

Section five: improvement to cost estimating.

However, this paper focuses on the major results of the survey (main methods of cost estimating, cause of inaccurate cost estimates, and role of site feedback in improving accuracy of cost estimates) rather than talking in detail about each of these sections.

In total 1000 copies of the questionnaire were sent out to practicing estimators of mechanical and electrical construction organizations in June 2005. The final total response rate was 10.4% (104), this is considered as low when compared to other recent survey response rates (Ross, 2005; Akintoye *et al*, 2000).

4.2 Estimating Techniques and Methods

Mechanical and electrical construction organisations were classified into five categories based on their annual turnover in the last financial year, namely:

Very Small (N=24)	:	<£1.5m
Small (N=16)	:	£1.5m-£2.99m
Medium (N=20)	:	£3m-£6.99m
Large (N=21)	:	£7m-£24.99m
Very Large (N=19)	:	>£25m

The respondents were asked to provide information on the effectiveness of the estimating techniques that their organisations used when predicting the likely cost of a typical project. A six point Likert scale was used to gather the data, ranging from 1=least effective to 6=most effective.

The techniques were drawn from the literature review and were, unit rate technique, operational method, comparison with similar past project based on personal experience, comparison with similar past project based on documented facts, and parametric estimating technique.

Descriptive statistics indicated that the most effective technique was the unit rate method of estimating (mean=4.2), followed by comparison with similar past projects based on documented facts (mean=3.8), comparison with similar past projects based on personal experience (mean=3.7), parametric estimating technique (mean=3.5), and then operational estimating (mean=3.4).

To determine whether there was a significant difference between different organisation sizes and the main method of cost estimating being used by mechanical and electrical construction organisations, a non-parametric Kruskal-Wallis (KW) test was carried out, which indicated that the only two methods that approached a significant difference in estimating construction costs were unit rate method of estimating $X^2_{(4,88)}= 11.9$, $\rho = 0.018$, method of comparison with similar past projects based on personal experience $X^2_{(4,92)}= 10.6$, $\rho = 0.031$. No significant difference was found between different organisation sizes and operational method of estimating $X^2_{(4,66)}= 2.2$, $\rho = 0.702$, method of comparison with similar past projects based on documented facts $X^2_{(4,83)}= 7.44$, $\rho = 0.114$, and parametric estimating technique $X^2_{(4,55)}= 6.3$, $\rho = 0.178$.

In order to establish whether a significant correlation existed between organisation sizes and the estimating techniques being used, a non-parametric bivariate analysis was carried out. In each case Spearman's rho is reported and displayed in Table 2

Table 2: Bivariate analysis of estimating techniques - Spearman's rho

			Unit rate	Operational	Personal exper.	Docu. facts	Parametric
Spearman's rho	Org. annual turnover	Corr. Coef.	.295 **	.080	-.266(*)	-.182	-.271(*)
		Sig. (2-tailed)	.005	.521	.011	.099	.046
		N	88	66	92	83	55

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

The analysis indicated that a positive correlation significant at the 0.01 level was found between unit rate method r = +0. 319, ρ = 0.002 and organisation sizes. A negative correlation significant at the .05 level was found between comparison with similar past projects based on personal experience r = -0.266, ρ = 0.011 and organisation sizes. No significant difference was found for other estimating techniques.

This indicated that larger organisations tended to consider unit rate method of estimating as being the most effective technique compared to smaller organisations that considered comparison with similar past projects based on personal experience as being the most effective estimating technique. Bearing in mind what the literature review revealed about insufficiency of these methods, a more sophisticated estimating technique is suggested to improve the quality of the estimating process.

4.3 Site Feedback

One of the reliable sources of information upon which estimating is based, should be from recorded company data derived from site feedback or work-study exercises. Only 52% of respondents indicated that their organisations rely upon historical cost data provided as site feedback when producing estimates. The results displayed in Table 3 indicated that the most important reason why estimators do not routinely use site feedback in estimating cost, irrespective of organisation size, was: unique characteristics of each project; followed by unstructured site feedback; lack of confidence in data provided; incompatibility of the information for future estimating needs. However, the data analysis indicated that unstructured site feedback was rated more highly (mean=4.053) as a reason for not using site feedback in predicting resources productivity with very large organisations compared to other organisation sizes. This indicated that for historical productivity data provided as site feedback to be routinely used by very large mechanical and electrical construction organisations (annual turnover >£25m) needed to be more structured. Smith (1995) in this regard, reported that a major reason given why estimators disassociate themselves from site feedback is due to the poor recording systems employed by contractors and hence a lack of confidence in the data provided.

Despite the above, there is no doubt that, systematic, realistic and more structured site feedback would be of great benefit to the estimator as this will minimize estimators' reliance upon judgment and experience in estimating construction cost which leads to more accurate results.

Table 3: Reasons for non- use of site feedback

Reasons	Overall	V. Small	Small	Med.	Large	V. Large
The unique characteristics of each project	3.630	3.571	3.875	3.526	3.619	3.579
Unstructured site feedback	3.620	3.238	3.688	3.579	3.667	4.053
Lack of confidence in data provided	3.370	3.143	3.438	3.211	3.476	3.579
Incompatible of information for future estimating needs.	3.260	2.762	3.375	3.211	3.470	3.474

The results displayed in Table 4 indicated that increasing the accuracy of the estimate was rated very highly as an effect of site feedback on the estimating process (mean=4.218), compared to increasing the time required to develop estimate (mean=2.655), and increasing net cost of estimate (mean=2.636). This indicated that while site feedback had a high effect on increasing the accuracy of the cost estimate, it had a low level of effect on increasing the time and the net cost of estimate. Adrian (1982: p. 31 *et seq.*), from Smith (1995), for example, asserts "An important component of any estimating system is the collection of past project data and the structuring of the data for use in estimating future projects".

Table 4: Suggested effects of structured site feedback

Effect of structured site feedback	N	Mean	Std. Deviation	Variance
Increasing accuracy of estimate	55	4.2182	.73764	.544
Increasing time consumed in developing estimate	55	2.6364	.94992	.902
Increasing net cost of estimate	55	2.6545	.90714	.823

4.4 Accuracy of Cost Estimating

The overall purpose for an accurate cost estimate is its use in establishing the budget for a project and as a tool used for scheduling and cost control. When bidding on a project, the accuracy of a cost estimate has a number of different implications. The most obvious is the effect on winning the contract. The importance of cost estimating is emphasized by Hicks (1992) that " without an accurate cost estimate, nothing short of an act of god can be done to prevent a loss, regardless of management competence, financial strength of the contractor, or know how.

The survey revealed six major factors that affect the accuracy of the estimating process within mechanical and electrical organisations, and is displayed in Table 5. Insufficient time for estimate rated the highest factor (mean=4.398), followed by inadequate specification (mean=4.252), incomplete drawings (mean=4.146), quality of project management (mean=2.942), lack of historical cost data (mean=2.592), and then lack of confidence in structured site feed back (mean=2.563).

Table 5: Factors that affecting accuracy of estimating process.

Reason	Overall	V. Small	Small	Med.	Large	V. Large
Insufficient time for estimate	4.398	4.087	4.500	4.600	4.381	4.737
Inadequate specifications	4.252	3.826	4.250	4.300	4.333	4.579
Incomplete drawings	4.146	3.826	3.938	4.250	4.238	4.474
Quality of project management	2.942	2.957	3.250	2.900	2.714	2.947
Lack of historical cost data	2.592	2.783	3.000	2.550	2.238	2.421
Lack of confidence in structured site feedback	2.563	2.435	3.000	2.800	2.238	2.526

Generally, however, very large organisations, where their turnover exceeded £25 million in the last financial year rated insufficient time for the estimate as a cause of inaccurate cost estimates (mean=4.737) more highly compared to other organisation sizes. This can be explained by what the previous data analysis and the extensive literature review showed about the reliance of very large organisations on unit rate as the main method of cost estimating and the more time consumed in developing an estimate that is associated with such method.

The results displayed in table 5 indicated that incomplete drawings and inadequate specifications as reasons for inaccurate cost estimates were rated more highly by very large organisations (mean=4.474, mean=4.579 respectively) compared to other organisation sizes.

The data analysis clearly indicated that lack of confidence in structured site feedback rated the lowest as being a cause of inaccurate cost estimates. This confirmed what previous analysis showed that mechanical and electrical organisations, irrespective of organisation size, generally have similar opinions regarding the confidence of site feedback in increasing the accuracy of cost estimating.

5. CONCLUSION AND THE WAY FORWARD

Cost estimating is a process designed mainly to predict the likely cost of undertaking work. However, the paper shows that the main methods of cost estimating being used by mechanical and electrical construction organisations do not differ from conventional/traditional ways of estimating, which entail estimating the cost of specialist construction resources for a project, including labour, materials, plant, subcontractor and preliminaries, and to which profit, overhead and allowance for risk is added.

The reviewed literature indicated that such traditional methods are inaccurate, unstructured and rely up judgment and estimator's own experience in assessing resources cost. However, one of the reliable sources of the information upon which estimating is based, ought to be from recorded company data derived from site feedback or work-study exercises. The survey revealed that very large organizations (annual turnover >£25m) considered unstructured site feedback as a main reason of not using site feedback as a source for providing productivity information.

The paper highlighted that the main causes of inaccurate cost estimates are: Insufficient time for estimate development (rated the highest factor); followed by inadequate specification; incomplete drawings; quality of project management; lack of historical cost data; and then a lack of confidence in structured site feed back. One of the reasons for such inaccuracy may be the estimators' reliance upon the unit rate method of cost estimating, which requires more time to develop estimates. In order to address this problem and to improve the accuracy of the estimated cost, a more sophisticated estimating technique requires developments.

The results from the first quantitative phase of the research will be used to inform the second phase, which adopts an in-depth case study approach. The aim of the use of case study in this research is to explain, expand, and generalise the results obtained from the first phase.

The resultant data from the two phases will then be used in developing the proposed cost estimating model/technique in order to improve the prediction of specialist resources productivity using historical productivity data provided as site feedback.

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ASSESSING VALUE FOR MONEY IN CONCESSIONS CONTRACTS: DEFINING AN IMPROVED FRAMEWORK

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ABSTRACT: Concession arrangements, also known as PFI, DBFM, DBFO or BOT, are a relatively new means of providing and managing infrastructure with private finance and can overcome financial and other bottlenecks associated with traditional public sector provision of infrastructure. Due to requirements towards accountability, concessions are in need of a correct assessment framework. As the argument for application of concessions is that these provide better Value for Money (VFM) compared to the public provision of infrastructure, VFM is the main criterion on which to account for concessions arrangements. The current method to assess VFM is based on benchmarking the financial gains of concessions with a Public Sector Comparator. In this paper, this method is analyzed on basis of literature. Critics on this method for VFM assessment are highlighted as well as directions in which future assessment methods for VFM should be developed.

Keywords: performance, public private partnerships, PFI, Public Sector Comparator

1. INTRODUCTION

Public facilities, resources and services known as infrastructure are vital to a nation's production and distribution of economic output as well as to its overall quality of life. Infrastructure is commonly taken to include roads, transport systems, communications, water and sewerage. These physical facilities are often collectively termed 'hard infrastructure' or 'economic infrastructure'. Infrastructure also includes what is sometimes called `soft infrastructure' or `social infrastructure'; schools, universities, research facilities, hospitals, libraries, public buildings and parks (WATIAC, 2004).

Traditionally, national government in most countries has been responsible for providing a wide and diverse range of infrastructure and its services, such as healthcare, education, justice, and defence. However, nowadays, many governments are deregulating and privatizing public-service delivery. Yet in infrastructure the entire transfer of responsibilities from public to private is not possible neither desirable. In answer, an alternative for deregulation and privatisation had to be found and the answer was concession arrangements (Winch, 2000).

Concession arrangements, also known as Private Finance Initiatives, are a relatively new means of providing infrastructure and can overcome financing and other bottlenecks associated with traditional public sector provision. In the latter the public sector itself is responsible for the design of the infrastructure, its finance and maintenance, while only the construction is contracted out to the private sector. It, however, has a reputation of not being organized in the best possible way (Dixon et al, 2005). There are claims that traditional procurement frequently leads to budget and planning overruns and long term technical problems. Concession arrangements are expected to be a solution for the problems described above. This form of providing infrastructure and its services is based on a scheme by which the public authority transfers the design, construction, operation, and financing of the infrastructure to a private organization.

Under concessions, the private sector finances the project and also has full responsibility for operations and maintenance. The contractual regime used to regulate the relationship between public authorities and private partners is the ‘concession’, which comes within the scope of public-private partnerships (PPPs). Characteristic for the concession variant of PPPs is the long-term duration for contract and the fact that maintenance and exploitation are outsourced to a private organization, the so-called concessionaire. Different variants have been developed around it. Of frequent occurrence are the Build Own Operate Transfer (BOOT), the Build Own Operate (BOO), the Design Build Finance Operate (DBFO), the Build Operate Transfer (BOT) and the Design Build Finance Maintain (DBFM). The private sector participation in concessions transforms the role of the public sector from being an owner of capital assets and direct provider of services into a purchaser of services through a long-term agreement. This is expected to generate different benefits over the traditional way of procurement. The magnitude of these benefits is expected to compensate the additional costs of having recourse to the private sector.

While concession arrangements are a means to implement public tasks and responsibilities and involve public money, the public sector needs to justify and explaining the application of concessions to the public. A valid accounting system proving the quality of performance and legitimate use of resources is a defining aspect of the public sector ethos and is gaining in importance in many countries. The increasing requirement for accountability in terms of performance and results can be seen as a driver of the development of assessment systems. In this paper, it is analyzed which assessment systems are applied to concession arrangements. It is the question of whether current methods to assess concessions are reliable to justify the application of private money and skills. In order to do so, first insights need to be gained in what the rationale for concessions is and what concessions are expected to deliver. The next step is to clarify the way accounting offices and evaluators demonstrate these benefits in practice. After that, these methods are analyzed by means of a literature study. Recommendations are made on how to improve the accounting system for concessions arrangements.

2. MOTIVES FOR CONCESSIONS

The introduction of concession arrangements for the provision of infrastructure can be seen as a reaction of the unfavourable financial position governments had been dealing with in several countries. National public agencies increasingly faced incapacities to finance the provision of public services such as infrastructure services. One of the causes is the increased pressure on public capital budgets since the Maastricht conditions of fiscal policy came into play (Owen & Merna, 1997). These monetary criteria restricted EU government’s deficits not to exceed three percent of their Gross Domestic Product (GDP) and their total gross government debt not to exceed sixty percent of the GDP. Thus, restricting both public expenditure and total debt became paramount political objectives. This is one of the explanations why concession arrangements came into play in many countries.

However, concessions are now increasingly justified in terms of delivering lower financial costs over the lifetime of an infrastructure project (Broadbent & Laughlin, 1999; Dixon et al, 2005; Edwards & Shaoul, 2003). Concessions are expected to provide certain benefits above the traditional way of procurement through the introduction of managerial change and expertise drawn from the private sector. In many countries the public sector is eager to utilize the private sector in the provision of public services. In the UK, the front-runner of concession arrangements, the involvement of the private sector for the provision of infrastructure is primarily justified on the basis that it is more efficient and more cost-effective than the public sector. This probably enhances significant improvements in performance and efficiency savings (Grimshaw et al, 2002; Field & Peck, 2003). These improvements are often capitulated in the term Value for Money (VFM), which is nowadays seen as the key rationalizing for concessions (Edwards & Shaoul, 2003; Broadbent & Laughlin, 1999). The Private Finance Treasury Taskforce (1997) presents a number of different dimensions on VFM.

The taskforce initially relates VFM in terms of savings that can result from the integration of and synergies between design, build and service operation. As the concessionaire is constituted of both the operator of the infrastructure service as well as a company responsible for designing and building the infrastructure asset, this should lead to more cost-effective designs. This is because the integration of the different phases of the infrastructure project is expected to encourage the concessionaire to make risky 'asset specific investments' that it would not be willing to make if it was contracting for an isolated phase. It is claimed that because payment to the private sector are linked to performance, there will be fewer instance of public sector projects costing more than originally estimated and being delivered years late (RICS, 2005).

VFM is also expected to be achieved by efficient working practices as the private sector will introduce innovations in service delivery (Broadbent et al., 2003; Edwards & Shaoul, 2003). Since the private sector will 'own' the infrastructure as well as running and maintaining it, it will therefore be more careful about design and build quality. This will result in an avoidance of over-specification ('gold plating') and a more efficient management of the facility. It should also lead to time saving by accelerating project development and by avoiding delays in project delivery (Li Bing et al, 2005). Furthermore, the intention of concessions projects is to allocate risks to the parties able to manage them at least cost. This means that certain risks are transferred from public towards private sector. This risk transfer operates as an insurance policy: if certain aspects of the project go wrong, the private sector will bear the cost, thereby encouraging greater efficiency on the part of the private sector (Edwards & Shaoul, 2003). It is expected to result in improved delivery of the asset with respect to time, cost and quality; improved maintenance of public infrastructure and better delivery of public services (Dixon et al, 2005)

Another VFM driver is the intensive exploitation of assets including the additional revenues from shared use of facilities and sale of redundant assets (PFP, 1997). In concessions the project scope is capable of expansion to reflect a broader context. This might permit the development of an integrated solution, such as binding several small projects formerly dealt with under different departments (school, library and recreation centre) into a single project, thus achieving economies of scale and therefore VFM (Li Bing et al, 2005).

Summarized, concessions are seen as a means of improving the public procurement process by means of VFM in the delivery of infrastructure. This is achieved by contracting the skills of the private sector in designing and managing this infrastructure projects and their services. The aim is to stimulate cost reducing innovation – either in the construction phase itself, or in the exploitation of the asset (Winch, 2000). The magnitude of these benefits is expected to compensate the additional costs of having recourse to the private sector.

3. ACCOUNTING FOR CONCESSIONS

Concessions represent a major and so far under-evaluated experiment in the delivery of social infrastructure (Thompson & McKee, 2004). Detractors of concessions argue that many of the gains fail to materialize and, in particular, that long-term costs are higher, structures are rigidified, and public sector continues to bear the risk promised to be transferred to the concessionaire. Various authors argue that the expectations of concessions are not answered and that benefits are unproven, specifically for the provision of social infrastructure. IPPR's report into PPPs (2001) investigated publicly available evidence comparing bid costs of concessionaires with public sector comparators. The results were mixed. Some projects for mainly economic infrastructure showed significant VFM in terms of prescribed methodology (Asenova et al, 2003). This was however less than the public agencies had estimated. Other concession schemes demonstrated more marginal savings compared to the traditional procurement (IPPR, 2001). Particularly concerns exist about concessions in the health and education sector. In health care concessions have been criticized for their complex and non-transparent decision making during the planning phase, the low standard of physical facilities provided once the project was completed and the lack of cost effectiveness (Asenova et al, 2003; Pollock et al., 2001).

Literature demonstrates similar results in the education sector (Ball et al, 2001). Audit Scotland (2002) released data about operational PFI schools and dismissed any final cost savings in concessions as 'narrow'. In addition, the Audit Commission (2003) compared twelve traditionally funded schools with seventeen school concessions and found that the quality of PFI schools was not as good as schools built by traditional procurement, while the best examples of innovation came from traditional procured schools.

It will be important for the public to engage in evaluations that elucidate whether concessions are gaining the benefits in the provision of infrastructure. Also public agencies are in the increasing extent drawing up new accounting measures for concession arrangements. The motivation behind this is to ensure better accountability for public expenditure by informing taxpayers and service users. Performance and quality management are becoming more central to the market-based management of the public service (Deakin & Walsh, 1996). However, there is widespread concern in the private and public sector, that the current process by which the VFM assessment for a particular project is determined has in many cases been highly problematic and lacking in transparency. It is questionable whether expectations of concessions can be met in social infrastructure. Insights need to be gained in the accounting procedures for concession arrangements and how VFM is to be assessed.

4. ASSESSING VALUE FOR MONEY

To ensure that decision making for concessions is based on a sound approbation of alternatives and that the option likely to deliver the best VFM is selected, an appraisal process is developed and applied. This process consists of several phases. It starts with a Strategic Outline Case in which an outline sketch of the project is prepared. Subsequently, an Outline Business Case is drawn up in which the service requirements are defined and different options are appraised. Finally a Full Business Case is drawn up, which consists of a definitive investment appraisal. The outline of the appraisal process is similar in most countries applying concessions. Central in this process is the comparison of discounted cash flows of different procurement options (public versus concessions) to select the option that suggests the greatest VFM. Besides the criterion of affordability, approval of the concession option takes place on VFM demonstrated up-front of the operation of the facility. VFM obtainment should be demonstrated in the documents prepared (Froud and Shaoul, 2001).

The diversity of concession arrangements and the potential they offer in terms of VFM are themselves challenges to evaluate VFM. Arrangements are not uniform and given the various manifestations of the arrangement, it is not surprising to find that the evaluation of a concession project is itself complex. Besides, the term VFM has an intuitive appeal, could have substantive meanings and therefore is ambiguous (Heald, 2003). This creates tensions in assessing VFM.

Demirag et al. (2004) define VFM as an examination to determine whether an organization is performing economic, efficiently and effectively (3E) in its use of resources, operations, procedures and pursuit of objectives. Although the economy aspects of VFM are relatively easy to quantify, assessing policy efficiency and effectiveness is more difficult. This is primarily because of the difficulties involved in measuring output and outcome.

In practice, for a variety of conceptual and methodological reasons, VFM audits imply 'examining PFI projects as they are agreed between the public sector clients and the private sector suppliers at the contract negotiation stage'. Only public sector costs are included as performance measures. Most audit offices take this narrow view in which VFM is restricted to the 'economy' dimension (Demirag et al, 2004).

Although some authors and organizations being cursed with performance measurement in concessions argue that there is no one best way of establishing VFM, in practice, there is a standard assessment method to assess VFM. In de Full Business Case (FBC) the concession option is compared with the variant in which the public sector would be responsible for the design, construction, finance and maintenance of the infrastructure asset. This public sector variant is called the Public Sector Comparator (PSC).

4.1. The Public Sector Comparator

In several countries a Public Sector Comparator (PSC) is used as a benchmark for establishing VFM. The PSC is a hypothetical construct and describes in detail all costs to the public sector, if the project was developed in a traditional way (Akintoye et al, 2003). Risks transferred to the private sector are added to the public variant to obtain the 'risk adjusted PSC' which is then compared with the concession bids (see Figure 1). The difference between the risk adjusted PSC and the concession bid measured in Net Present Value (NPV) is VFM and is demonstrated in the FBC. The FBC must identify and discount the future pattern of costs for the private financed option and the PSC to arrive at net present cost, the inverse of a net present value calculation (Froud & Shaoul, 2001). A PSC is always prepared in the development of a concession project, whether public funding is an option or not (RICS, 2005). In the UK and some other countries prove of VFM is required for proceeding a concession arrangement project.

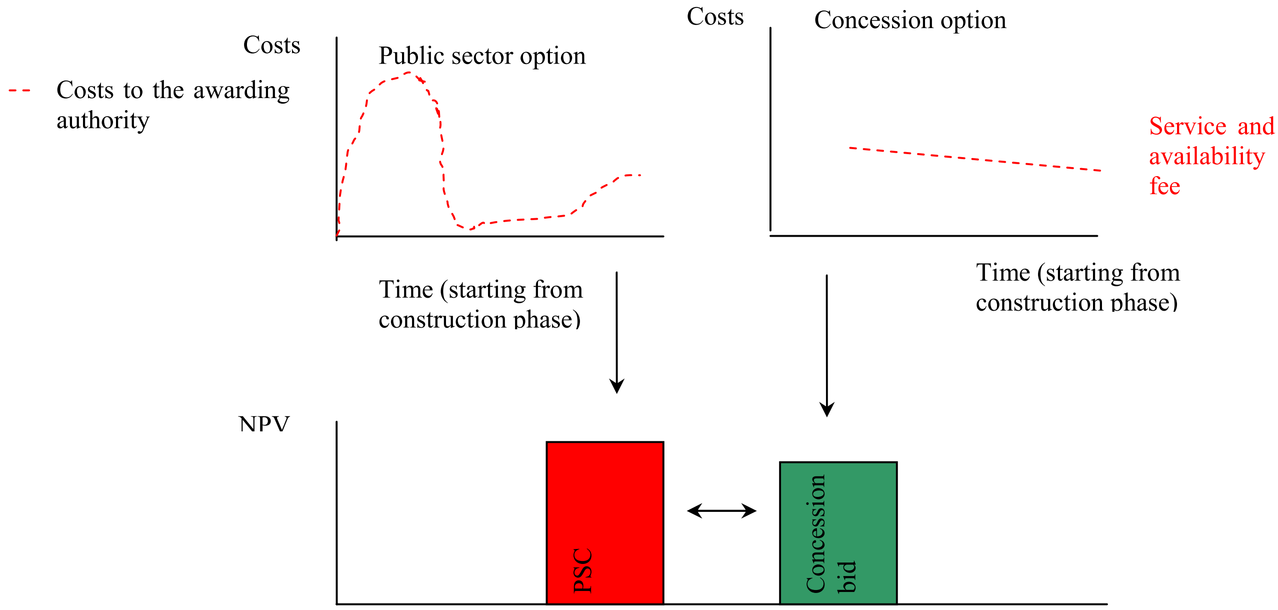

Figure 1. Comparing traditional finance option with the concession option

In return of providing the infrastructure requested, the concessionaire receives a fee. The fee tariff has two components: the charge for rental or 'availability' and the charge for the service element. The rental charge is broadly equivalent to the charges made for public assets. The service charge however, corresponds to services that used to be provided by the public agency and as such is impossible to identify in the accounts. The services to be transferred to the SPV should also be compared with the public agency 'normal' service provision. It is, however, difficult to establish proper comparison with what a public sector alternative would deliver.

Some authors raise concern about the use of the PSC and are of the opinion that its purposes are being overestimated. In the reports of the UK National Audit Office concerns are raised about the reliance that can be placed on the complex financial modelling required for the VFM appraisals (NAO, 2000). Other commentators have disputed many of the underlying assumptions and calculations of the various concession arrangements.

4.2. Critics on assessing VFM by the PSC

This paper argues that the current up-front assessment of VFM is insufficient to account for concessions arrangements in a right and transparent way. Both academic and policy evaluators observed deficiencies in VFM assessments during the FBC. These deficiencies are summarized below.

The first difficulty is related to the quality of information on which offers are compared with the PSC (Broadbent & Laughlin, 2003). Often, the information provided is incomplete and inconsistent. Vital information needed for comparison is frequently missing. Besides, researchers evaluating the appraisal process of specific concession projects sometimes found it difficult to gain access to the FBC. Due to commercial confidentialities documentation is not widely available resulting in that only parts of the FBC are accessible for the public. Even when researchers have access to all the information, they find out that due to negotiations during the appraisal process a number of revisions are carried through, while the PSC is not updated according to these new insights. This makes the judgments between concession bids and the PSC very trivial.

Another obstacle is the transfer of risk. By allocating some of the risks associated with the construction and management of infrastructure to the concessionaire, the public sector is expected to enjoy greater VFM than under a publicly financed alternative where, it is assumed, the public sector bears all the risk (Froud & Shaoul, 2001). Risk allocation therefore lies at the heart of the concession rationale. There is, however, a lack of comparative data of historical nature to assess probability and risk exposure (Akintoye et al, 1998), which hampers the process of allocating risks. In result, the definition, valuation and attachment of probabilities of risks is hollow. For example, in some cases it was found that the probability of a risk was the same for each year in the concession period, which is not correct. Significantly, there is no requirement to assess to what extent new risks are created by the use of concessions, such as those that may arise as a consequence of being locked into a long term contract where changes must be negotiated (Froud & Shaoul, 2001). The public sector is free to devise its own methodology in assessing risks. Since risk transfer is the main constituent of VFM, there should be a consistent reporting methodology that clearly identifies and presents all the project risks and attended costs. If a clear methodology does exist, it is not always strictly adhered to. Demirag et al. (2004) argue that VFM related to risk transfer is subjective. In most cases, conventional public procurement in the FBC provides greater VFM until risk is included in the analyses. In result, the margin of difference between PSC and concession option is often small (Pollock et al, 2002). Some authors even notice that the real function of the risk adjustment is to disguise the true costs of the concession and make it look a more efficient procurement route. This raises doubts on the objectivity of the risk transfer methodology used. Besides, the supposed risk transfer to the concessionaire is potentially meaningless as the government cannot allow essential public services to fail (Flinders, 2005).

Another difficulty of PSC benchmarking is the restricted time path VFM assessment is concerned with. VFM assessment by the PSC is aimed at a comparative analysis in the design and procurement stage of the concession arrangement. The PSC is therefore necessarily based on estimates of future costs and operates only at the point of procurement. In consequence, long term VFM effects of concession projects are still unknown. However, ex-post monitoring mechanisms such as parliamentary scrutiny are important for achieving VFM as well (English & Guthrie, 2003). The PSC does not provide possibilities for accurate estimates for costs over the long term. Besides, the application of concession arrangements is too recent for there to be many empirical studies evaluating VFM on an ex post facto basis. With respect to estimate future VFM, however, there is a considerable change that problems arise in obtaining data and observing effort and performance during the life of the contract (Edwards et al, 2004).

Competition in the procuring process is considered necessary for obtaining VFM. In some concession arrangements, however, no competitive tension was observed. In these projects only one or a few bidders had been announced, which endangered the competitive elements of the process. There are also reports of cases in which the contractor raised the price after becoming the preferred bidder (Glaister, 1999). This does not benefit achieving VFM.

Concessions are sometimes the only option available to public agencies (the only show in town), in particular in the UK. If alternative public sources of funds are not readily available, VFM tests against a PSC become less than real, with the public sector being pushed towards seeking the concession variant as the 'best and only' alternative in a restricted range of choice (Mayston, 1999). Most project managers know that they will only get permission to build their infrastructure if the concession scheme comes out cheaper, regardless of how marginal the supposed savings are (IPPR, 2001). This facilitates a biased assessment of VFM.

Another difficulty is the discount rate used. The different economic costs and time preferences of the alternative procurement system are expressed in a single rate known as the discount rate. This rate is economically significant in assessing VFM. The current rate as a basis to compare the procurement systems is subject to sustained critiques as being unrealistic (Pollock et al, 2002).

In conclusion, it can be said that the current method of assessing VFM is dominated by financial measures and criticized for a number of reasons. The process by which the VFM assessment is determined has in many cases been problematic and lacking in transparency. In our view, a restriction on NPV measures as applied in benchmarking the concession option with the PSC is an incomplete basis to assess a procurement system's superiority. This view corresponds to Froud & Shaoul (2001) who argue that benchmarking on the basis of financial measures alone is too narrow to be taken as any kind of approximation to rational resource allocation at a national level.

5. AN ALTERNATIVE FOR VALUE FOR MONEY ASSESSMENT

In this paper we argue that although VFM assessment by PSC benchmarking is needed for decision-making regarding the pursuit of concession arrangements in the pre-contract phase, there is a need for a more comprehensive assessment method giving emphasis to a broader definition of VFM. There is the an important short and long term question about whether concessions do generate benefits over time not only in financial terms but also according to criteria that goes beyond this perspective (Broadbent & Laughlin, 2001). Therefore, insights into the financial as well as non-financial measures of concessions are needed to be assessed in the long run. Accounting offices should extend their current pre-contract focus with a post-contract assessment of concession arrangements. Post-contract evaluation is needed to determine whether or not concessions actually produce the benefits promised and thus in practice delivers VFM (Edwards & Shaoul, 2003). This corresponds to the view of the UK Public Accounts Committee which draws the conclusion that there is a need for improved evaluation of concession arrangements in progress (Edwards & Shaoul, 2003). Such an evaluation involves an analysis to the extent in which the operational project deviates from the bid offered in the FBC. More specifically, this means that the ongoing performance of the infrastructure facilities and related management services should be compared to the proposed implementation on which VFM assessment is based. As such method has not developed yet the researchers suggest the directions and requirements of preferable evaluative systems to assess long-term VFM, based on a framework suggested by Broadbent & Laughlin (2003).

First, a future assessment method should link the output specifications defined in the FBC to the allocation of risk between the parties in practice (Dixon et al, 2005). Considering risk allocation, it is argued that a number of dimensions should be taken into account. The emphasis of the assessment tool is on analysis whether risk assessment and allocation is as agreed upon in the contract of the project (which is framed immediately after the FBC). An issue to be analyzed is whether the financial consequences of the risk allocation have been as expected (Broadbent & Laughlin, 2003). Many have expressed concerns as to whether risk does, in reality, get transferred to the concessionaire. These commentators point to instance where clear breaches of contract are not followed up by termination or even the imposition of contractually agreed penalties (Lonsdale, 2005). Researchers argue that assessments of risk transfer were best assessed post-contract, while some FBC assessments had proved disastrously wrong (English & Walker, 2005). In some cases, the public sector even became asymmetrically locked-in to the private sector. This means that the public agency becomes dependent to the concessionaire and empowers the concessionaire to engage in the relationship on the terms of its own choosing (Lonsdale, 2005).

Second, a focus on facilities management is important in the VFM assessment, while it provides insights in the operational effects of the infrastructure facility. An assessment whether the facilities provided through the concession arrangement achieve the standards intended for the payment is strictly necessary. More specifically this involves ensuring that the ongoing performance of the facilities management services and the infrastructure are properly reviewed and that any variation issues are appropriately managed (Broadbent and Laughlin, 2003).

Third, a non-financial benefit analysis should be conducted in order to generate insights in whether concessions are progressing to highlight any problems encountered. The intended non-financial measures or aspects should concentrate on those aspects which are typical for concession arrangements. For example, the social effects that arise from the partnership between the awarding authority and concessionaire can be integrated in such a design. After all, concessions ask for new attitudes for both public and private partners towards managing public infrastructure. Another element should concern the design of the built facility. The workability of the design for staff and customers is important to assess, while this has an effect on patients receiving health care or pupils receiving education. As cost-effective designs were one of the pillars on which VFM claims are based, the design implications should be assessed when the asset is in operation. Considering the long term nature of concessions the flexibility and adaptability of the design to changing circumstances and requirements are to be assessed as well.

Post contract VFM assessment, however, is dependent on the possibility to specify outputs up-front clearly and observe these during the contract (Deakin en Walsh, 1996). After all, the public agency will have to 'manage' the infrastructure project at distance. Contract outputs are currently formulated in general terms and this could enhance problems during the monitoring of the project, which will result in extra costs. Besides, it is obvious that information must be provided by the concessionaire in order to organize an efficient and effective monitoring process, while the diverse interests of public and private partners could end in information asymmetries.

Table 1. Framework for post-contract VFM assessment

VFM indicator	Operationalization	Focus of analysis
Risk transfer	Financial consequences of the risk allocation as appointed in the contract?	The way risks are allocated and financial consequences are distributed among partners in (unexpected) circumstances.
Facilities management	Services as provided achieve the standard intended for in the payment structure (in contract)?	On-going and active monitoring of performance of concessions arrangements. Analysis of the payment of service fee in relation to delivered performance.
Non-financial benefit analysis	Social effects of applying concessions	Views on partnering aspects of the concessions (awarding authority and concessionaire)
	Workability of design	Flexibility and adaptability of the built asset

6. CONCLUSIONS

Concession arrangements are promised to deliver benefits over the public variant of development and provision of infrastructure. These benefits are primarily expressed in terms of VFM. In this paper, we state that the use of VFM as key criterion for the assessment of concession arrangements is legitimate and can be realized in practice. A correct evaluation framework, pre-contract and post-contract, is needed to justify the application of these arrangements. The question is whether current methods to assess VFM in concession are sufficient for both pre- and post contract evaluation. As the current method of pre-contract accounting based on NPV measures on a project-by-project basis is subject to many critics a proper post-contract VFM assessment framework is extra needed.

We believe that accounting officers and evaluators of concession arrangements should focus at whether the concession delivers the benefits it promised in the FBC on the long term. Although the current benchmarking approach of concession options with a PSC can be questioned because of problems concerning objectivity, transparency and validation, a pre-contract VFM assessment tool should remain in operation. Pre-contract VFM assessment is an important tool in considering the concession alternative. The approval of the concession bid over the PSC and the implementation of a concession project is however no guarantee for obtainment of VFM, as several studies show. More emphasis should be placed upon the assessment of post-contract VFM aspects, such as risk transfer, facilities management in operation and other non-financial issues. In this paper, recommendations are given for building a post-contract assessment framework. In the next research phase, this framework will be applied to a number of social infrastructure projects in the UK and Australia.

Giving emphasis to financial as well as non-financial aspects in a new assessment method will improve the definition of VFM. Our view is that the development and implementation of such a method will contribute to the discussion on the merit and transparency of concessions for the development and provision of social infrastructure.

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RESULTS OF AN EXPLORATIVE RESEARCH INTO VALUE QUANTIFICATION METHODS

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ABSTRACT: This paper presents the results of an explorative research into value quantification methods called the Quick Scan. An overview of value quantification methods was needed in order to be able to establish the economically most advantageous tender, which in turn is needed for improvements in the Dutch construction sector. The Quick Scan project researched the literature, consulted experts and interviewed those involved in construction projects. Several value concepts and accompanying quantification methods have been found.

Keywords – Differentiation strategy, economically most advantageous tender, public value, quantification methods, value.

1. INTRODUCTION

This paper presents the results of an explorative research into value quantification methods entitled the Quick Scan. Context of this research is the ongoing effort to realize better ways of procurement and co-operation in the Dutch construction industry by enabling selection based on "economically most advantageous tender" instead of "selection based on the lowest price for a fixed and very detailed specification".

Section Two describes the theoretical background of value/price based selection is described in section two.

Section Three describes the approach of the Quick Scan approach. The results of this project are represented in section Four. Conclusions and recommendations are respectively discussed in section Five and Six.

2. BACKGROUND OF THE RESEARCH

2.1 Background

In the year 2002 evidence of collusion in the Dutch construction industry, especially in the sector of public works, caused great public outrage. A parliamentary enquiry committee concluded that radical measures were needed to overcome similar cases. Transformation institutes were installed and contractors that had made illegal price agreements were persecuted.

In the mean time one of the largest principals in the Dutch industry for public works, the Directorate-General for Public Works and Water Management, was already reorganizing and trying out new ways for procurement. Already, much earlier than the public outrage, it had concluded that the "selection based on lowest price in combination with a very detailed design brief" was contributing to unhealthy market dynamics.

Because of the tender regulations and moreover the way they are implemented, contractors were not able to distinguish themselves on anything but the lowest price. The motivation for creative and smart solutions was taken away and the already thin profits were becoming negative. Instead of fighting each other, the contractors decided to fight their main client by resorting to making price agreements, blocking competitors and dividing the market. This behaviour is in no way justifiable, but it is nevertheless understandable in the context of the vicious circle of price competition and with the absence of any possibility for other ways of competition.

2.2 Competitive strategies

Porter (1980) distinguishes between three generic strategies commonly used by business enterprises namely the Cost Leadership Strategy, the Differentiation Strategy and the Focused Strategy [URL 1]:

1. The Cost Leadership Strategy emphasizes efficiency. By producing high volumes of standardized products, the firm hopes to take advantage of economies of scale.
2. The Differentiation Strategy involves creating a product that is perceived as unique. The unique features or benefits should provide superior value for the customer if this strategy is to be successful.
3. In the Focused Strategy the firm concentrates on a selected few target markets. It is hoped that the needs of that target market can be met better by this specialisation.

Treacy and Wiersema (1993) have modified Porter's three strategies to describe three basic "value disciplines" that can create customer value and provide a competitive advantage. These are operational excellence, product leadership, and customer intimacy:

1. Operational Excellence provide reliable products for very competitive prices on a user friendly way.
2. Product Leadership is a strategy about technologically advanced products, quick commercialisation and constant improvement
3. Customer Intimacy is a very precise tailoring of the supply to a specific niche market. Thorough knowledge of the client and quick adaptation to the needs of the clients is needed. The focus is on customer's lifetime value, that can imply that initially, services are provided below production costs, because these costs will be compensated in later stages due to customer loyalty.

The tender regulations of public works prescribe two ways of selection: lowest price or “economically most advantageous tender”. Because the second way involves more than one selection criterion, it is often perceived as more difficult, or more difficult to account for. For this reason principals often fall back to selection based on lowest price and in doing so they blocking the differentiation strategy in doing so.

The customer intimacy strategy is also blocked. Because of tender regulation and the policy to stimulate market dynamics, public clients cannot afford to establish a long-term relationship with one supplier. This is deteriorated by the project based character of the construction industry.

Due to these specific conditions of the public works sector, the only available strategy left for suppliers is the cost leadership strategy.

2.3 Value-Price-Cost model

As a framework for analyzing transactions in the construction industry, De Ridder et al. (2002, 2004) have introduced the Value-Price-Cost model (Figure 1). The parameters in this model can be compared to the principles of neoclassical economics. Value relates to the willingness to pay for a certain object. In theory, the cost is the minimum amount a producer is willing to accept. The price is somewhere in between value and cost, dividing the total benefit into a consumer surplus and a producer surplus.

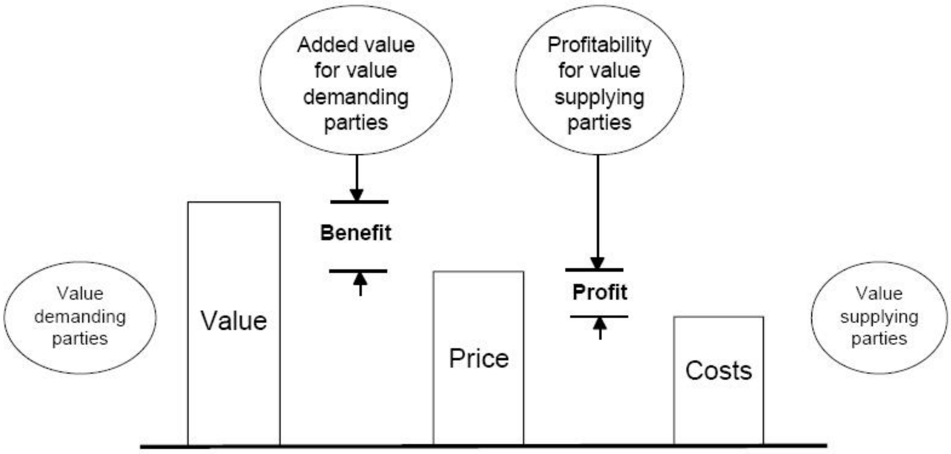

Figure 1: Concept of the Value-Price-Cost model

How to determine the value or "willingness to pay" is subject of this investigation.

2.4 Illustration of economically most advantageous tender

To illustrate the concept of selecting based on the economically most advantageous tender, Figure 2[1] has been constructed, using the concepts introduced in section 2.3. The economically most advantageous tender has to be located in the procurement space. The procurement space has three limits, which are all determined by the client; the ultimately available budget, the minimal value to price ratio and the minimal required value. The tender with the highest value to price ratio is the winner.

In this procurement system, suppliers are stimulated to think in the interest of the client and create value, one way or the other. Suppliers will need to anticipate on and interpret the question of the client; they need to imagine and ask what is of use to the client and think in the interest of the client and act accordingly; for most suppliers in the construction industry this will require new competencies.

[1] Note: it can be argued that this graph can be rotated 90 degrees clockwise, in order to conform to normal reading conventions. The authors have not chosen to do so since this picture is part of a larger graph of the section Building and Construction Processes of Delft University of Technology, with the dimension cost on the right side.

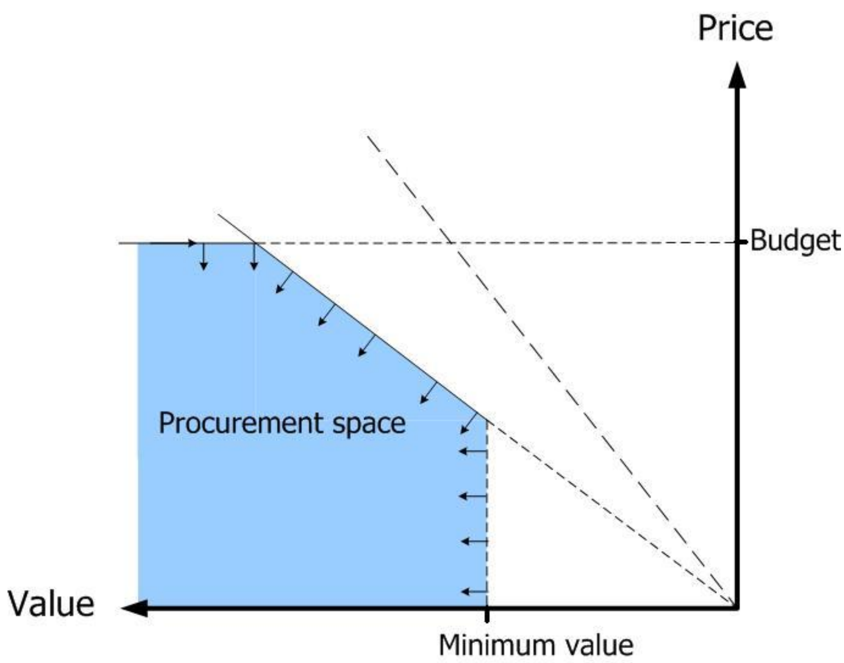

Figure 2: Economically most advantageous tender is measured by Value to Price ratio

It should be noted that economically most advantageous tender can also be used in a broader sense provided the word "tender" is replaced by the term "alternative". Selection based on the best value to price ratio should not only take place during procurement, but also during the phases of feasibility, design and use. When used in this broader sense, selection on economically most advantageous tender can play a role in the dynamic control paradigm.

The dynamic control paradigm is proposed to improve the Dutch construction industry (de Ridder, 2002, 2004). Under the dynamic control paradigm, client and supplier cooperate and an initial value to price ratio is agreed upon. In this regard the design is not fixed in the beginning because it is clear to al parties involved that the design will change in due course of the project. If changes occur, both parties will continuously try to find ways to maintain or even increase the value to price ratio. In order to be able to do this the measurement of value is needed.

3. THE RESEARCH

3.1 Purpose of this research

As described in section 2 there is a need for another way of competition in the Dutch construction industry, especially in the public sector. Instead of competition based on lowest price, suppliers should be able to apply the differentiation strategy. Theoretically this will mobilize and stimulate the creativity of the suppliers to match their production possibilities with the client needs. In theory, a selection based on the economically most advantageous tender will contribute to this end, but in order to determine the economically most advantageous tender, public clients will need to quantify (their) value in a justifiable, transparent and objective way.

As a first step towards a system for quantification of value, an explorative research into value quantification methods called the Quick Scan has been carried out. The Quick Scan has searched for value quantification methods and has examined the concept of value itself.

3.2 Research Method

Several research questions were formulated. The answer to these questions were sought via literature research, expert interviews (professionals originating from developers, public principals and knowledge institutes) and workshops in cooperation with several parties from the Dutch construction industry (two public clients, two knowledge institutes and two contractors were involved). A project team carried out the research and their work was evaluated by a steering committee.

4. RESULTS OF THIS RESEARCH

4.1 Definitions of value

The literature survey revealed research a lot of definitions of value as well as the meta-analyses about value were encountered (Bastiat, 1850) (Saxon, 2005) (Kamann, 2003) (Ramsay, 2005) (Boon, 2001) [URL 1]. In an earlier publication authors of this paper reported three general categories of value definitions; value as some absolute quantity, value as a ratio between the level of benefit and the price or value as the difference between the total benefits and the price (Dreschler, 2005).

The economics definition applies to this investigation. This does not mean the economical science can provide one single definition of value. A glance at the economical literature indicates that since the time of Adam Smith, the concept of value has been a popular subject for discussion.

In classical economics, value refers to "the innate worth" of a commodity. The value of a product is determined by the cost of production input (Smith; Ricardo; Malthus; Mill; Marx) [URL 4]. In another classical tradition, Marx distinguished between the "value in use" (use-value, what a commodity provides to its buyer), "value" (the socially-necessary labour time it embodies), and "exchange value" (how much labour-time the sale of the commodity can claim, Smith's "labour commanded" value.

In neoclassical economics, the value of a product is determined by the relation between cost and subjective factors [URL 5]. There is no value intrinsic to objects or things and value derives entirely from the psychology of market participants. Economists such as Ludwig von Mises asserted that "value" was always a subjective quality. Thus, it was false to say that the economic value of a good was equal to what it cost to produce or to its current replacement cost.

In this research, the value of a product, effect or project proposal is a subjective quality which is determined by to which extent the product, effect or proposal fulfils the needs of the evaluating subject.

4.2 Value concepts and quantification methods

Via literature survey, expert interviews and workshops a list of value concepts and corresponding methods has been collected. These concept and methods were placed on a list which became known as “The Matrix”. The list is too large to be included in this paper, but to provide a general idea, the heading of the matrix is included (Table 1).

This table is included to demonstrate that for each value concept more than one quantification method is possible. For each method, there is room for several characteristics.

Table 1: Table heading of the value concepts matrix

Value concept Description	Usage By whom?	Method + Source	Explanation + Remarks	Scale				?
				Nominal	Ordinal	Interval / Ratio	Monetary	Accepted?

5. CONCLUSIONS

5.1 Discussion about the concept of value

During the Quick Scan project, a lot of effort went into discussing the concept of value, associated terms and the role which it should play in the continuous effort to improve procurement and co-operation, especially in the public sector of the Dutch construction industry. It became clear that when talking about value, it's easy to have ambiguity about the concept of value, so it is important to come to a common understanding of the concept.

Furthermore, it became clear there is not an "intrinsic" of "objective" value. Value is always subjective. In a free market, transactions only occur because subjects have a different value perception of the product they are trading. What can be of great value to one person, can be worthless to another. It can even be said that the different value estimation or perception by economic actors is the corner stone for the economy.

5.2 Multitude of value estimation methods

A multitude of value estimation methods was encountered. To illustrate the different outcomes that these value estimation methods can produce, they have been applied to the case of a chestnut three, which has to move because of the construction of a road.

Table 2: Example of estimation methods (proxies, shadow prices)

Value concept	Estimation method
Recovery value	The cost for transplantation of the three
Replacement value	The total cost of purchase of a piece of land, replanting, years of maintenance, compensation for emotional damage
Production value	O2 production, CO2 absorption, production of chestnuts, leaves and shade
Environmental value	The function of the three in a habitat
Recreational value	The effort day-trippers put up with in order to enjoy the three (hourly wage * time)
Execution/liquidation value	Selling value timber -/- expenses
Cultural value	Cost + time an action committee puts up with in order

	to preserve the three
Market value	The price the three would yield in an auction
Historical value	Comparison of costs made in the past for comparable threes
Juridical value	The value for threes as appears from legislation/jurisdiction
Emotional value	The influence of the presence of the three on the psyche and wellbeing of persons, expressed in euros. Possible estimation methods: - Evaded costs caused by sickness - Change in production output of persons - The cost of replacing matters which increase wellbeing

With a little extra brainstorm, probably even more valuation methods can be found. This approach can also be applied to other projects and effects which are more relevant to the construction sector.

As shown by this example, the lack of valuation methods or tools is not the problem. It is the multitude of estimation approaches, the uncertainty on the authority of these methods and the ad hoc character of the application of these methods, which hampers value quantification.

So there is a need "best practices" in the field of value estimation. The best practices provide the answer to the question of the most appropriate method to use, as well as how and when.

5.3 Best practices

For some situations, best practices have been found. In the Netherlands for instance, the so-called "OEI leidraad" [URL 3], which was developed by leading economists by order of the Ministry of Public Works, is an accepted guideline for performing cost-benefit analysis of large infrastructure projects. But even then, the quantification of value is no hard science. There is plenty of room for interpretation and the result of the cost-benefit analysis will always depend on the made assumptions made.

Decision flowcharts which point out when what estimation method is to be used were encountered as part of the environmental economy literature (Ruijgrok, 2004; Pearce, 2002).

During the interviews, several point systems were encountered which had been used to establish the economically most advantageous offer. This lead to the impression that the shift towards selecting the economically most advantageous offer instead of selecting based on lowest price is already taking place. Suitable (point-) systems are being developed and gain legal momentum. Besides the lowest price, quality aspects enter the equation for selection and the influence of these criteria is becoming more and more important. Thus the possibilities for suppliers to distinguish themselves from their competitors seem to be increasing.

6. RECOMMENDATIONS

Considering which definition is being used is utmost important in order to prevent disruptions in communication when using the concept of value in a discussion or negotiation. In the context of this paper, the use-value occurs when a need or the wish of a client is fulfilled. The exchange value is the price for which a product changes owner. The total value for the client is determined by the expected use-values over the lifecycle of the product plus the residual exchange value at the end of the life cycle minus the additional costs.

When performing a cost-benefit analysis of large infrastructure projects, adhere to the principles of the "OEI leidraad"– a guideline for project appraisal, Outline Effects Infrastructure. The principles mentioned in the guideline can also be used for establishing the relative importance of design criteria, but for the more detailed design criteria, best practices still need to be found or developed.

Bringing the maturity of point systems to the next level. Point systems have been found as means of quantifying client-specific values. These systems seem to facilitate selection based on economically most advantageous tender and enable the desired differentiation strategy. So the use of these methods needs to be encouraged and promoted. An analysis of used points systems will provide insight in which functionalities are seen as interchangeable, how functionalities are quantified, why it is done in this way and whether the point system has contributed to success in terms of total benefit or not. Based on these insights, improved point systems can be developed. Because the point systems have been applied in practice, insight is gained into what extent they comply with the regulation.

The Centre for Procurement Expertise of the Civil Engineering Division of the Directorate-General for Public Works and Water Management has shown a very keen interest in this latter recommendation.

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THE DEVELOPMENT OF A CONTINUOUS IMPROVEMENT FRAMEWORK FOR LONG-TERM PARTNERING RELATIONSHIPS

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ABSTRACT: The sub-optimal performance of the global construction sector in the last two decades has led to its scrutiny. Accordingly, improvements in the efficiency and competitiveness of the industry through reforms in contracting, tendering, design process, and other areas had been advocated. This consequently led to steady flow of research, reports and analyses on the nature of the industry, its various components, systems and structures. One of the key findings is the effective use and management of inter-organisational project teams in enhancing project success, thereby resulting in enormous interest in collaborative approaches such as partnering. However, when new initiatives and techniques are introduced, the challenges of quantifying their impact on performance improvement arise. The difficulty of the evaluation increases with complexity, duration and multitude of parties involved in the procurement process. This paper aims at describing the methodology proposed for a PhD research underway to develop a continuous improvement framework for long-term partnering relationships. The methodology adopted for the research is a hypothetico-deductive approach that comprises of two main stages. First, the framework is conceptualised from the synthesis of literature and preliminary interviews while the second stage involves the empirical testing of the framework using triangulated methods for collecting and analysing data. The framework will consider the complete whole life cycle of a construction project; planning and design, construction and operational stages.

Keywords - continuous improvement, hypothetico-deductive, long-term partnering, NHS LIFT, research methodology.

1. INTRODUCTION

The global construction industry has been under intense scrutiny in the last 20 years, and this is set to continue as owners and users demand better value for money from a more sustainable built environment. ECI (2003) reported that the traditional arrangements for delivering long-term contracts in the UK seldom achieve best value and repeatedly fail to facilitate continuous improvement in both client and contractor performance. This is because cost and performance are driven by market forces rather than a sharing of risks, opportunities and objectives between the parties. As a result, improvements in the efficiency and competitiveness of the industry through reforms in contracting, tendering, design process, quality management, productivity, training, education and other areas have been advocated.

One of the key findings in the many research efforts is the effective use and management of inter-organisational project teams in enhancing project success (Abudayyeh, 1994; Albanese, 1994). Propagated by this enormous interest is the emergence of ‘partnering’, which is purported to be the major agent of change within the construction industry, focussed on eschewing traditional adversarial relationships between project parties to encourage relationships based on the principles of trust, mutual respect and cooperation towards the achievement of a common goal (Warne, 1994; CIRIA, 1999). Although it seems that the very essence of partnering is to provide platform for the contracting parties to continuously improve their performance for mutual satisfaction and benefits (Bennett and Jayes, 1995), practitioners face the challenge of how to embed and sustain its principles and practices into organisations (Thomas and Thomas, 2005). For the purpose of this research, continuous improvement is defined as "a purposeful and explicit set of principles, mechanisms and activities within an organisation adopted to generate continuous and systematic improvement in deliverables, operating procedures and systems by the people who actually perform these procedures and operate the systems".

However, when organisations adopt new philosophies, such as partnering or other collaborative approaches, they are usually faced with difficulties in measuring or quantifying the contribution that the new approach has made to the overall performance of the organisation (Giunipero and Brewer, 1993). Ibrahim and Price (2005) noted that the difficulty increases with the complexity, duration and multitude of parties involved in the procurement process and conceptualised a continuous improvement framework for long-term relationships, such as long-term partnering (LTP) arrangements. LTP has been defined by ECI (2003) as "the development of sustainable relationships between two or more organisations, to work in cooperation for their mutual benefit in the requisition and delivery of works, goods and/or services over a specified period to achieve continuous performance improvement". The LTP model that will be the focus of this research is the NHS LIFT (National Health Service Local Improvement Finance Trust) scheme, which involves participants from the public, private and voluntary sectors.

The overall aim of the PhD research is to develop a continuous improvement framework (including "what" and "how" to measure construction processes, products and services) in long-term partnering relationships. However, this paper aims at describing the methodology proposed for the development of the framework. The following sections describe the structure of the NHS LIFT scheme, the approach adopted for the research, the research process including the research methods used, the research scope; the use of the framework in measuring improvement; and finally a conclusion.

2 THE NHS LIFT

The NHS LIFT scheme is focussed at developing and encouraging a new market for investment in primary care and community-based facilities and services. It is expected to serve as the new engine both for improved quality of care provided and the environment in which it is delivered. To date, 51 projects have been approved under the scheme in four waves. As at December 2005, almost 50 facilities have become operational, and over 50 more are expected to open in 2006 (Department of Health (DoH), 2005). All the 42 LIFT projects under the first three waves have reached financial close, and several are proceeding towards second and subsequent financial closes, with a total capital value (for initial buildings) of over £700 million (DoH, 2005).

Under the LIFT scheme, the DoH has established a national joint venture (NJV), *Partnerships for Health* (PfH), with Partnerships UK plc (PUK) which is itself a public-private partnership (PPP. Subsequently a *private sector partner* (PSP), a consortium of diverse specialties, is identified through a competitive procurement and then a local joint venture (LJV) established between the local stakeholders, PfH and the PSP. The LJV (the *LIFT Company*) enjoys the benefits of a long-term partnering agreement to deliver investment and services in local care facilities over contractual period of between 15 to 20 years. Figure 1 shows the structure of a typical LIFT and the recommended shareholding limits.

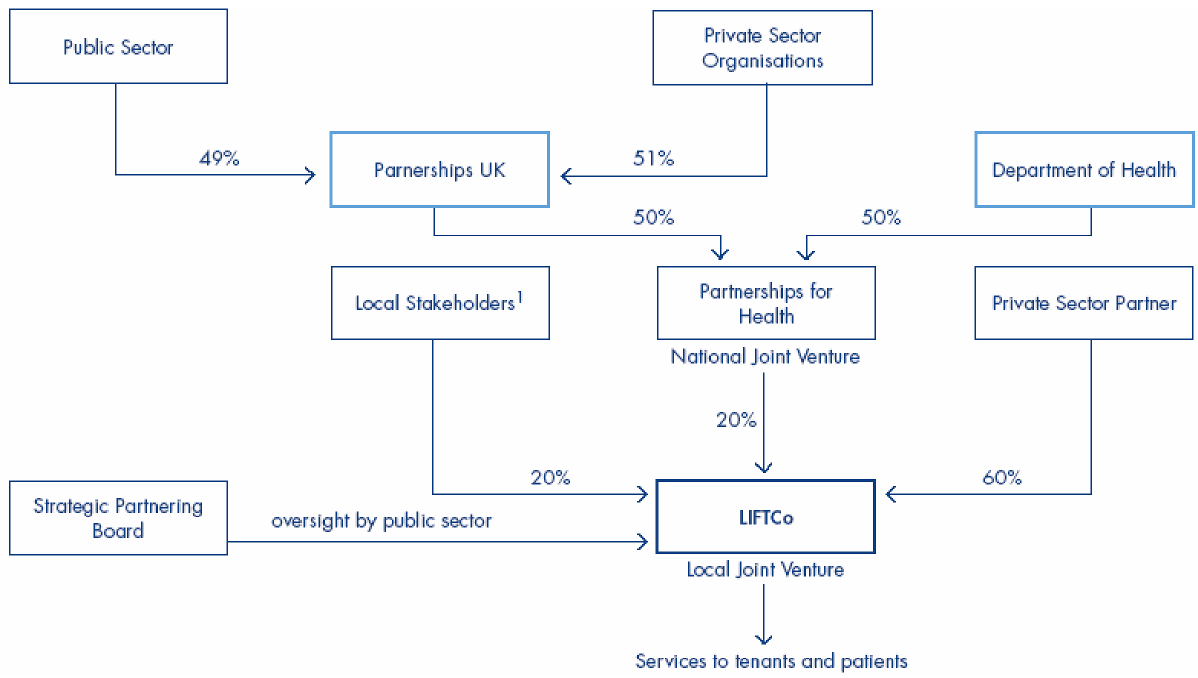

Figure 1: Structure of LIFT (Source: National Audit Office (NAO), 2005)

The local LIFT companies are set-up as public-private partnerships in the form of limited liability companies, and each is run by a management board comprising of directors nominated by the shareholders; the PSP, local NHS and PfH. They are structured to enable GPs or groups of GPs to be shareholders also. A public sector *Strategic Partnering Board* (SPB), formed between the core statutory bodies in the local health and social care community (i.e. Primary Care Trusts, Local Authorities, voluntary sector, etc.), through a *Strategic Partnering Agreement* (SPA) to develop *Strategic Service Development Plans* (SSDP), incorporating local primary care service needs and relationships with, for example, intermediate cares and local authority services. The SPBs are also responsible for monitoring the performance of the local LIFT companies and for identifying their future workloads. The local LIFT Companies are responsible not only for managing and implementing agreed investments and services, but also for planning future estate and services requirements to meet the local health economy's needs and developing opportunities identified by the private sector partners.

Like the Private Finance Initiative (PFI), LIFT is a way of accessing private money for public projects but unlike PFI deals, LIFT deals are based on the local LIFT Company owning the premises which it builds and refurbishes. Income comes from leasing space to Primary Care Trusts, healthcare professionals (including General Practitioners (GPs), pharmacists and dentists) and other interested social care or voluntary sector tenants (NAO, 2005). However, although the LIFT scheme has a contractual requirement for continuous improvement from the demand and supply sides, the attainment still remains elusive (NAO, 2005). Specifically, the NAO report was critical about the inconsistencies in the evaluation and performance measurement arrangements, and emphasized the need for strengthening of the accountability framework.

3. HYPOTHETICO-DEDUCTIVE APPROACH

Royer and Zarlowski (2001) advocated the use of a hypothetico-deductive approach in developing conceptual frameworks in doctoral dissertations. Under this approach hypotheses are formulated from existing principles and theories in literature and, subsequently, verified through experiencing and testing (Vittikh 1996). In engineering and management research, the hypothesis can be in the form of a conceptual framework that is verified through empirical testing (Royer and Zarlowski 2001).

In the light of this approach, this research has been divided into two stages. The first stage is the formulation of the framework based on the synthesis of a rigorous literature review and preliminary interviews. The second stage will be the empirical testing of the framework through triangulated data collection and analysis methods, where both quantitative and qualitative techniques are used to modify, confirm and validate the framework (Fellows and Liu 2003).

4. THE RESEARCH PROCESS

Based on the discussion in the previous section and in the light of the adopted hypothetico-deductive approach, a full research process was developed. This is illustrated in Figure 2 and subsequently explained below.

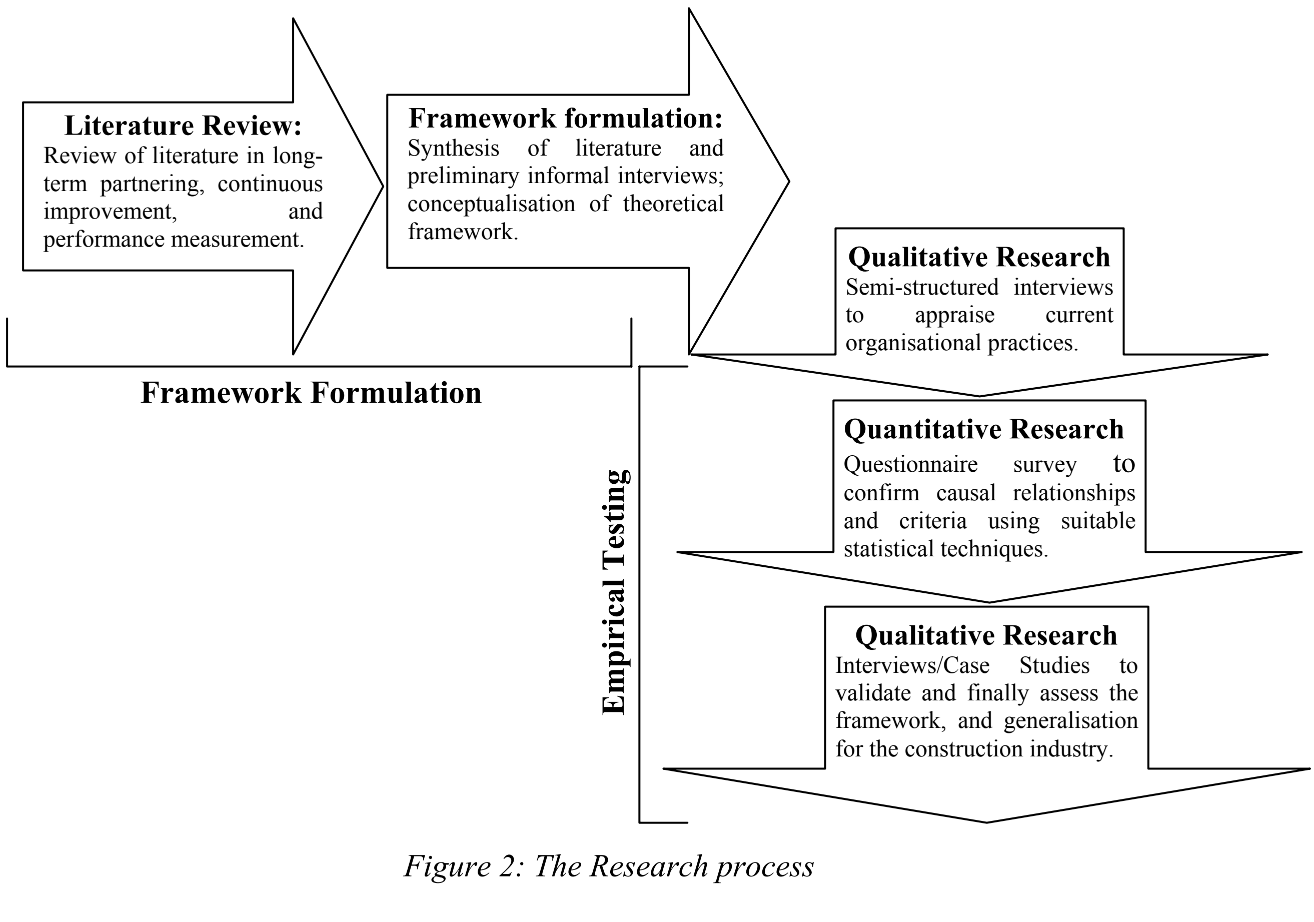

Figure 2: The Research process

4.1 Literature Review

Literature review is concerned with reviewing established theories, findings from other research and particular applications of theory (Fellows and Liu, 2003). Databases of journals, texts and conference papers were used, in addition to Internet searches. The search resulted in a bibliography of over 250 citations. For this research, the topics reviewed include: long-term partnering relationships; continuous improvement concept, principles and application; building performance measures/indicators/criteria and measurement systems, with a view to identifying gaps in knowledge and practice. These topics were reviewed in general and particular applications in construction.

This review served three main roles: first it provided a good foundation for the future of this research by throwing light on all relevant issues; secondly, it has made the contemporary issues more clearly while highlighting the gaps in knowledge and practice; and thirdly it acted as a basis for the formulation of the proposed framework that is discussed in the following sub-section.

4.2 Conceptual Framework Formulation Process

In formulating the conceptual continuous improvement framework, this research used Atkin *et al*. (2003)'s view on the definition of construction process improvement to conceive the theoretical framework. The aim of this objective is to facilitate a clearer understanding and diagnosis of the construction process towards ensuring proper measurement of any improvement initiatives. By synthesis of the reviewed literature and through three preliminary informal interviews with persons with hands-on experience on NHS LIFT procurement strategy, a theoretical framework was developed. The resulting framework for long-term contracts was reported by Ibrahim and Price (2005) and uses a three-phase process in a sequential process flow (see Figure 3). The continuum represented by the loops distinguishes long-term relationships from the traditional one-off contracts. These provide opportunity for performance improvement through feedback from lessons learned throughout the lifecycle of the relationships.

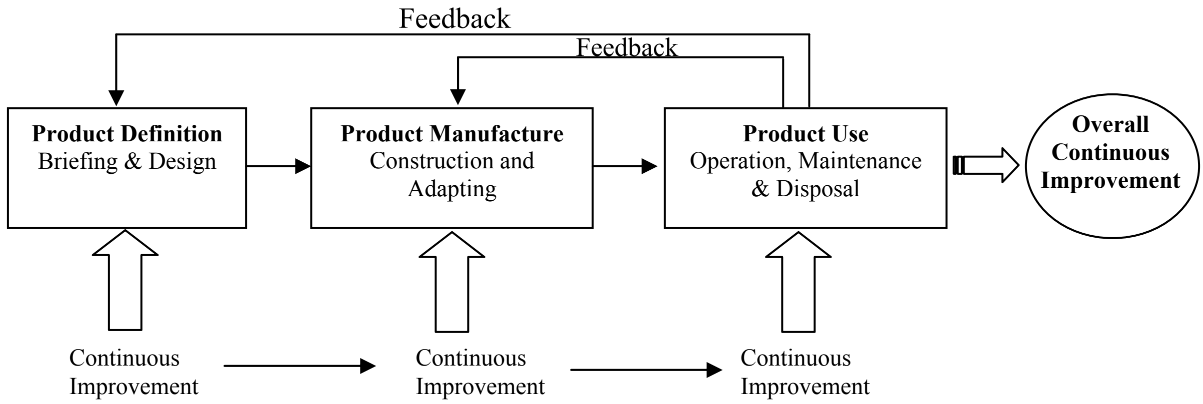

Figure 3: A conceptual model of continuous improvement (Ibrahim and Price, 2005)

The basic philosophy of the proposed framework is to assist organisations involved in long-term construction contracts in identifying performance gaps by analysing current operations, and through that, identifying the causes of gaps, and to generate and manage improvement activities targeted at closing the performance gaps. In so doing, a full-blown model will include both vertical and horizontal communication processes. The vertical communication includes both the top-down strategy-driven process of goal-setting and deployment of improvement initiatives and the bottom-up process of reporting the results to sustain the improvement initiatives through effective feedback mechanism. The horizontal communication process involves dissemination and exchange of results and experience obtained from performing improvement activities.

4.3 Interviews

Interviews are methods of collecting data through face-to-face or voice-to-voice interactive dialogue in order to discover the opinions or feelings of people on a certain subject (Hussey and Hussey, 1997). In general, there are three forms of interviews commonly used in business research: structured; semi-structured; and unstructured (Fellow and Liu, 2003; Hussey and Hussey, 1997).

Structured interviews are by definition very specific and include defined questions and limited probing. They are similar to a questionnaire conducted in person. In unstructured interviews, questions can differ among the interviews, the interviewer might not have questions prepared and can probe freely. In the middle of the above two extremes are the semi-structured interviews in which the interviewer has prepared some questions or a frame for the dialogue and is also free to probe when necessary. Because of the objectives of this study, the semi-structured type of interview has been selected in preference to structured or unstructured interviews.

Issues that will be investigated at this stage relate to improvement measurement practices. This will include determining whether:

1. Stakeholder (client, employees, investors, suppliers, alliance partners and community) satisfactions are measured.
2. The Measures used help in establishing whether the organisations have the right targets, right strategies for achieving the targets, the strategies are understood throughout the organisations, and whether the strategies are being implemented or need changing.
3. The measures used enable the establishment of whether the processes for developing the construction products are efficient and effective, service planning and delivery are efficient and effective, planning and management of the organisations are efficient and effective.
4. The measures used allow the establishment of whether the technologies, people skills, infrastructure and the best practices the organisations require are in place.
5. The organisations have formal quality improvement system in place. Here, formal quality certifications and specific quality initiatives implemented will be investigated together with how long they have been implemented in the organisation.
6. The organisations use any improvement tools/techniques. A list from literature will be provided but respondents will be given the opportunity to include any additional tools used. Here, the current level of use and the perceived level of importance will be investigated.

The sample of the interviews is initially planned to cover respondents at different management levels in 5-8 key stakeholder organisations amongst the functional NHS LIFT schemes. Following the interviews, an improvement measurement framework that will address the issues raised above and identified during the interviews will be developed, and this will be the subject of the questionnaire survey that will follow.

4.4 Questionnaire Survey

A questionnaire is a prepared set of questions in which respondents record their answers in an administered survey (Sekaran, 2003). The aim of the questionnaire survey in this research will be to confirm, reject or modify the causal relationships between the various components of the framework. Different aspects of conducting the questionnaire survey will be considered to obtain the best results in terms of statistical significance, validity and reliability. The design of the questionnaire will follow the widely accepted principles of formatting questionnaire layout described in Easterby-Smith *et al*., (2002) that include: starting with factual questions, then asking more opinionative questions; including instruction on how to answer questions; and varying the types of questions, while keeping similar types grouped together. The questionnaire will be used to assess the detailed theoretical framework and to obtain preliminary feedback on its usefulness, practicality, applicability and comprehensiveness.

A pilot survey instrument will be reviewed for content and facial validity by practitioners and academics. Feedback from the pilot study will be used to modify and clarify the wording and format of the survey instrument. One of the key issues that will be considered at this stage is the validity of making meaningful comparisons and generalisations if the respondents' experiences are not under similar circumstances or not linked to a specific project environment. Therefore, in order to obtain homogenous data set, the NHS LIFT scheme will be used as the typical model of long-term partnering relationship.

The basic framework and criteria of the *Achieving Excellence Design Evaluation Toolkit* (AEDET Evolution) already in use for evaluating NHS LIFT proposals (shown in Figure 4) offers a viable platform for the proposed continuous improvement framework, but with some expansion and restructuring.

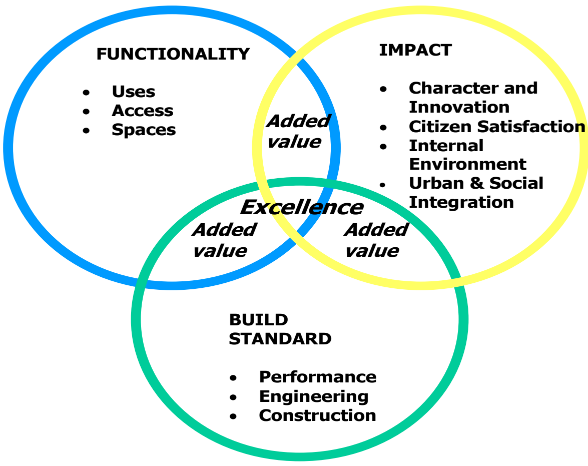

Figure 4: Basic framework and criteria for AEDET Toolkit (NHS Estates, 2005)

The expansion will recognise the intricacies and dynamisms of long-term partnering relationships amongst the stakeholders through the lifecycle of the relationships. This will require reactive as well as proactive measures (Shiba *et al*., 1993) involving the use of both lagging and leading performance indicators. Whilst the lagging indictors shows the final outcome of an action usually after it has been completed such as time/cost growth, the leading indicators predicts, with certain degree of confidence, a future outcome such as process cycle times. Although most of the information provided by lagging indicators may have come far too late to allow any immediate changes to be made, they may still be useful under long-term relationships. Leading indicators have been argued to be far more effective in driving forward continuous performance improvement (Atkin *et al.*, 2003). On the other hand, the restructuring will take cognisance of the purpose of the framework, which is for the evaluation of the continuous improvement of the processes, products and services in long-term partnering relationships.

Also, because it is often not possible to survey an entire population for practical and cost reasons, a sub-set or sample of the population will therefore be suitable for study (Brewerton and Millward, 2001). However, the appropriateness of sample size is generally not a straightforward decision and can sometimes be very complex. Nonetheless, different methods can be used to estimate the sample size, based on the statistical power required to report significance or non-significance accurately. For research based in the construction industry, Mbugua (2000) had outlined a rule-of-thumb dictating a minimum of 30 responses being adequate. The above considerations are relevant where the study population is infinitely large. However, where the study population is known, the rough formula provided by Easterby-Smith *et al.* (2002) for calculating sample size (n) in terms of the maximum error (E) required, as shown in equation (1) will be used:

$$n = \frac{2500}{E^2} \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \qquad (1)$$

Thus, responses for this research will be restricted to the stakeholders in the fifty-one (51) NHS LIFT projects approved in the first four waves.

4.5 Validation and Generalisation

Before the survey results are discussed, reliability and construct validity tests will be conducted to determine the appropriateness of the proposed classification. Cronbach's alpha (α) model, which measures the internal consistency, will be utilised for the reliability analysis. The values of alpha reflect the degree to which elements in a group are homogenous and the extent to which these elements are related to each other (Sekaran, 2003). The construct validity testing, which encompasses content, face, convergent and divergent validity, will be undertaken using qualitative and quantitative means. While content and face validities will be conducted through pilot survey, the convergent and divergent validities will be conducted using factor analysis.

Although the use of the above statistical methods for data analysis provides quantitative validation for the causal links of the framework, further validation is required. Pidd (2003) stressed the need for the scientific and professional community to show acceptability for any proposed framework. This research will therefore utilise expert interviews in selected case study projects to achieve the validation objectives.

Case studies are another qualitative evaluation method involving in-depth contextual analysis of similar situations in other organisations, where the nature and definition of the problem happen to be the same (Sekaran, 2003). Case study research can follow pure inductive or a mixture of inductive and deductive methods. The purely inductive method is used for building theory from scratch as in the case of exploratory research. However, the mixture of inductive and deductive methods is recommended if a prior theory exists and is more confirmatory in nature (Sekaran, 2003). The latter has been preferred by many authors even those who are proponents of the first method (Perry, 1994), and is therefore, used in this research. Within this method, a prior proposition is charted from literature, and evidence is sought to critically evaluate the proposition, either by substantiating or negating and thus, modifying it (Rowley, 2003; Sekaran, 2003). The theoretically formulated framework acts as the prior proposition and evidence is will be sought to either confirm or revise the framework.

The essence of this stage is to further identify the implementation bottlenecks that will facilitate the development of a practicable framework. The usefulness, practicality, applicability and acceptance of the final framework will be assessed within this step of validation through 5-6 semi-structured expert interviews each in three case study NHS LIFT projects.

5. USING THE FRAMEWORK FOR MEASURING IMPROVEMENT IN LONG-TERM PARTNERING CONTRACTS

The major stakeholders involved in a typical LIFT company include Partnership for Health the local health authorities/PCTs and various organisations that make up the private sector partners. The key driving objectives of these parties are quite diverse, could be conflicting and subject to change from project-to-project and at different times of the same project. This therefore necessitates the systematic development of the key value drivers of each project and during each improvement measurement exercise.

In implementing the framework, a procedure involving three converging levels is recommended. The first level identifies the evaluation phase within the whole life cycle of the project; the second level identifies the relevant performance categories; and the third level defines the elements of performance and equates them to the needs and goals as identified in the project key value drivers. The extent of attainment of the aligned project objectives can then be used as the criteria for determining areas that require improvement. The causes of performance of gaps will be identified and corrective strategies for closing the gaps generated and managed. This will rely on both vertical communication processes of goal setting, deployment and feedback and horizontal communication processes of exchanging results and experience obtained from improvement practices.

6. CONCLUSION

The need for a continuous improvement framework that comprehensively encapsulates the performance aspects of a construction facility has been advocated by many researchers and reviews. This is especially necessary for projects procured under long-term relationships. This doctoral research aims to develop such a framework for long-term partnering relationships and the paper in hand describes the research methodology followed. A hypothetico-deductive approach has been advocated and this divides the research into two stages: the framework formulation stage and the empirical testing stage. The first stage starts with a thorough literature review which formed the basis for the development of a conceptual framework. The second stage of the research process is concerned with the empirical testing of the framework and adopts a triangulated approach of research methods that includes interviews and questionnaire survey. Validation and assessment of the framework generalisation over various types of project organisations will be conducted via expert interviews/case studies.

The framework is expected to provide the construction industry with a tool that can be used to assess performance improvement in a more comprehensive way. It should assist managers in identifying specific problem areas and their effects on performance and thereby taking better and more effective decisions.

Although the proposed framework will have fixed main criteria and causal relations, organisations would have flexibility in defining project-specific indicators for each criterion. This flexibility substantiates the idea that it is a framework rather than a strict model. Nonetheless, it is possible and recommended to develop standard indicators for each criterion and consequently use the framework for benchmarking purposes.

7. ACKNOWLEDGEMENT

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THE IMPACT OF REAL-ESTATE INTERVENTIONS ON CORPORATE PERFORMANCE. CONCEPTUAL FRAMEWORK AND PRACTICAL EXAMPLES

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ABSTRACT: Several cases in which real-estate interventions have improved corporate performance are described in professional journals. The scientific literature, by contrast, contains few reports of research into the nature of effects of this kind. Such research meets with a number of problems. Effects are hard to quantify, because performance is a compound variable; and real-estate changes are almost always accompanied by organisational changes, making it difficult to explain any enhancement in performance found as (solely) due to the real-estate changes. A conceptual framework for the impact of real-estate interventions on corporate performance, based on theoretical assumptions and an extended survey, is presented in this paper. Corporate performance is defined and assumed relations between real estate and corporate performance are identified. The application of the framework is illustrated with reference to practical examples. The measurability of performance indicators and prospects for ongoing research are touched on briefly in the conclusions.

Keywords – Added value, corporate performance, corporate real estate, measurability of real estate interventions.

1 INTRODUCTION

The main function of corporate real estate is to accommodate people and their activities. During the past decade, however, increasing stress has also been laid on the role of real estate in contributing to competitive advantage and corporate image. This explains why the buildings erected to house similar organisations often look quite different. In the Dutch insurance and banking sector, for example, several concerns such as Interpolis (Tilburg), Centraal Beheer (Apeldoorn), ING Bank (Amsterdam) and INHOLLAND (Rotterdam) have recently invested large sums in the construction of distinctive modern offices (see *Figure 1*).

In general, however, organisations invest in new buildings because they hope that the increased real-estate costs will be more than offset by improved corporate performance. The key performance indicators vary according to the type of organisation involved. For example, the main function of industrial organisations is to produce and market products; that of banks and insurance companies is to provide (financial) services; and that of educational institutes is to turn out graduates with the necessary practical and intellectual skills.

The objective of the present paper, which is part of a large-scale ongoing investigation, is to enhance our understanding of how real-estate interventions can lead to improved organisational performance with special reference to Dutch institutions of higher education. The problem of how to measure such effects is discussed in Part 2 of the paper. A conceptual framework, based on theoretical assumptions and an extended survey, is presented in Part 3. This framework embodies a definition of corporate performance and relations that have been identified between real estate and corporate performance. It is used in Part 4 to study a number of practical cases taken from the field of education. The results of the analyses of Part 4 are discussed in Part 5, and finally the Conclusions (Part 6) include brief comments on the measurability of performance indicators and prospects for ongoing research.

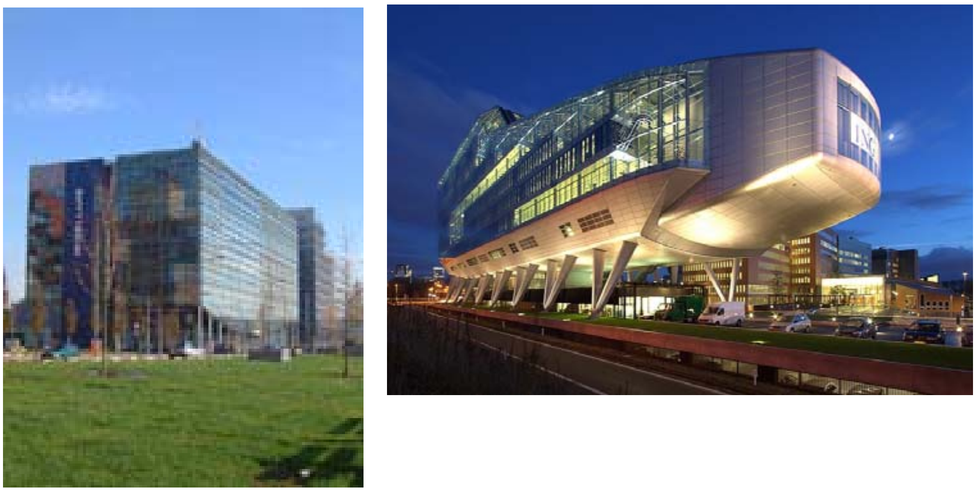

Figure 1. Inholland Rotterdam (photo www. Arcitectuur.org)
ING House Amsterdam (photo www.larscape.nl),

1.1 Example: the Coca Cola Case

An interesting example of the way real-estate intervention can improve corporate performance is provided by the case of Coca Cola's Dutch Sales Centre South (de Vries, 2002), which is responsible for the sale of Coca Cola products in the southern part of the Netherlands. Plans were made to increase the profitability of this sales centre by decreasing costs and/or increasing revenue. These plans involved both modification of the centre's organisational structure and rethinking the accommodation strategy for management. Changing the organisation from a hierarchy into a matrix structure led to increases in effectiveness. Giving each manager his own office caused accommodations costs to rise but also improved management productivity by 40% within a single year. Calculations showed that the increase in revenue far outweighed that in costs. There were no other changes in the organisation or its environment. It may thus be concluded that, in this case at least, real-estate investments combined with changes in the organisational chart led to a marked increase in productivity. Managers who were interviewed stated that their new offices were as important to them as their new tasks, and appreciably enhanced their motivation.

1.2 General information requirements

Any study of the influence of real estate on organisational performance will encounter three major barriers. Firstly, no definition of organisational performance exists which covers all aspects of performance. This issue is dealt with in Part 2 below. Secondly, the impact of real estate cannot be isolated from that of other variables like capital, technology, human resources and ICT. Real-estate interventions are generally realised in combination with changes in one or more other corporate assets. And thirdly, the influence of real-estate intervention is hard to quantify because suitable indicators are lacking.

The last-mentioned problem is visualised by the Corporate Real Estate Management (CREM) information demand matrix of Den Heijer & De Vries (2004) shown in Fig. 2. This matrix is based on the definition of CREM as the range of activities undertaken to attune corporate real estate optimally to corporate performance. The four blocks shown at the centre of Fig. 2 represent the four management functions involved in any decision relating to corporate real estate: general management, asset management, facility management and project management (including cost control). The four outside blocks contain the information each management function requires in order to take a well-based decision on any CREM issue. In many cases, much of this information is not routinely available at present. For example, inspection of Fig. 2 shows that the performance indicators used by general management do not usually include real-estate figures; and if they do, the real-estate performance indicators are not linked to the corporate targets and objectives.

The information demand was inventoried and assigned to one of the management functions on the basis of the analysis of several benchmark initiatives. The model was completed and validated in panel discussions with the real-estate managers of a number of institutes of higher educational in the Netherlands.

Most used benchmarks shown in Fig. 2 relates to one or two management functions, such as investment cost per m2 which is used in project management. This information is insufficient for strategic decision-making, however, since it focuses on efficiency to the exclusion of effectiveness. As the Coca Cola case in section 1.1 showed, the most expensive organisation can also be the most effective or productive one.

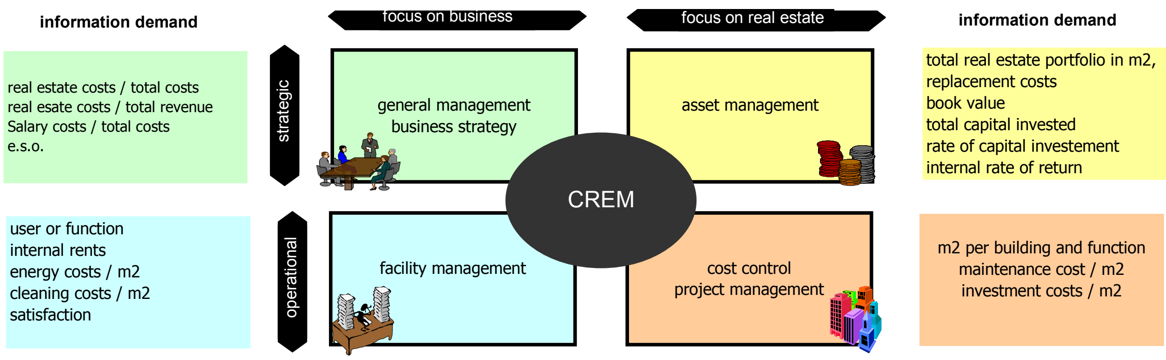

Figure 2: CREM Information demand matrix (Den Heijer & De Vries, 2004)

According to the CREM information demand matrix, benchmarks need to be at least three-dimensional and must be related to general management targets. One aim of our research into the impact of real-estate interventions on corporate performance is to pinpoint the parameters that are useful in this respect.

2 CORPORATE PERFORMANCE

Our next task is to choose an appropriate definition of organisational performance. In management theory, an organisation is perceived as a unit producing a desired output with a certain input. It uses resources such as labour, technology, ICT, capital and real estate to this end. As illustrated in Fig. 3, the output is determined by the resources available, under the influence of specific effects such as organisational culture, structure, leadership and the goals of the organisation. This explains how different organisations can produce different outputs while using the same input. The task of management is to make the right choice in the use of scarce assets.

Organisations strive for continuity, the most important requirement for the realisation of which is a positive balance between costs and benefits. This financial result was traditionally called organisational performance, and organisations were – and still largely are - judged by their bottom line.

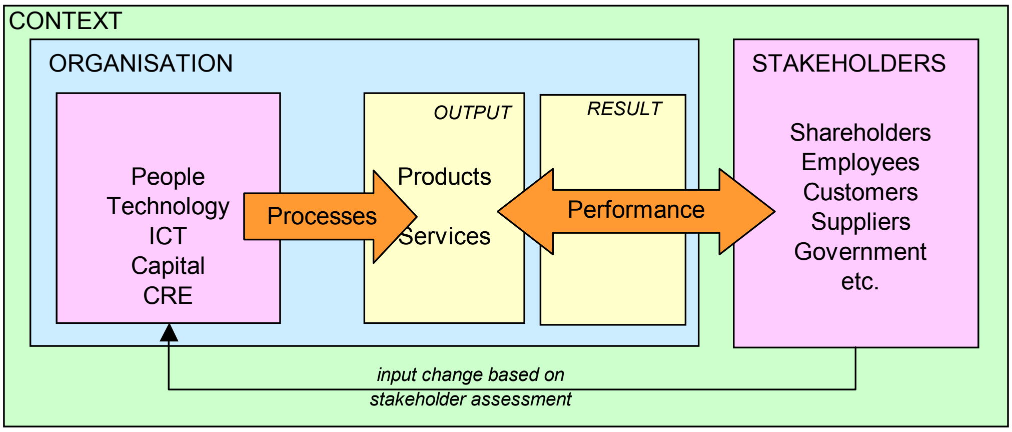

Fig. 3: Input –output model of organisation

Nowadays, however, many more ratios (such as organisational growth, turnover, and market share) exist with which one can express an organisation's performance. More immaterial factors like image and employee satisfaction are also considered relevant, as organisations increasingly set social targets while still striving for continuity. As a result, new parameters are needed to give a better insight in all aspects of organisational performance. Krumm and De Vries (2003) stated in line with Kaplan and Norton (1996, 1998, 2001) that cost reduction and revenue growth are the key elements for organisational performance. Tangen (2005) reviewed publications on organisational performance taken from both the academic and trade journals over the past 30 years, and developed a model (shown on the left in Figure 4) that illustrates how productivity, profitability and performance are related to each other.

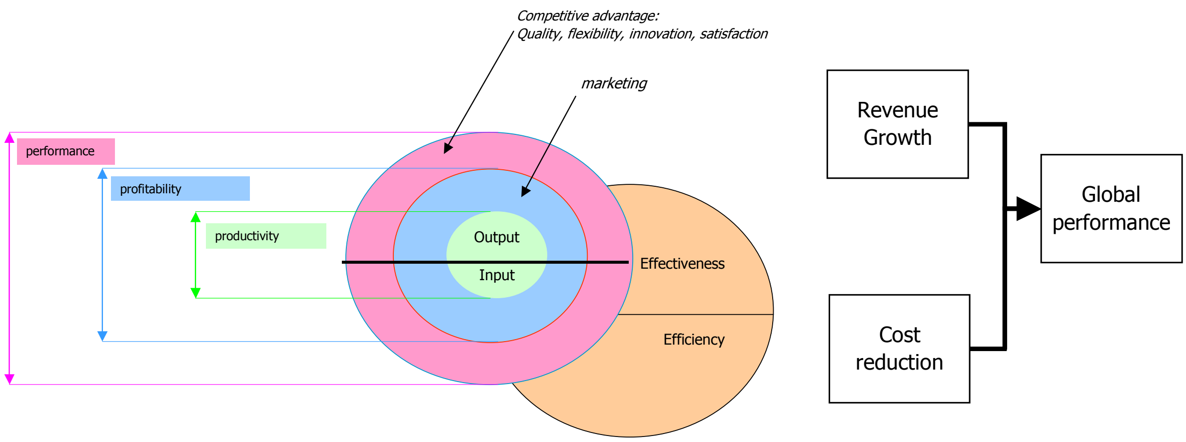

Figure 4: Triple P model (Tangen, 2005) on left, combined with Krumm and De Vries model (2003) on right

Tangen concludes that performance is a compound variable embodying competitive advantage or excellence, profitability and productivity. This can conveniently be combined with the Krumm and De Vries model (shown on the right in Fig. 4), in which profitability is the result of income minus costs, cost reduction is influenced by productivity and revenue growth is based on competitive advantage.

Combination of the triple P model and the input – output model leads to the theoretical view on organisations used in the present study (Figure 5).
Here, profitability is measured by the difference between costs and benefits, competitive advantage by (developments in) market share and productivity by the quotient of input and output. The last-mentioned factor is the most difficult to quantify, especially when the organisation concerned is a service provider or an educational institute. The most all-embracing view is that in which changes in input (assets) are related to changes in output (performance).

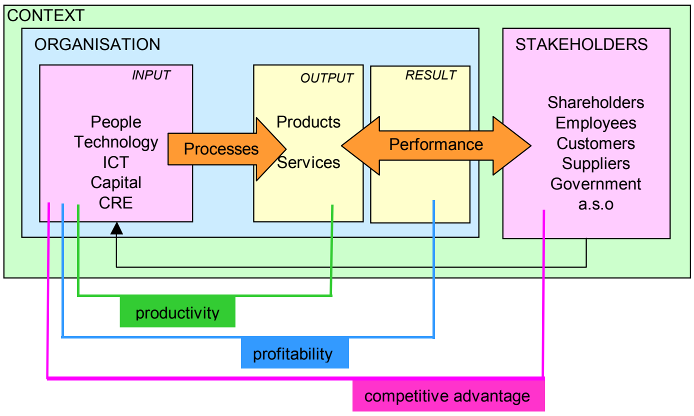

Figure 5: Theoretical model of organisation used in present study

3 TOWARDS A CONCEPTUAL FRAMEWORK

With the aid of the model derived in the previous section, we can now start to build up a conceptual framework that will allow us to investigate how real-estate interventions can contribute both financially and in other ways to organisational performance as defined above. First of all, however, we must take a closer look at the nature of real estate and real-estate interventions.

3.1 Added value of real estate

Real-estate interventions are carried out to achieve a better fit between demand and supply in the real-estate portfolio of the organisation concerned and contribute to corporate performance in some way. In terms of the definition of organisational (or corporate) performance as a function of competitive advantage, profitability and productivity given in the previous section, real-estate interventions must contribute to one of these aspects. A number of authors have analysed real-estate interventions in the scientific literature. The components of these interventions as mentioned in three publications are summarised in Table 1. Two further columns in this table give a composite view of the conclusions cited, and the aspect of corporate performance (competitive advantage, profitability or productivity) affected by the component in question.

Nourse and Roulac (1993), the first authors cited in Table 1, stated that multiple rather than single real-estate strategies may be required to support a range of corporate objectives effectively. They listed eight types of property strategies that might contribute to the overall success of an organisation.

On the basis of empirical studies, De Jonge (1996) presented seven ways in which real estate can add value to the business. These are also shown in Table 1, together with the conclusions of van de Voordt (2003) in his '3 circle' model that increased employee satisfaction leading to higher labour productivity are the elements needed for good organisational performance.

Table 1: Intentions of real-estate strategies and aspects of performance affected

RE Strategies Nourse and Roulac ('93)	Adding Value De Jonge ('96)	3 Circles Van der Voordt ('03)	Composite view used in present study	Aspect of performance affected
Minimise occupancy costs	Decrease costs		Decrease costs (real estate, occupancy, total)	Profitability
Facilitate and control production, operations, service delivery Facilitate managerial process and intellectual work	Increase productivity	Increase labour productivity	Increase production Increase labour productivity	Productivity
			Increase innovation	Profitability, Productivity, Competitive advantage
Flexibility	Increase flexibility		Increase flexibility	Productivity, Profitability
Promote human resources objectives	Stimulate culture		Support culture	Productivity, Competitive advantage
		Increase employee satisfaction	Increase employee satisfaction	Profitability, Productivity, Competitive advantage
Promote marketing message promote sales and selling process	Increase PR and marketing		Support marketing/ PR	Competitive advantage
Capture the real estate value creation of business	Increase value of real estate		Increase financing possibilities	Profitability
	Decrease risk		Decrease risk	Profitability

Combining all these results, we find that there are nine distinct real-estate strategies that contribute to competitive advantage, profitability and productivity and hence to organisational performance, and that the choice of strategy depends on the environment within the organisation.

3.2 Synthesis of the conceptual framework

Combination of the input-output model given in Fig. 3, the organisational model of Fig. 5 and the real-estate intervention strategies listed in Table 1 leads to the conceptual framework of Figure 6. This shows the input vector, comprising all the various sources of added value, on the left. It indicates the place of the different real-estate interventions in the organisational structure, under the influence of the common and specific context, and shows the output vector symbolising organisational performance as perceived by the stakeholders on the right. While the framework displays the hierarchy of and the relationship between all variables, and relates cause and effect within the common context, it provides no quantitative insight into the interrelationship between interventions and does not allow their consequences to be predicted. As we shall see below, however, it is a useful guide to research in this field.

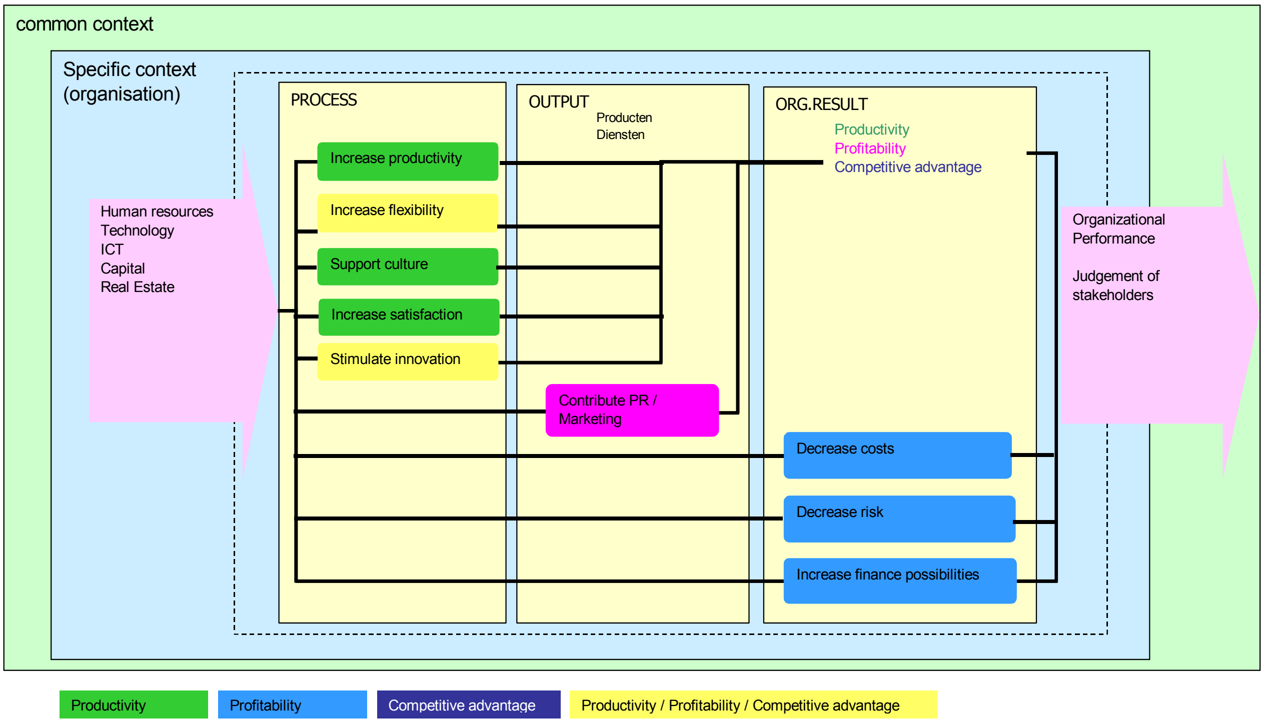

Figure 6: Conceptual framework for study of effect of real-estate interventions on corporate performance

4 IN SEARCH OF EMPIRICAL EVIDENCE

We will now use the conceptual framework derived above to analyse three cases which form part of a programme of ongoing research into the effect of real estate interventions on organisational performance. These cases have been selected from nine in-depth studies of the effect of real-estate interventions in Dutch institutes of higher education. A brief overview of the nature of the real-estate intervention, its objectives and the change in corporate performance subsequently observed is given for each of the three cases, while the key performance indicators are summarised in tabular form.

4.1 Changes in common context

In 1994, the Dutch government gave *hogescholen* (institutes of higher (professional) education) economic and legal responsibility for the management of their own real estate. From then on, the performance of these schools has been influenced by real-estate decisions. In the same period the government stimulated, and in some case ordered, a large number of mergers. These changes led to enormous investment in real-estate renewal. Now, in 2005, the long-term effects of these investments are visible. All *hogescholen* are comparable from an organisational point of view, and they all have the same goals – basically, to produce an appropriate number of graduates in various professional fields. Their market development is comparable, and they are all subject to the same governmental rules.

An extensive survey among all *hogescholen* in the Netherlands shows the quantitative changes in their real-estate portfolios in the period 1997 - 2002 (Table 2). The population included 47 institutes. A questionnaire was sent to all 47, and 16 replied. These 16 respondents represent 65% of the total number of students in all *hogescholen*. The questionnaires have been supplemented by interviews with real-estate managers and corporate managers. The interviews deliver the qualitative data which supports the quantitative data from the questionnaires.

A number of trends may be derived from the results of this survey: there was (1) an increase in the number of students and (2) an even larger increase in real-estate costs, while there was (3) a large decrease in the number of institutes, (4) a very small decrease in the amount of available floor space and (5) a decrease in the total number of buildings. Not only real-estate objectives but also the organisation of real-estate had changed in the period under review.

Table 2: Core data (De Vries, 2004)

	1997	**2002**	**Change**
Total number. of students	176,395	205,221	+ 16%
Total number of institutes	27	16	- 41 %
m2 available floor space	1,459,000	1,441,000	- 1 %
Total number of buildings	246	204	- 17%
Real estate costs (NLG 1,000)	233,522	322,259	+ 38 %
Corrected for inflation	*279,840*	*322,259*	*+ 15%*

To gain a deeper insight into the real-estate interventions than that given by Table 2, the interventions were classified as follows: (1) new building(s), (2) renovation, (3) functional adjustments, (4) regular maintenance, (5) only necessary maintenance, and at portfolio level (6) (de)centralisation of the accommodation and (7) reshuffling of the portfolio.

Table 3 shows how the main real-estate interventions of each of the respondents fell into these classes. Seven institutes had centralised their portfolio. Two of the 16 institutes had only performed necessary maintenance in expectation of total real-estate renewal, while most had carried out regular maintenance.

Table 3 Real-estate interventions carried out at Hogescholen, 1997-2002

	No Real estate (RE) portfolio changes	Centralisation of RE portfolio	Decentralisation of RE Portfolio	*Total*
New buildings				
- Total	-	2	-	2
- Partial	-	2	1	3
Renovation *(technical and functional adjustment)*	-	-	-	-
Functional adjustment	1	1	1	3
Regular maintenance	5	1	-	6
Necessary maintenance	1	1	-	2
Total	*7*	*7*	*2*	*16*

4.2 Case 1: Minimal real-estate intervention

The first case concerns an institute that had undergone a merger for the last time in 1998. At that time, management attention was focused on the educational process, staff reorganisation and cost reductions. One of the former partners had planned to construct a new building; this plan was postponed due to the merger. In order to reduce costs, only necessary maintenance was carried out. In retrospect, it appears that cost reductions were not realised. Postponing the new building work left the existing educational buildings less attractive; as a result, the total number of students increased less than in the best case considered (14% as compared with 21%).

Table 4: Key performance indicators (Case 1)

Performance indicator	Quantity measured	1997	1998	1999	2000	2001	2002	Trend or assessment
Size	Students	15,840	16,503	17,309	17,879	18,537	18,021	+ 14 %
Cost reduction	Occupancy costs (x € 1,000)	9,500	9,900	10,400	10,600	12,700	12,400	[redacted]
	Total costs (x € 1,000)	88,000	94,000	102,000	111,000	127,000	132,000	[redacted]
Productivity	Real estate productivity (students / m2)	0.11	0.12	0.12	0.13	0.13	0.12	0
	Organisational productivity (total number of students / new students)		25	21	31	28	-35	decreasing
Profitability	Cost / benefit ratio	-	-0.6	3.3	5.4	1.6	5.8	good
Competitive advantage	Market share	-	5.2	5.1	5.0	5.2	5.0	bad

4.3 Case 2: Move to a new central building

In the second case, a new building had been developed to increase educational synergy (such as cooperation between faculties) and lower costs through more efficient use of assets. The new building was situated near a railway station and replaced 14 smaller (and older) buildings scattered throughout the same neighbourhood. Thanks to the convenient location and the attractiveness of the new development, the total number of students increased by more than 15 % in the first year after the central building opened (before 1997) , while at the same time the overall number of students nationally increased by 2 % .

Apart from the new building, there were no changes in organisation, operational management, curriculum or teaching philosophy. It may therefore be concluded that the change in organisational performance was due to the real-estate intervention. Time-series analyses revealed that the intended educational synergy and lower costs had not been achieved. Housing all teaching staff in one building gives no guarantee of synergy. There was poor interaction and communication between staff from different faculties, since they were accommodated in one- or two-person offices in separate wings of the building. There was thus nothing to stop the old "closed-door" culture from continuing unchecked.

Occupancy costs were not an issue in the decision-making process during the development stage. The new building is much more expensive in use because of high energy consumption, high cleaning costs and the fact that more students use the building and the facilities than planned.

The student intake fell back to average after one year (1998), and after three years (2000) the overall increase in student numbers was below average for the study population as a whole, leading to a decrease in income. This, combined with the relatively high occupancy costs, led to poor financial performance. The favourable cost/benefit ratio was due in part to postponing even necessary maintenance work to avoid exceeding the budget.

Table 5: Key performance indicators (Case 2)

Performance indicator	Quantity measured	1997	1998	1999	2000	2001	2002	Trend or assessment
Size	Students	15,858	16,462	17,092	17,924	17,486	17,048	+ 8%
Cost reduce	Occupancy costs (x € 1,000)	14,600	16,100	17,000	18,000	16,000	15,600	
	Total costs (x € 1,000)	73,800	82,000	85,000	97,000	107,000	103,000	
Productivity	Real estate productivity (students / m2)	0.17	0.18	0.18	0.19	0.19	0.18	0
	Organisational productivity (total amount students / new students)	-	27	27	22	-40	-39	decreasing
Profitability	Cost / benefit ratio	-	1.2	4.1	4.7	2.1	5.2	good
Competitive advantage	Market share	-	3.7	3.4	3.5	2.9	3.0	bad

4.4 Case 3: Partial renovation and centralisation

In the final case considered here, buildings on two campuses were partially renovated. This educational institute also resulted from mergers. During the first years of the new organisation's life, management attention was focused on organisational and educational processes. Real-estate renewal was planned sequentially and was intended to provide optimal support for educational change and new concepts. Management did not limit their attention to the costs aspect in real-estate decision-making: other aspects like image, support for the institution's mission and other corporate objectives were also taken on board.

The different real-estate solutions realised on campus show that the faculties themselves were responsible for managing their real estate.

All organisational objectives were realised during the period covered by the study. Comparison of the key performance indicators with those for other cases also gave favourable results.

Table 6: Key performance indicators (Case 3)

Performance indicator	Quantity measured	1997	1998	1999	2000	2001	2002	Trend or assessment
Size	Students	15,484	15,839	16,400	17,661	18,164	18,701	+ 21%
Cost reduce	Occupancy costs (x € 1,000)	-	11,000	9,800	10,100	12,000	11,000	
	Total costs (x € 1,000)	-	97,000	100,000	105,000	118,000	130,000	
Productivity	Real estate productivity (students / m2)	-	0,12	0,12	0,13	0,13	0,13	good
	Organisational productivity (total amount students / new students)	-	45	29	14	36	35	increasing

Profitability	Cost / benefit ratio		-1.4	0.8	1.5	1.2	1.3	good
Competitive advantage	Market share		4.8	4.9	5.2	5.0	5.3	good

5 DISCUSSION

The cases described above show the impact of contextual change, organisational behaviour and (incorrect) decision-making on the attainability of organisational objectives. All performance indicators improved in case 3, and case 1 performed better than case 2 with respect to the growth in the number of students. In case 1, postponing real-estate intervention in order to improve financial performance actually led to a decrease in staff motivation and site attractiveness, subsequently resulting in a drop in income and ultimately negative performance. Case 2 illustrates the facts that concentrating staff and activities does not necessarily creates synergy, that failure to include occupancy costs in decision-making can lead to nasty financial surprises and that a new building's attractiveness to students can be short-lived. Finally, case 3 shows that organisational objectives can be achieved when real-estate decisions are aligned with organisational policy and organisational context.

The tabular summaries of key performance indicators (Table 4 - 6) did not include measures of staff or student satisfaction, since such data was not available. The growth in profitability shown in all cases is due to the fact that occupancy costs were based on fixed budgets.

These three cases show that not paying attention to real estate or effects of real estate interventions can have adverse effects on corporate performance. Case 1 indicates that staff and student satisfaction and image can be damaged by postponing real-estate interventions. Of course, the facts that centralisation of staff and facilities in a new building was found in case 2 to lead to poor financial performance or to postponed maintenance, and that partial renovation and centralisation led to an increase in market share in case 3, do not mean that such findings will be universal. Many more cases will have to be considered before firm conclusions can be drawn.

The performance indicators in our conceptual framework also show that competitive advantage may be associated with both good and bad results with regard to profitability and productivity. This means that the effects found in the present study are not causally determined, and that other variables also influence the ultimate result. More insight is needed into the hierarchy and dominative aspects of the effects of real estate interventions.

6 CONCLUSIONS

Neither the literature nor the cases investigated here provide conclusive evidence for causal relationships between real-estate interventions and changes in corporate performance. However, the three cases we have studied do give plausible indications that such effects can exist. In particular, the fact that the move to a new central building in case 2 was the only noticeable change associated with a short-lived increase in student intake to well above the national average suggests strongly that in this case at least a real-estate intervention did affect corporate performance. (Though theoretically, of course, there could be other reasons.)

A great deal of work needs to be done before firm conclusions can be drawn in this field. The many external influences need to be quantified or excluded, and performance indicators will have to be found that will lend themselves to the achievement of measurable results. The performance indicators currently used for productivity, profitability, and competitive advantage are quantitative, and need to be replaced by qualitative ones. Furthermore, the real-estate interventions employed need to be tailored to fit the organisation, the objectives and the people concerned.

Ongoing research in this department makes use of chronological progression analyses to give insight into the interdependence of the different variables concerned and the effect of organisational context. Cross-case analyses of as many cases as possible involving the same intervention, the same performance trends and the same context can shed light on the actual ways real-estate intervention influences corporate performance in qualitative terms and can also lead to the development of new, more suitable performance indicators.

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TO WHAT EXTENT IS THE CAPITAL MARKET NEEDED IN LIBYA

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ABSTRACT: In order to have a healthy economy there is a need to have a variety of financial markets, such as money markets and capital markets. These consist of two main markets; the primary and the secondary markets.

Libya has made remarkable strides towards economic reforms and is courageously facing the new trends of change and involvement in the global economy. On the other hand, there is only a primary market available in Libya in which the private companies are selling their issued shares. Most of these companies are unable to sell the shares issued for financing the capital needed and as a result, there short and long-term investment opportunities are hindered. It could be perceived that the absence of a secondary market in Libya might constitute a major barrier for the private companies' ability to sell the issued shares.

This paper attempts to answer the question "To what extent is the capital market needed in Libya?" The data is collected by personal interviews. More than twenty interviews have taken place with Libyan experts from Government, Banks, Companies and Academia.

The paper concludes that it is very important for Libya to establish a capital market but the main problem toward it is because the environment is not yet suitable.

Keywords: Capital Market, Economic Reform, Investment, Libya and Privatisation.

1. INTRODUCTION AND BACKGROUND

According to Blake (2000), every advanced financial system is composed of participants, securities, markets, trading arrangements and regulations. The Securities (sometimes called investment products) traded in the financial markets. Any financial transaction creates securities, which are simultaneously a financial asset (to the holder) and a financial liability (to the issuer). It can classify Securities in many ways. For example, classify according to: their issuer or their ownership and their income payments (Blake, 2000).

An organized financial market is a place where securities are created and transferred. Financial markets might be classified in a number of ways such as, Money v. Capital markets and Primary v. Secondary markets. The money markets deal in securities with less than one year to maturity whereas the Capital Markets deal in securities with more than one year to maturity. The primary market is the new issues market. When an investment bank brings a new company to flotation, its shares are issued on the primary market. If this company subsequently decides to gear up by issuing bonds, these are floated on the primary market. Similarly, if a company decides to expand using either equity finance or bond finance, the additional shares or bonds are floated on the primary market. The secondary market is the market in which existing securities are subsequently traded.

Any market is expected to play an important and significant role in the process of economic and social development through the collection of individual and institutional savings and provide the required source of finance for existing and potential investors (Blake, 2000). The development of the capital markets is measured in a number of ways such as; the number of stock exchange listed companies, market capitalisation and intensity of the use of the securities markets also by the relationship between market capitalisation and GDP. In recent years, a number of developing countries, concerned with the International Finance Corporation (IFC) and the World Bank, have taken steps to establish capital markets. The volume traded in these markets has grown rapidly; in a number of cases, the market is already larger than in some developed European markets. These emerging Capital Markets now in existence in approximately fifty countries are being monitored and reported on by IFC, whereas in 1996 over 60 developing countries had stock markets compared with half the number in 1985 (Blommeston, 1997).

The growing importance of stock markets around the world has recently opened a new avenue of research into the relationship between stock market development and economic growth. For example, (Murinde, 1994) gives a summary of recent work on emerging stock markets, which include 17 studies taken between 1985 and 1993, in addition to more recent studies such as; Abdullahi (1993) and Al-Shayeb (1999).

Libya has recently started taking many steps to being a Market economy. The path of transition from planned economy to market economy is not easy for any country, but the best thing is that there have been a number of similarities in the way in which a lot of other countries have gone through the transition to market economies. This allows us to look at how such economies develop and also learn something about what we need to ensure it works smoothly. Although, there are many successful factors of the new Libyan programmes, on the other hand, there are many obstacles toward it; the important one is the absence of the capital market that is because of the important role it plays in economic development.

The establishment of the first stock company in Libya goes back to its independence in 1951. When the Libyan commercial Code (LCC) enacted, in the year 1953, it allowed trading of stocks. But stock trading found its way in Libya by the beginning of the nineties of the previous century, which witnessed a substantial increase in the number of stock companies. Now Libya, as with many other countries has made remarkable progress in privatising their enterprises by transferring ownership from the state to private citizens. This has created a lot of new shareholders. Libya needs to develop the stock market and related institutions to handle the large volume of share trading that is likely to occur after privatisation.

In July 2002, the Libyan General Peoples Committee (LGPC) issued the decision no (49), concerning the executive regulations of the Law No (21) for the year 2001. The articles (48-50) of this decision allow the establishment of a stock market in Libya. Based on this decision and by decision no (242) for the year 2003, the committee gave the Libyan central bank the right to establish stock market, but by decision no (105) for the year 2005 it cancelled that right and gave it to the Libyan General Peoples Committee for economy and trade.

This paper is trying to examine "to what extent the capital market is needed in Libya". It attempts to answer the main four questions. The first question, "what are the results of the absence of a capital market in Libya?” The second question "what is the expected role of capital market in the Libyan economy?” The third question, "How will the capital market work in Libya?" and the last question, "will the level of disclosure of Libyan companies be an obstacle towards establishing a capital market in Libya?"

The paper is organized as follows. Following the introduction, the second section briefly describes Libyan economic reform. The third section discusses perceptions of Libyan experts about stock markets in Libya while the final section provides some conclusions.

2. LIBYA AND LIBYAN ECONOMIC REFORM

Libya is part of the Arab world, which occupies a strategic geopolitical location in North Africa as it links Eastern with Western Africa and Southern Europe with the rest of Africa. It occupies nearly 678,400 square miles and is located along the Mediterranean coast of North Africa. It has a population now of almost six million (about 15% non-nationals) most of whom are concentrated in the costal strips of Tripolitania and Cyrenaica where most agricultural activity takes place. A large part of Fezzan in the south is part of the Sahara Desert. The Islamic religion and Arabic language are two elements that characterise Libyan culture (Azema, 2000).

2.1 Libyan Economic Characteristics

The United Nations Development Programmer's (UNDP), in its Human Development Report, classified Libya as a medium-developed country, ranked 59th out of 162 countries in the human development index in 2001 (UNDP, 2002) also as 61st out of 175 in 2003 and 58th out of 177 in 2004 (UNDP, 2004). Table no. 1 illustrates Libyan per capita income over many years between 1970 and 2003 and also gives some key economic and monetary indicators.

In general the main five economic characteristics of the Libyan economy are:

(a) Heavy dependence on the exports of crude oil for exports receipts and Government revenue.

(b) A relatively small private sector and a tradition of strong public sector ownership of the means of production and as a main driving force in the domestic economy.

(c) The limited availability of natural resources other than hydrocarbons and the natural water supply is scarce.

(d) A very low degree of self-sufficiency in most requirements except hydrocarbons

(e) A limited domestic labour force and its low involvement in most basic production activities because of cultural and social mores and constraints;

Table 1. Main Economic Indicators in Libya

Years	Population	G D P in M. Libyan Dinar (At Current Prices)	Per Capita income (Libyan Dinar)	Contribution of the oil sector to GDP	Ratio of oil exports to total exports
1970	1,963,000	1,288	656	63.6%	98.25%
1980	3,246,000	10,554	3,251	62.3%	99.96%
1990	4,844,000	7,750	1,600	37.4%	94.41%
2000	5,427,000	17,775	3275	30.2%	95.61%
2003	5,827,000	28,007	4807	56.4%	96.00%

Source: Central Bank of Libya, Annual Reports 1980-2003.

2.2 Libyan Economic Development

The Libyan economy was one of the poorest countries in the world and the country was suffering from a budget deficit, when it declared its independence in 1951. The population was engaged in agriculture and animal husbandry and Industries mainly focused on processing the local agriculture products such as flour, textiles, tobacco, footwear, and clothing.

The Libyan economic situation had changed after the discovery of oil in 1959 and the need for direct foreign subsidies declined as international oil companies began to invest in Libya. The investment in the oil industry brought a surplus to the country's economy in general. The Libyan economic system was mainly capitalist. Private ownership existed with minimum governmental interference. Public ownership was in sectors that required large-scale investment (Abusnina and Shameya, 1997).

Since the revolution in 1969, the country has changed from capitalism to socialism. State intervention in the economy has increased and the government has started expanding the public sector and cutting back the private sector. The State ownership structure of businesses started in the early 1970s, gained momentum in the mid-1970s and reached its peak in the 1980s where most of the businesses became owner or controlled by the state.

Whilst the Libyan economy was characterised by its central control and authority policies, some private companies emerged and started to operate in Libya in the 1990s. This was mainly due to the crises the Libyan economy had faced in the late 1980s and 1990s as economic conditions and standards of living worsened as world oil prices slumped. In response to these crises, the State introduced a series of liberalisation measures including a significant role for the private sector.

Libya looks forward to World Trade Organisation (WTO) membership with the aim of achieving diversification of its sources of income, economic development, the attainment of economic benefits and the consolidation of good trade and economic relations with WTO member states, for the accomplishment of economic development for all. Libya first applied to become a WTO member in December 2001; Libya's last application was received by the WTO on 10 June 2004. On 27 July 2004, WTO members (148 countries) agreed to start talks with Libya on its membership bid and the General Council established a Working Party. It has not yet submitted a Memorandum on the Foreign Trade Regime.

2.3 Review of Libyan Economic Reform

The Libyan economy suffers many negative aspects; the Libyan government introduced a series of reforms in order to restructure the economic sectors to allow expanding the base of ownership and allow direct participation of the private sector in economic activities.

From the beginning of the last decade, the state issued a number of legislations, which regulate the economic operation. This started by unifying the exchange rate, which stopped the informal market and smuggling of foreign currency. In addition to cancelling Import and Export Licenses in order to facilitate for individuals, corporate bodies and companies to practice economic activities. This improved the role of banks in economic activities and increased the size of the commercial operation and competition. At last, in a bid to spur trade and make the country a free trade, last August, Libya lifted all duties except for cigarettes and these duties replaced by 4% taxes called service import taxes.

In more specific terms the Secretariat of the General Peoples Congress (the Libyan parliament) enacted, for example, the following Economic laws:

1. The Law concerning the encouragement of foreign capital investment (law no 5 of 1997). This law modified by Law no 7 for the year 2003.
2. The Law concerning the practice of economic activities, specifying the tools for practicing economical activities exemplified in individuals and public companies (law no 21 of 2001).
3. The Law regarding regulation of Transit Commerce and Free Zones (law no 9 of 2000).
4. Banking Law (law no 1 of 2005).
5. Law on Combating Money Laundering (law no 2 of 2005).

Also, the General peoples Committee (the Libyan government) issued several Economic regulations, such as;

1. The decision concerning the executive regulations to the Law organizing the work of agencies (decision no 178 of 2001).
2. The decision concerning organization of Import and Export (decision no 2 of 2002).

3. The decision concerning the executive regulations of Law no (5) for the year 1997 (decision no 21 of 2002).
4. The decision concerning opening of representatives' offices for foreign companies in Libya (decision no 8 of 2005).
5. The decision of the GPC for economy and trade organizing arrangements of registration of branches and offices for representing foreign companies (decision no 737 of 2005).

2.4 Libyan Privatisation Programmes

As in most countries, privatisation is a much-debated subject in Libya. While many countries have moved fast, despite such debates, to privatise state-owned enterprises, Libya has been relatively slow in privatisation; it might be faster in these years. The road to privatisation in Libya would be far from easy. Initially, laws and regulations covering privatisation will have to be drawn up and enacted. If privatisation is to be attempted in the oil and gas sector- a stated priority - a new petroleum law that the government has been drafting for several years will also need to be finalised and passed. Privatisation will be hampered by the extensive red tape and bureaucratic practices that have become entrenched in Libya over the past three decades.

In 1987, the Libyan General Peoples Committee issued decision no (447), concerning the transfer of ownership of government plants to employees. That was the first step of the Libyan privatisation programme. Based on this decision to the end of the year 1994, the ownership of 145 plants and productive units had been transferred to employees. In addition, according to decision no (9) for the year 1995, the ownership of 295 plants had been transferred to employees.

In June 2003, in a speech to The Libyan People's General Conference "Libyan Parliament", Colonel Moamar al Gaddafi (Leader of the Libyan Revolution) called for the wholesale privatisation of the country's vital oil and other industries. Meanwhile, trade and economy Minister Shukri Ghanem had been appointed prime minister to start a new privatisation policy in all sectors (Alexander's Gas & Oil connections, 2003). Before the end of 2003, the government of Libya announced its intention to privatise 360 plants in the industrial and agricultural sectors in five years (Decision no. 313 for the year 2003). Table 2 illustrated the numbers of plants planned to privatise by sectors and phases.

Table2. The Libyan Privatised Plants by sectors

Sector	Phase 1	Phase 2	Phase 3	Total
Industrial sector	145	41	18	204
Agricultural sector	28	4	24	56
Animalism Fortune Sector	71	0	11	82
The Sea Fortune sector	16	1	1	18
Total	260	46	54	360

Source: The Libyan General Peoples Committee decision no (313) for the year 2003.

The ownership of 260 factories will be transferred from the public sector to the private sector immediately. The factories will be transformed into shareholding Companies in which employees and others will be able to own shares. The government also decided to exempt the privatised institutions from income and export taxes for five years. During the grace period, the factories will be able to import equipment and raw material needed for their production without paying any fees (ABQ Zawya Ltd, 2003).

3. THE METHODOLOGY

3.1 Data Collection Method

In social research, the main methods of the surveys data-collection are personal interviews, postal questionnaires, observational techniques and the analysis of documents (Jankowicz, 2000). Many researchers preferred the personal interviews as the most powerful and useful way of social scientific survey research. That is because it enables the researcher to gather both sociological facts and psychological facts (Abdullahi, 1993).
The data in this study was collected using structured face to face interviews with Libyan experts from the following groups: Libyan Government, Libyan Banks (Private and Government), Libyan Companies (Private and Government), and finally Academic & Provisional.

The interview was designed to take no more than approximately 30 minutes and because of the sensitive position of many interviewees, the interviews is not taped. It includes two kinds of questions asked to participants; the first kind: questions about the interviewee position, experience and qualification and the second part: includes twenty questions to survey the perceptions of Libyan experts about stock markets and Accounting Disclosure. All of these interviews have taken place face to face, except the interview with the Governor of the Central Bank of Libya. It was started in the same way then the researcher left the interview questions with him and collected the written answers later.

3.2 The Sample and Limitations

Although, we planned to take at least 25 interviews, just 22 interviews were conducted between June and July 2004. The reason for that is subject to limited time and resources for data transcription. As the following list of interviewees divided into four groups:

1. *Libyan Government Group*: Dr. A. Menesi, Dr. A. Elfeituri, Dr. J. Elhassy, Mr. A. Alsherkase, and Mr. G. Guider.
2. *Libyan Banks Group*; Dr. S. El-Arbah, Mr. M. Albargati, Mr. A. Balkhair, Mr. J. Abdulmalek and Mr. S. Algoroshey.
3. *Libyan Companies Group includes* Dr. S. Bengharbia, Dr. A. Elbadry, Mr. G. Alasta, Mr. A. Elsahely, and Mr. N. Albakoush. And,
4. *Academic & Experts Group includes*: Dr. A. Abusnina, Dr. A. Altarhoune, Dr. M. Badi, and Mr. M. Anower Mr. T. Elhousady, Mr. M. Abseer, and Mr. R. Sowideeq.

More information about interviewees is provided in appendix 1. According to this appendix, all respondents have at least a university degree in related subjects. More specifically nine have a PhD (2 in Economics, 5 in Accounting, 1 in Law and 1 in Management); five have a MSc in Accounting; six have a BSc (3 in Accounting, 1 in Engineering, 1 in Economy) and one has a BA in Law.

4. PERCEPTIONS OF LIBYAN EXPERTS ABOUT CAPITAL MARKETS IN LIBYA

Regarding the main questions of this study the interview questions were divided into four sections. It covers the following themes:
(I) The importance of a capital market in Libya and the negative affects of the absence of a capital market in Libya, (II) the expected role of the capital market in Libyan economy, (III)

the drawing of policies of the capital market' in Libya and (IV) the impact of the level of accounting disclosure of Libyan companies on establishing a capital market in Libya.

4.1 The Importance of Establishing a Capital Market in Libya

In this part, we have asked five questions related to the importance of establishing a capital market in Libya. Also about the Libyan environment in general - is it ready to establish a capital market or not?

All the interviewees said the capital market is very important to Libyan economic development, because the absence of a capital market causes many negative affects. It has delayed many important reform programmes such as, privatization programmes; attracting investment of foreign capital and establish free zones. Some experts argued that it caused an increase in the number of bankrupt companies over many years.

On the other hand, most of the interviewees said that the Libyan environment is not ready yet to establish a capital market because many factors are not ready in Libya. Several trends emerge from the interviewees about the most important factors to establishing an active stock market. It includes; a stable and clear political environment, a stable economic environment, an adequate tax framework, adequate accounting and auditing standards, an adequate market infrastructure and an adequate legal framework. Also they said that the Libyan financial institutions and corporations such as banks and insurance companies do not have any experience regarding the capital market and are not yet mature enough to play any role in it.

The experts recommended the Libyan government to enact the important rules and regulations to eliminate these problems before establishing the capital market in Libya.

4.2 The Expected Role of a Capital Market

In the second part, we have asked four questions about the roles of the capital market that will be played in Libyan economy.

The majority of experts believe that the stock market will be playing an important role in the Libyan economy. It might provide the companies with the opportunity to obtain finance from the investors and provides the investors with investment opportunities. In addition to encouraging investors to invest in securities, protect small investors, allowing liquidation of securities easily, regulating the issuance and dealing of securities, channelling saving to serve the interests of the national economy, improving the level of financial disclosure in the Libyan companies and improving the level of competitions between Libyan companies.

Finally, as a result, it will play an important role in Libyan economic development by increasing the GDP. Moreover, it will help in restructuring the Libyan economy and provide the actual evaluation of Libyan companies. All economic reform programmes will be moving faster than before. In addition, they expect that all economic reform programmes would be moving faster after establishing the market than it is now.

4.3 The drawing of policies of the capital market' in Libya

This part includes seven questions that have been asked to interviewees about drawing suitable policies for the Libyan environment.

The following are the most important points summarised from experts' points of view:

1. The market should be independent and not controlled by the Libyan Central Bank but it might be inspected by the Ministry of Financial Control or Ministry of Economy and Trade to protect the investors.
2. The assistance from the international Finance Corporation and the learning from the experience of other Arab counties in capital markets are essential to help Libya in establishing the market.
3. State should enact Capital Market law; it must also issue the important regulations of the registering rules.
4. Electing the market authority from the government vice, Central Bank, merchants, Businessmen Counsel, and related others.
5. Start by one capital market in the capital city of Libya (Tripoli) is preferred at the beginning then it might open other branches in important cities like Benghazi, Sabha, Sirte, and Misurata.
6. The Libyan banks must be banned from playing the role of primary market when the formal capital market will be open.
7. All companies, both private and public, might be listed in the stock market, if the basic conditions are available.

4.4 The Impact of the Level of Accounting Disclosure

The last part includes four questions about the impact of the level of accounting disclosure of Libyan Companies in the establishing of a capital market in Libya.

According to Libyan experts, also as in the finance literature, the efficiency of the capital market depends on the availability of information to all investors on time with the minimum level of cost.

In Libya, experts' believe that the information published by Libyan companies is not enough and not available to all users on time. Most financial statements of companies are not published for many years or at least not audited yet. In addition, they believe that there are not any issue tools such as financial magazines or newspapers that it might be an obstacle towards establishing a capital market in Libya and might cause a decrease of the efficiency of the Libyan capital market in future.

To improve that level the experts suggest that the Libyan accounting profession develops and adopts accounting standards that are suitable for the country's environment and comply with the international accounting standards in the near future.

5. CONCLUSIONS

The capital market is very important in any country because it plays an important role in economic development. In Libya, the financial system faces several developmental challenges relating to limited access to finance by the corporate sector in the absence of a capital market, also it causes a lot of negative affects. It is very important for Libya to establish a capital market but the main problem toward it is the environment is not yet suitable.

Relevant conditions for establishing an efficient stock Market in Libya or in other countries include; establishing a legal framework, developing a regulatory environment, introducing appropriate accounting, auditing, and disclosure practices for financial sector reporting, removing any tax or other regulatory impediments, which may hamper trading in securities.

This study will be part of a PhD theses written by student Khaled Ellabbar and supervised by Dr. Tim Havard, titled "The capital market and accounting disclosure in emerging-economy countries: The case of Libya". The research will examine to what extent the capital market is needed in Libya, focusing on accounting disclosure as one of the successful factors towards an emerging capital market in Libya.

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LGPC decision no (313) for the year 2003, concerning to privatise a number of plants.

LGPC decision no (8) for the year 2005, concerning to opening of representatives offices for foreign companies in Libya

LGPC decision no (105) for the year 2005, for establishment of capital market will be the responsibility of secretariat of peoples GPC of economy & trade.

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Appendix 1 Some Information about Interviewees

No	Name	Qualification	Current and Previous jobs
1	Dr. A. Menesi	PhD in Economics	-Governor of the Central Bank of Libya -Professor of Economics, Garyounis University
2	Dr. A. Elfeituri	PhD in Economics	-Director of Economic Research Centre, Ministry of Economy -Professor of Economics, Garyounis University
3	Dr. A. Abusnina	PhD in Management	-The head of Management department, the academy for higher studies -Chairman of the Federation of Libyan and Chamber of Commerce, Industry and Agriculture (previous) -Professor of Management, Garyounis University
4	Dr. A. Altarhoune	PhD in Law	-Lawyers and Legal Consultants in Commercial Law -Professor of Commercial Law, Garyounis University
5	Dr. A. Elbadry	PhD in Accounting	-Chairman of the Libyan company for Engineering Consultants -Professor of Accounting, Garyounis University
6	Dr. J. Elhassy	PhD in Accounting	-Director of Tax department, Ministry of Finance -Professor of Accounting, Garyounis University
7	Dr. M. Badi	PhD in Accounting	-Professor of Accounting, Accounting Department, University of Garyounis -Secretary of the General People's Committee for Public Control (previous)
8	Dr. S. Bengharbia	PhD in Accounting	-Chairman of the Libyan Insurance Company -Under-Secretary of the Libyan Ministry of Finance -Professor of Accounting at Garyounis University -Member of the Audit Committee of the Arab Insurance Group
9	Dr. S. El-Arbah	PhD in Accounting	-Account & Investment Division manger, Central Bank of Libya
10	Mr. A. Alsherkase	MSc in Accounting	-Secretary of the People's Committee for Tourism, Shabiat Benghazi -Lecturer of Accounting at many Libyan Universities
11	Mr. A. Balkhair	MSc in Accounting	-Vice Chairman of the board of directors, the National Commercial Bank -Member of the board of directors of the Libyan Arab Foreign Bank -Member of the board of directors of the Housing Bank for Trade & Finance, Jordan.
12	Mr. J. Abdulmalek	MSc in Accounting	-Chairman of the Bank Of Commerce & Development
13	Mr. M. Al Bargati	MSc in Accounting	-Vice Chairman of the board of directors of the Savings And Real Estate Bank - Lecturer of Accounting at many Libyan Universities
14	Mr. R. Sowideeq	MSc in Accounting	-Charter Accountant and Financial Experts
15	Mr. G. Alasta	BSc in Accounting	-Chairman of Assada Development Trade and Investment Association -Board Member of the Libyan Businessmen Council
16	Mr. G. I. Guider	BSc in Engineering	-The Investment department Manager, Libyan Foreign Investment Board
17	Mr. A. Elsahely	BSc in Accounting	-Chairman of General Company for Wires and Electrical products
18	Mr. S. Algoroshey	BSc in Accounting	-Vice Chairman of The national Benghazi Bank
19	Mr. N. Albakoush	BSc in Economy	-Chairman of General Company for Textiles and Clothing
20	Mr. M Anower	BA in Law	-Legal Consultant (Expert in Companies Contracts)
21	Mr. T. Elhousady		-Lawyers and Legal Consultant (Expert in Companies Contracts) -Professor of Commercial Law, Garyounis University
22	Mr. M. Abseer		-Board Member of the Libyan Businessmen Council

RISK MANAGEMENT IN THE DUTCH REAL ESTATE DEVELOPMENT SECTOR: A SURVEY

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ABSTRACT: Real estate development is considered to be the most risk taking enterprise in the construction industry. This paper presents the results of an explorative survey of the top representatives of the Dutch real estate development sector on the usage of risk management. The survey is based on in-depth interviews to gain insight of the real estate development process, the risks involved, and the risk analysis and control methods used. With regard to risk analysis, it was found that real estate developers do not make use of probabilistic techniques; scenario analyses are thought of as most applicable because of the complexity of real estate development; several methods to assess the total risk exposure are used; and intuition and experience are necessary for decision-making. The characteristics of the real estate development process and the best practices concerning risk management will be used to develop an improved risk management method for real estate development.

Keywords – real estate development, risk management, decision-making, interview survey

1. INTRODUCTION

Many people think of real estate developers as very risk taking organisations making lots of profit, while using their gut feeling to decide on the purchase of land or the design to be realised. All of these assumptions can be questioned, as little is known about how risk management is applied in the practice of real estate development. In the literature several studies are described on the application of risk management in the construction industry:

- Akintoye and MacLeod (1997) carried out a survey on risk analysis and risk management of 70 UK contractors and 30 project management practices;
- Uher and Toakley (1999) carried out a survey on risk management in the conceptual phase of a project of 200 Australian organisations in the construction industry, of which 37 were property developers;
- Baker, Ponniah et al (1999) carried out a survey identifying the most successful risk analysis techniques of over 100 large companies within the construction industry, and every oil and gas operator in the UK;
- Lyons and Skitmore (2004) carried out a survey on the usage of risk management techniques of 44 organisations involved in the Queensland (Australia) engineering construction industry comprising owners, property developers, consultants and contractors.

These studies focused mainly on the construction industry as a whole, not describing the specific risk characteristics of real estate development. However, it is clear that the risks taken by a property developer differ strongly from the risks taken by a consultant or a contractor. Therefore, it is interesting to conduct research specifically on real estate development. The objective of this study is to gain insight of the risk characteristics of real estate development and the best practices used to manage these risks.

The previous studies were based on a survey through a questionnaire, describing the usage of risk management in general. To gain deeper insight in the usage of risk management explaining the reasons behind the different techniques and, as a follow up, being able to propose a more appropriate risk management method for real estate development, the research method used in this study is a survey through in-depth interviews. The results of this explorative survey are presented, conclusions are drawn and implications for a new risk management method are suggested.

2. THEORETICAL FRAMEWORK

2.1 Risk management

Risk management has been object of research in several industries and academic disciplines. With regard to real estate development, Byrne and Cadman (1984) identified risk as 'the measurement of a loss, identified as a possible outcome of the decision'. Analysing other definitions (Cooper and Chapman, 1987; Raftery, 1994; Wang and Roush, 2000) it can generally be said that a risk is constituted of a probability and a magnitude component. The probability component is in each discipline equally measured. However, the magnitude or the effect of a risk can be expressed in different ways, for instance in terms of physical damage, but usually it is finally measured in economic terms. For example, in environmental studies a risk is expressed in social, economic, human health and other environmental costs. In this study risk is considered to be the exposure to the possibility of economic or financial loss from the perspective of a real estate development firm; an opportunity is the counterpart of risk resulting in economic or financial gain.

Risk management is usually described as a cycle composed of risk analysis, risk response, and risk control (Gehner, 2003). Most literature focuses on risk analysis techniques aimed at identifying and assessing risks. To assess or quantify risks people make use of objective or subjective estimations of the probability and magnitude of a risk. As real estate development is not like gambling in a casino, one has to rely largely on subjective judgements of the riskiness of an action, which is defined as risk perception (Sitkin and Pablo, 1992). The risk response or a decision is based on the risk propensity of people or the willingness to knowingly take risks' (Simon et al., 2000). As for risk control one can take risk measures according to the four general types of risk response: avoidance, reduction, transfer, and acceptance of a risk.

2.2 Real estate development

'Real estate development is a multifaceted business, encompassing activities that range from the renovation and re-lease of existing buildings to the purchase of raw land and the sale of improved parcels to others. Developers are the coordinators of those activities, converting ideas on paper into real property' (Peiser and Frej, 2003). The process through which this objective can be realized is described in general terms of the process, actors involved, and functional types of developments by several authors (Cadman and Austin-Crowe, 1991; Birrell and Gao, 1997; Miles et al., 2000; Peiser and Frej, 2003). Fisher (2005) contributes to the theory of real estate development by presenting seven major elements that define the complexity of the process; long-term trends, the economy, property markets, actors, government, the site and the events-sequence. In addition to these elements, Gehner (2005) mentions the unique character, the sensitivity to contexts and the life time of real estate as reasons for complexity and riskiness of real estate development.

A specific focus on risk analysis comes from Miles and Wurtzebach (1977) and Gehner (2003) who both propose a risk analysis framework exclusively adjusted to the real estate development process. Their research mainly focuses on the techniques of risk analysis in order to evaluate risks. However, the relationship with the next step of the risk management cycle is underexposed, whereas the applicability of the risk analysis is determined by the extent the risk analysis either supports decision-making or the daily project management practice. The individual and organisational aspects of risk management must be taken into consideration.

2.3 Risk management supporting decision-making

In the search for a risk management method that supports decision-making, it can be argued that the risk management perspective should correspond with the perspective in decision-making. Considering the risk analysis techniques, it is clear that the underlying paradigm is ‘a rational, engineering approach, that is based on the idea that the outcome and probability of a risk can be assessed more or less objectively and decisions are made in a rational way, that is following logical decision rules’ (Gehner, 2005). However, the leading perspective in decision-making is the bounded rationality theory saying that people act intentionally rational, but only limitedly so, as reality is complex and ambiguous, information is limited, and time pressure is often high (Simon, 1977). People base their decisions on their risk perception and propensity, which are influenced by cognitive biases and social processes. Therefore it is interesting to know the complexity and possibilities of making risks in real estate development explicit and more or less objective to prevent people from the negative consequences of irrational decision-making.

3. RESEARCH METHODOLOGY

To gain insight of the real estate development process, the risks involved, and the risk analysis and control methods used, an explorative survey is carried out based on in-depth interviews. The interviews are obtained from a selection of Dutch real estate development companies. In the Netherlands over 100 real estate development companies are active at a regional or national level with only a few of them operating abroad. As most developments are on national territory, the Dutch real estate development sector has adjusted itself to a large extent to the local characteristics of market, legislation, and spatial and land policy. This distinguishes it from the same sector in other countries.

To start with, a first selection is made that comprises of the 41 largest companies having an investment value of projects in portfolio over 400 million euro (Wessels, 2004). The research problem does not require a representative selection of the sample; it is more interesting to investigate real estate development companies which are 1) able to carry more risk because of their size in comparison to smaller companies, 2) supposed to be professionally organized and therefore are frontrunners in the field of risk management. From this first selection companies are excluded which are either subject to a merger or take-over, and companies that develop exclusively for owner/users and, in doing so, take no sales risks. A total of 31 companies were approached. The sample consisted of 13 independent real estate development companies, 4 financier related, 8 contractor related, 4 investor related, and 2 remaining categories (owner-user, housing corporation). The sample gives a representative distribution over the different backgrounds of the companies in the Netherlands.

A total of 15 companies took part in the interviews, thereby giving an overall response rate of 48% (see Table 1). The response rate varied over the different backgrounds showing the lowest response rate from the investor related companies. A possible explanation for this may be that these companies are restricted in their development activities by legislation and therefore are less interested in professionalizing the real estate development sector. However, the number of interviews per category is too limited to draw valid conclusions on the differences between the categories. The interviewees were general managers or directors (9), risk managers (2), project managers (2), or financial directors/controllers (3), all of whom were regarded as the specialist on risk management within their own organisation.

Table 1. Response rate of real estate development companies by background

	Independent	Financier related	Contractor related	Investor related	Remaining categories	Total
Number targeted	13	4	8	4	2	31
Number responding	7	3	3	1	1	15
Response rate	54%	75%	38%	25%	50%	48%

In depth semi-structured interviews were conducted, recorded, reported and returned for confirmation. The interview schedule comprised of a total of 20 questions focusing on four main aspects: the organisation structure related to the project teams and the decision-making process; the phasing and risks of the real estate development process; current and desired risk analysis techniques; and the decision-making process determined by information flows, decision criteria and decision behaviour. Respondents were asked to elaborate on these issues to gain on insight of the essence of real estate development and the dilemmas in strategic decision-making they face. The results in the next section are restricted to the relationship between characteristics of the real estate development process and the risk analysis techniques. The other topics are only treated slightly. The analysis of the results consists of finding similarities and differences within the responses and with existing theories. Similarities lead to general descriptions of real estate development, while differences might hint at best practices that can be put forward as exemplars for the development of a risk management method for real estate development.

4. RESULTS

This section provides insights in the phases of the real estate development process, the risks in real estate development and the current and desired use of risk analysis and control techniques. At first the main concepts are defined based on existing theories, second the results from the interviews are presented and some preliminary conclusions are drawn.

4.1 Phases of the real estate development process

Birrell and Gao (1997), like other authors (Cadman and Austin-Crowe, 1991; Miles et al., 2000; Peiser and Frej, 2003), describe the real estate development process as a list of phases, such as site selection, feasibility survey, design, and letting, all using different headings. However, these phases are functional descriptions of activities. In this study phases, or stages, are viewed as temporal groupings of activities, according to Miles and Wurtzebach (1977) who describe the real estate development process as interactive stages, while at each stage in the process different aspects of development planning, financing, marketing, and construction are accomplished. The process can roughly be divided into the phases: acquisition, development and construction (Oude Veldhuis, 1993). Gehner (2003) distinguishes the following activities:

- land acquisition: all activities concerning the acquisition of land, including site identification, investigation and purchase;
- planning application: all activities concerning the granting of all necessary building permits by following the planning procedures;
- design and construction: all activities concerning the management of the design, tendering and contracting, and construction process;
- marketing: all activities concerning the rental and sale of the real estate project, including a market analysis, feasibility studies and promotional activities;
- financing: all activities concerning the raising of necessary funds under the investments.

In the survey the interviewees were asked for their phasing of the process and for the most important decision moments. Looking at the process, nearly one third of the developers do not subdivide the three main phases, acquisition, development and construction. Just over half of all respondents subdivide the process following the traditional steps of the design and construction process, being sketch design, preliminary design, final design, specifications and working drawings, tender, site preparation, and construction. And two development companies divide the phases based on the planning and marketing activities, as they think of these activities as far more decisive factors concerning the critical path (in terms of time, quality and money) of the process. In their opinion, the advisors (architects, construction engineers, environmental advisors, etc.) in the Dutch construction market have reached such a high level of professionalism that they do not influence the critical path.

Despite the differences in phasing, the respondents were almost unanimous on the most important decision moments or gates in the process. A gate is defined as a ‘project review point where continuation or termination decisions are made’ (Schmidt and Calantone, 2002). Nearly everyone mentions two decision moments as most important because of their irreversibility. The first decision moment is the commitment to a project either by a site purchase or by an engagement with a municipality or client. It is only possible to go back on this decision by selling the site or dissolving the contract. This decision moment marks the step from acquisition to development. The second crucial gate we find at the start of the construction phase. Once construction has started, all financial obligations are committed so abandonment has become unrealistic. The decision of starting construction works is strongly related to the marketing process.

4.2 Risks in real estate development

As real estate development comprises of such a wide scope of activities from the initiation of a project to completion, the risks involved are numerous. In the literature an exhaustive overview of risks in real estate development cannot be found. Most studies concentrate solely on construction management and contractor’s risks (Ng and Skitmore, 2002), others have a much broader scope on large engineering projects in several industries (Miller and Lessard, 2001), or research focuses on risk allocation in PPP or PFI projects (Li and Akintoye, 2001). In general, a risk can be described in terms of its causes and its outcomes. Usually risks are described on the basis of causes, varying largely in the level of detail. Miller and Lessard (2001) distinguish at the lowest level of detail market-related risks, completion risks and institutional risks. Well-Stam et al. (2003) propose in their risk management method to identify risks according to environmental, legal, political, technical, social, fiscal, organisational and spatial perspectives.

In the interview survey the respondents were asked to list the most important risks and indicate for what reasons these risks are highly prioritised. The risks are generally described in risk categories that can be subdivided in risks with a higher level of detail. These categories are either related to the main activities of the real estate development process or the above mentioned perspectives. In table 2 an overview of risks is given that is mentioned during the interviews varying in level of detail: this list is exemplary and not exhaustive, because the risks are not systematically obtained.

Table 2. Risks in real estate development

Risks	Respondents	Percentage
risks of planning procedure	15	100%
delay of development process	15	100%
marketing risks	15	100%
technical/construction risks	15	100%
legal/judical risks	12	80%
risks of abandonment	10	67%
objection against building plans	8	54%
tendering: construction costs	5	33%
changes in politics	4	27%
changes in legislation	4	27%
design errors	4	27%
risks of site acquisition	4	27%
interest risks	4	27%
opposition of administrative machinery	3	20%
delay in construction time	3	20%
risks of making ready for building	3	20%
archaeological excavation	3	20%
land pollution	3	20%
protected flora and fauna	2	13%
liability risks	2	13%
financing risks	2	13%
fiscal risks	2	13%
risks of monumental building	1	7%
vacancy	1	7%
longer time to rent/sell	1	7%
risks in rental/sale price	1	7%
bankruptcy of advisors/contractor	1	7%
construction defects	1	7%

All developers consider the risk related to the procedures of area planning and building permits as most important. The reason they think of the procedural risk as most important is that it is hardly possible to influence the causes and it has many indirect effects. Some of the more detailed causes of the procedural risk are:

- changes in politics;
- resistance/opposition of administrative machinery;
- objection against the building plan by a citizen;
- changes in environmental legislation (land pollution, protected flora and fauna, archaeological excavation, conservation of monuments and historic buildings).

This risk will result in a delay of the project with many indirect consequences, such as an increase of interest costs, possible necessary changes in the design, and postponement of the start construction which accordingly leads to a delay of the completion date and thus influences the marketing process. Because of all the risks involved in the planning application procedure, it becomes clear that this procedure makes up the critical path for the whole process. All other activities should be geared to this process.

The marketing risk is thought of as the second most important by most developers, because it is dependant on the variations in the real estate market and therefore hardly controllable. The real estate market causes various effects on the variables determining the revenues of the project:

- decrease in rental/sale price;
- decrease in velocity of sales;
- higher vacancy rate;
- lower investment value (increase of gross initial yield).

Knowledge of the real estate market is essential for managing this risk: this knowledge is used in the feasibility study as well as in the marketing plan. If a plan turns out to be unprofitable, a real estate developer might consider changing the design: therefore the plan has to be flexible as well as the process. Process flexibility can be guaranteed by making as little commitment as possible.

Most respondents consider the risks affecting the construction costs as less important, because this risk is manageable. These risks include the categories: design risks, soil risks and construction risks, which can be caused by:

- design errors;
- construction market/tendering;
- construction defects;
- bankruptcy of contractor or designer;
- site pollution, archaeological excavations;
- delay in construction time.

During the design process many of these risks can be managed for instance by conducting a soil survey, changing the design, thus changing directly the construction costs, or hiring qualified advisors, thus preventing design and estimation errors and guaranteeing optimisation of the spatial design. With regard to construction, the real estate developer is able to transfer most construction risks to the contractor or by taking out insurances and to reduce risks by (hiring) good construction management. Though construction seems not that risky because of all possible control measures, outcomes can be very negative if construction is not adequately managed. Construction errors causing real damage to people or its surroundings will result in legal procedures about liability, which usually will be recouped either from the contractor or from the real estate developer.

Next to all mentioned risks respondents identify one exceptional risk, being the risk of abandonment. This risk occurs when one of the activities turns out not to be realisable.

4.3 Risk analysis

In risk management literature the term risk management is often used when it exclusively concerns risk analysis. Risk analysis is only part of risk management aiming at making risks explicit either in a qualitative or in a quantitative way. Several risk analysis techniques are described in the context of project and construction management, such as a sensitivity, scenario, or stochastic analysis, the expected-monetary-value method, risk-adjusted-discount rate method and real options (Byrne and Cadman, 1984; Flanagan and Norman, 1993; Raftery, 1994; Leung and Hui, 2002). Evidently, real estate development companies carry a lot of risks and managing these risks is inherent to their daily practice. In this part of the survey respondents were asked to what extent they make use of risk analysis techniques to make risks explicit and for what reasons they use or do not use the available techniques. The general conclusion on the current use of risk analysis techniques that can be drawn is that probabilistic risk analyses are not established in the real estate development sector, but that risk management is approached in a far more qualitative way (see Table 3).

Table 3. Use of risk analysis techniques

Risk analysis technique	Respondents	Percentage
Intuition/experience	15	100%
Qualitative description	15	100%
Scenario/sensitivity analysis	12	80%
Risk premium	4	27%
Checklist	3	20%
Assessment of total risk exposure	2	13%
Probabilistic techniques	0	0%

All real estate developers make use of some risk identification technique as part of an investment proposal consisting of a financial estimation and a qualitative description of the project. The risk identification is not aimed at completeness, but at making the most prominent risks explicit. For this aim a checklist can be useful so as not to overlook risks, especially when it concerns inexperienced managers. Other instruments to identify risks, such as a risk matrix, are hardly used: obviously, intuition and experience play an important role in risk management of real estate development.

When it comes to quantifying risks, most respondents make use of sensitivity or scenario analyses. The input for this kind of a quantitative analysis is merely based on subjective estimates as there is a lack of statistical and objective data. For the same reason, added with the difficulty of modelling the interdependencies of all variables and risks, the respondents have no faith in the results of probabilistic techniques. The respondents think the benefit of the sensitivity and scenario analysis techniques is that people consciously assess a project by making estimates of the future and the possibility to model and evaluate risk strategies.

Next to these risk analysis techniques two respondents explicitly make use of a model to assess the total risk exposure of a project especially in the initiative phase of a project. The total risk exposure is the maximum loss one suffers when the project is abandoned at any moment during the project. The risk exposure or loss consists of the total of costs increased with the financial commitments already made reduced with the execution value of the site and the project (if this can be valued). In general a project is not abandoned after the start of construction as the commitments made exceed the effects of still present risks. The aim of this risk analysis technique is to weigh the risk exposure of all projects against the equity of the firm to assure the continuation of the organisation.

In the interviews the respondents were also asked for their future expectations regarding the usage of risk analysis techniques. Most respondents are satisfied with their best practices and are looking for a slight improvement on their current techniques. The general response as for risk analysis techniques is that they see no future for extensive quantitative and probabilistic techniques. They mention two reasons: in the first place because they think too little objective, statistical data is available, and in the second place because they would rather focus on risk control measures.

Still, some future prospects are given for risk analysis. Some respondents indicate that tools to support the planning of a project are desirable because data are lacking, estimates often turn out to be too optimistic, and the risks related to time aspects are numerous. A proper risk analysis could possibly lead to more accurate time schedules and therefore reductions in several other indirect risks. Furthermore, some respondents are especially interested in a method to determine the risk profile of a project in order to support decision-making by comparing projects. In determining a risk profile, qualitative as well as economic characteristics need to be expressed in comparable figures, which can only be done by making use of historical data of projects and experience of real estate developers.

4.4 Risk management

In accordance with the risk management cycle a risk analysis is followed up by risk response and risk control. The risk response is part of decision-making and is supported by a risk analysis. From a narrow perspective, risk response aims at deciding whether to accept, reduce, transfer or avoid a risk and adding a risk measure to this response. In a broader perspective, risk response aims at deciding whether or not to accept the total of risks in a project. Similarly, risk control can be seen as the execution of specific project-related risk measures in a particular project or, in a broader perspective, as the total of methods or systems in an organization to manage risks. During the interviews the respondents mentioned several methods to manage the real estate development process, which in literature on risk management is not directly considered to be risk management, but happens to be best practice.

In the first place, all respondents make use of some process protocol in which criteria are set in terms of temporary results for each of the activities in the real estate development process to decide on the continuation of a project. These criteria can be seen as decision criteria as well as risk measures to keep the development process under control. For each decision moment different criteria are set in terms of qualitative results. For example, at the start of development the following criteria are set:

- the first survey on ownership, soil, and zoning plan of the site indicate a positive prospect;
- the market analysis is positive for the proposed functional program;
- the functional program can be transformed in a spatial concept that meets the specified level of quality;
- the project is financially feasible.

And at the start of construction suchlike criteria have to be met:

- to be owner of the site;
- to have reached a fixed percentage of pre-rental/sale agreements;
- to have obtained an irrevocable building permit;
- to have arranged financing.

By using these qualitative criteria a lot of risks are reduced or even avoided. However, in practice the actual decisions have to be made when a project does not meet all criteria. When reaching this dilemma the risks of deferring must be weighed against the risks of proceeding: these risks can be analysed either qualitatively or quantitatively, but at least the risk is taken consciously. In practice intuition plays an important role in summing up all risks in different activities and weighing them. A process protocol helps to weigh the risks by making explicit the ideal relationships between the different activities.

Furthermore, some risk management methods are used that go beyond specific projects. The application of a risk premium as a part of the budget is one of these instruments: although a risk premium sometimes is considered to be a risk analysis technique, it does not actually reflect the effect of the risks in a particular project as the percentage is usually standardised. Another risk management method mentioned by the respondents is document administration in which, for instance, standard contracts are regularly updated with improved clauses. In this way prior experiences of an individual become accessible for everyone within the company and risks might be prevented. Yet another form of managing risks is knowledge management: hiring people with the right competences and updating people's knowledge on hot topics by workshops, lectures or courses also contribute to the management of risks due to increased awareness of the risks and availability of knowledge of how to prevent or reduce risks.

5. CONCLUSIONS

The results of this explorative survey indicate some similarities with existing studies and give some new insights in real estate development. The phases and activities mentioned by the respondents can be found in several previous studies as described in the previous section. However, in the literature activities are presented as independent activities, whilst the activities are interdependent. Moreover, not the activities concerning design and construction, but the planning procedures and marketing activities determine the duration of phases. As for the risks of real estate development, the existing literature does not provide a list of risks. This study does not provide an exhaustive overview of risks, but determines the three most important risk categories, namely the risk concerning the planning procedure, marketing risks and construction risks. The importance depends on the extent to which the risks can be objectively evaluated, and can be influenced and thus controlled.

With regard to the use of risk management in real estate development the results are in line with the results of the studies mentioned in the introduction. Lyons and Skitmore concluded an overall preference 'for the use of qualitative methods of risk analysis ahead of quantitative and semi-qualitative methods' (2004) and the most frequently used risk assessment techniques are intuition, judgment and experience (Akintoye and MacLeod, 1997; Lyons and Skitmore, 2004). Moreover, 'the main obstacles to applying risk management in the conceptual [or initial] phase of a project life cycle were identified as inadequate knowledge [of risk assessment techniques] and the lack of understanding of its potential benefits' (Uher and Toakley, 1999). These conclusions also count for real estate development.

From these results some suggestions for risk management in real estate development are made. In the first place it can be concluded that the phasing of activities in the real estate development process, the risks involved and the usage of risk analysis techniques are joined together at the gates in the decision-making process. Schmidt and Calantone (2002) remarked that gates 'are crucial for maintaining a reasonable level of risk during an NPD [New Product Development] project' and also that 'although gates are a prominent feature of NPD processes, they have received little research information'. Both remarks apply to real estate development. Therefore, in future research it is relevant to develop a risk management method that concentrates on supporting the decision-making process in real estate development.

The risk management method should address the most important gates in the real estate development process, being the start of development and the start of construction. These gates are distinctive with regards to the amount of information available as well as the measures that can be taken to control risks. Moreover, the decision problems move from a continuation/termination decision towards a satisficing decision, since the amount of commitments makes the process irrevocable. This distinction asks for a different type of risk analysis. At the start of development there is more need for assessing whether the total risk exposure is acceptable in relation to the firm's equity, while at the start of construction one is more interested in analysing which risk management strategy leads to the most satisfying result.

Next to differences in decision problems, differences in risks also ask for a particular risk management method. Analysing the results, the risks in real estate development can be classified in two categories. The first category consists of risks relating to the unique characteristics of a project, for example the technical and functional program of the design, the site, and the actors involved. These project specific risks can be quantified with several known risk analysis techniques, for example sensitivity or scenario analyses, and can be managed by several risk measures. The second category consists of risks originating from the parallel sequence of activities and the interdependency of these activities. Time is crucial for this category of risks. As one of the real estate developers characterised these risks: 'if time was no constraint, I would not run any risk'. Managing these risks comes down to harmonising the parallel activities with each other at the gates by formulating qualitative decision criteria. This means that part of the risk management method is a process protocol in which the real estate development process is generalised and decision criteria are formulated taking account of decisive project features.

Finally we can conclude that a risk management method should not be a normative decision model in line with the rational engineering approach and the rational choice theory. On the contrary, many variables determine the success of a project, just as many decision criteria determine a decision. These decision criteria are not solely based on an economic perspective, but also derive from behavioural and cognitive processes (Tversky and Kahneman, 1974; Janis and Mann, 1977; March and Shapira, 1987; Sitkin and Pablo, 1992). Therefore, future research on risk management in real estate development should not only concentrate on analysing the risks of a project, but also take account of the organisational setting of the decision-making process.

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THE MARGINAL VALUE OF OFFICE PROPERTY FEATURES IN A METROPOLITAN MARKET

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ABSTRACT: It seems logical that rent variations within metropolitan boundaries, at one moment in time, are caused by building and site specific characteristics. The fitness for use, defined as the match between the office property characteristics and the general preference of office space occupiers, should influence the willingness to pay. The background of analysing the added value of office property characteristics from users' point of view is described in this paper. This study forms a part of a PhD thesis and focuses on the hedonic price model to determine the marginal value of office property features as expressed in the rent paid per square meter lettable floor area. Information about the added value of office building features and site characteristics are beneficial for developers of office space to establish a relationship between design decisions and the financial performance of office property. Secondly, it provides an objective basis for the selection of individual office property for the portfolio of investors. Finally, it also provides opportunities to monitor the changing preferences of office space users over a time interval and to analyse the influence on the willingness to pay for a specific office.

Keywords – analytical hierarchy process, hedonic price analysis, marginal value, office building attributes.

1. INTRODUCTION

Analysing the value of office property can be done from different perspectives and on different aggregation scales. The perspective of a market actor determines in which way the property is valued. It seems plausible that the value in use which a market party attaches to a particular office property or unit is expressed in the transaction price for the use of or ownership of the object.

This paper focuses on the value of the office property from users' perspective. Office space users have preferences concerning their accommodation. These general preferences can be translated in office property characteristics. It seems reasonable that users of office space are willing to pay more for an office that offers a high value in use.

2. BACKGROUND

Analysing price variations for the use of office space can be done on different aggregation levels. While focussing on one aggregation level it is important to remain aware of the influence of the other aggregation levels. This study focuses on the individual office building and tries to ascertain the influence of the office building and its site on the rent paid for the use of office space. Rental transactions take place in a specific market context. The market conditions and expectations influence the average price an office space occupier is willing to pay. Besides the market context in which the transaction takes place, there are transaction (contract) related factors such as lease length that influence the price paid per square meter lettable floor area.

2.1 Price analysis of heterogeneous goods

For heterogeneous goods it is not possible to compare market prices directly, because of different product configurations. Office property is heterogeneous by nature, first of all because every building stands on its unique site. Second, every building has its specific design and is also unique on this aspect. Dunse (1998) states that an office is a heterogeneous good consisting of a bundle of attributes, each of which are integral to the office unit and cannot be traded separately.

For the price analysis of heterogeneous goods it is necessary to define the product in terms of a bundle of characteristics. In terms of office properties these characteristics relate to the design and operational features of the office building and the characteristics of the location.

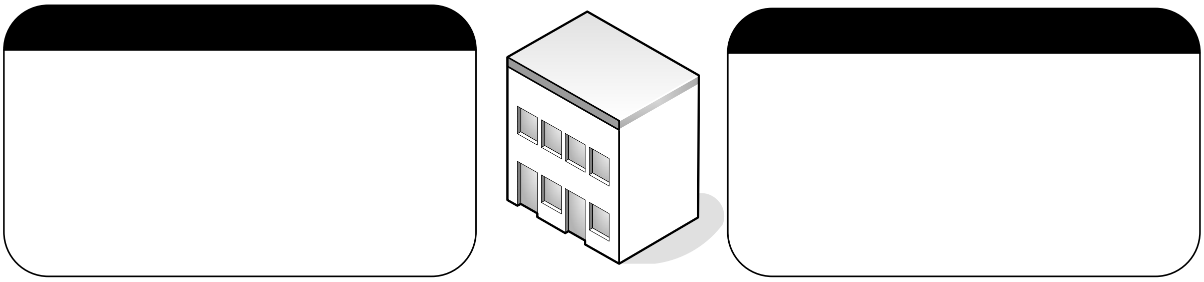

Fig. 1. Main categories of office property elements

2.2 Fitness for use versus willingness to pay

The rent paid per square meter lettable floor area depends on the office space market conditions, transaction specific aspects (e.g. contract terms, negotiating skills involved actors) and on the individual office property characteristics. When office space is scarce users of office space are generally willing to pay more for the right to use office space. The average rent level varies between nations, regions and cities. This can be explained by varying local market conditions caused by different local demand and supply flows. This does not explain why at a particular time within the metropolitan boundaries different amounts of rent are paid per square meter office space.

It seems logical that rent variations within territorial boundaries at one moment in time are caused by office building specific features, its inter-urban location and site characteristics. The fitness for use, defined as the match between the office property and the general preference of office space occupiers, should influence the willingness to pay. When the characteristics of office accommodation match the requirements of the potential user, the willingness to pay on the part of the potential occupant should increase. But is the fitness for use of office accommodation also expressed in the price paid on the market?

Transactions take place in the context of specific market conditions and under varying contract terms. To determine a relationship between the fitness for use and the price paid on the market for the use of office space, one should keep this context in mind. To accurately measure the added value of property features one should account, in the analysis, for the contract terms and market conditions.

-Spatial relationships: the choice of an office also brings a set of spatial relationships.

- Setting; encompasses the economic, social and cultural embedness in the urban context.

- Site; refers to location characteristics directly related to a specific site and its adjacent surrounding area.

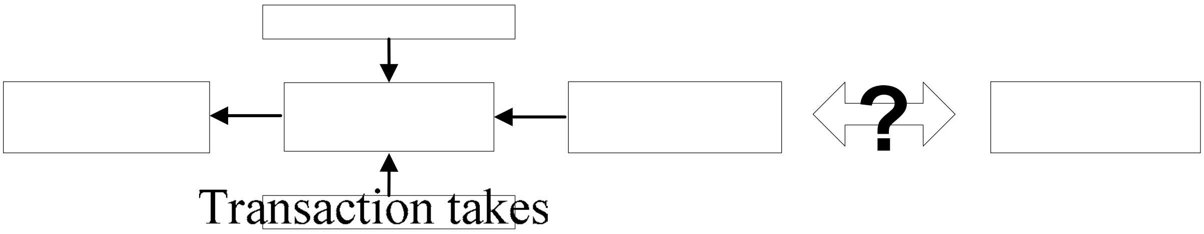

Fig. 2. Fitness for use versus willingness to pay

2.3 Literature review

Hedonic price models have been widely utilised to analyse the relationship between the bundle of office property characteristics and the observed market price. The hedonic price model employs multiple-regression to analyse market price variations between heterogeneous goods. *“The hedonic pricing technique offers the opportunity to establish a relationship between observed market prices and the implicit prices of the characteristics, which the good embodies”* (Gillingham, 1975). Rosen (1974) hypothesised that *“heterogeneous goods are valued for their utility-bearing attributes or characteristics”* where the hedonic price is the implicit price of each attribute associated with that good. Hedonic price models can be used to unravel the willingness to pay, or to separate the contribution of each feature to the price.

In its most simple form the hedonic price technique has an equation whereby the price is the dependent variable and the features are the independent variables. For office property the price of the product is usually expressed by the rent paid per square meter lettable floor area. Property attributes, the independent variables, relate to the office building features and the site characteristics.

$$R = f(B_1,....,B_n,.S_1,....,S_n) \qquad \text{Fundamental hedonic equation} \qquad (1)$$

Whereby R is the rent paid per square meter lettable floor area, f the implicit price of the building characteristics, B are the office building attributes and S are the characteristics of the site. Sometimes contract terms are also included as independent variables. Leasing agreements have become less uniform in both length and additional terms, for instance the incentives offered. This complicates the fair comparison of rent per square meter lettable floor area.

Through a survey of prominent journals, five earlier performed hedonic office rental regression models that include building design characteristics were discovered (see table 1.). The figure reported within the brackets is the number of independent variables that are significant at the 95 per cent level. Oven (2004) employs factor analysis, a complex algebraic method used to discover patterns among variations in values of several variables. The number of individual independent variables that are significant can therefore not be reported. Two of the five factors are significant at the 95 per cent level. Reported and observed predicaments when using hedonic regression models are:

1. The multicollinearity problem; when two or more exogenous observation series are highly correlated or have the same predictive power with respect to the endogenous variable they are called multicollinear.
2. Faulty or incomplete selection of independent variables.
3. Inadequately measuring of the interaction effects of the independent variables; attributes are valued differently when combined with other attributes (Dunse, 1998, Oven, 2004)

e.g. a high quality facade has a higher value when the building is located at a high quality location, with high visibility, than when it is located at a low quality location.

Table 1. Survey of Hedonic office rental regression models

Author	Adjusted R square (R^2)	Dependent variable	Number of independent variables relating to specific attributes		
			Building	**Location**	**Financial**
Bollinger (1998)	0.677	Asking rent	13 (11)	15 (11)	3 (2)
Dunse (1998)	0.613	Asking rent	21 (15)	4 (4)	0
Dunse (2002)	0.580	Asking rent	24 (15)	1 (1)	0
Mills (1992)	0.375	Asking rent and present value of the lease	10 (5)	10 (9)	0
Oven (2004)	0.775	Contract rent	10	39	5

2.4 Reflection

The rent a tenant is willing to pay for office space should bear relation to the achieved competitive advantage gained by the chosen location and characteristics of the office building. If a certain user has higher expectations of a specific building he will outbid those office space users with lower expectations. If a market is efficient the price determined should reflect the consensus view. Because of the deficiencies in the office space market, such as the lack of full information and heterogeneity of the product, it can be argued that the market is less efficient and that value in use and value in exchange may have diverged as rental levels have become disengaged from the tenant's ability (willingness) to pay (French, 2003). The consequence of market inefficiencies is that the price of office buildings can not be completely determined by the market, but that the market only determines a range of prices (Evans, 1995). Although the imperfections of the real estate market are widely recognised, most literature refers to it as though it were the very paradigm of a neo-classical perfect market (Evans, 1995). Kauko (2002) has six critical remarks about the use of hedonic rental price modelling for residential housing price analysis. These same points of critic holds true for the office market and are summarised as follows (Vink, 2004):

1. Theoretical shortcomings: the behavioural element, the cultural and institutional element are not incorporated in the model.
2. The model assumes the existence of equilibrium on the office space market.
3. Secondary data are used.

The assumption of equilibrium is arbitrary because of the existence of real estate market/development cycles. On the short term supply is often considered inelastic because of the lengthy development periods, durability, public-sector intervention through the planning system, the lack of information and the heterogeneous nature of property (Jones, 1995, Orr, 2003). Furthermore, a spatial adjustment of existing office stock is impossible because of the immobility of property.

Secondary data, the dataset for the analysis are most commonly supplied by market parties, this data is hardly ever verified and some remains confidential. Asking-rent is frequently used as dependent variable for hedonic price models. Data on asking-rents are freely available, but the actual contract rent or the effective rent, contract rent corrected for incentives, is regarded as commercially confidential. The use of asking-rents for rental analysis is arbitrary. The figure is not corrected for offered incentives and provides in this manner a distorted view of the current rent level. Incentives are common when the market can be classified as a buyers market; this is the case when supply exceeds demand. During this phase of the market cycle, landlords will try to attract tenants by providing additional financial benefits without adjusting the long-term rental rate; incentives such as rent-free periods, free hard fit-outs, compensation for the re-location costs and furnishing contributions offer this prospect. While the use of actual transacted rents, corrected for incentives have the theoretical preference, in practice, the confidentiality of these figures may complicate data collection.

3. THE THEORETICAL CASE

Occupiers of office space have a set of requirements and preferences in relation to office accommodation. These preferences relate to the location and the office building. A lot of academic interest is directed at explaining rent variations by the location characteristics of the office property. The design quality and the operational features of the office property are often neglected. The quality of the property is considered difficult to measure. The quality consist of "hard" and "soft" factors (Gerritse, 2005). Measurement of the more "soft" characteristics of the office building, such as aesthetic characteristics of the building is expected to be the most problematic.

Office accommodation requirements depend on the nature of the organisation, but some general preferences can be identified. First of all, it is important to make a distinction in location and building specific requirements. Second, preferences should be translated in location characteristics and office building features. Finally, the features and characteristics should be coded in indicators that describe the characteristics of the location and the features of the office building or unit.

Only characteristics relating to the site and part of the setting indicators are taken into consideration, because this paper focuses on rent variations within metropolitan boundaries. Indicators relating to spatial relationships are considered constant for the study area and do not offer added explanative power for rent variations within metropolitan boundaries.

3.1 Analysing the added value of office property elements on the rental market

Office space users can fulfil their space demand on different markets; on the development and construction market, on the office property ownership market and on the rental market. On some of these markets the office space users have to compete with investors or developers. These competitors are not competing for the right to use office space but for the ownership of the building or right to develop an office building. Determining relationships between the bundle of office property elements and the observed market price can most accurately be done on the rental market. On this market office space users are the only demanding actor and the market price, rent per square meter, should most accurately reflect the value a user ascribes to an office property or unit.

3.2 The local market and metropolitan submarkets

Office markets are considered local markets. McNamara (1991) stressed the need to move towards a more meaningful level of analysis. The level should encapsulate the intraregional rent variations that occur due to differential local demand and supply flows. Schiller (1993) argues that a satisfactory local office prediction model needs to take local demand and supply flows into account, future footloose demand and the interactions with adjacent office centres. Jones (1995) states that there even are supply imbalances within urban markets. This implies that the sub-urban level would be the most appropriate level of analysis. Geltner (2001) perceives metropolitan areas as the primary geographic unit for analysing the (office) space market. He defines a metropolitan area as a central city and its surrounding suburbs which tends to be relatively integrated economically, culturally, and socially. The economic structure of a metropolitan area is largely the same, but according to Geltner (2001) even within a single metropolitan area there is still considerable geographical segmentation of the space market.

Market segmentation is the process of identifying and analysing submarkets of a larger group of property markets (Miles, 2001). According to Dunse (2002) an office submarket is a category of offices which, although different in their combination of characteristics, are a reasonable substitute for each other. It seems plausible that the office submarkets are interrelated. Two kinds of segmentation are recognised: spatial and structural (Dunse, 2002). Spatial segmented submarkets are defined as geographically delineated market areas. Structural segmentation is based on the quality level of the office accommodation attributes. It is likely that there is a relationship between the structural attributes (quality level) of the office property and the site of the office property. For example, a high architectural quality of office building is only feasible when this is done on the proper location. The availability of enough cover deck parking is also valued differently in the city centre than in a less densely populated area. In this line of reasoning it seems plausible that spatial and structural segmented submarkets partly overlap.

In this study only geographic submarkets are incorporated in the analysis. This is done because it is assumed that the value that is ascribed to site characteristics and building features differs between submarkets. A priori metropolitan submarket definitions based upon real estate agents' views are employed. Research from Dunse (2001, 2002) points out that this is a good starting point, but that the actual submarkets structure is some what more complicated than what is perceived by real estate agents.

4. METHODOLOGY

When an extensive number of independent variables is included in multiple regression it becomes necessary to have a large research population; many rental transaction in varies office buildings. For multiple regression it is required to have a research population of at least 30 cases, but this depends on the number of independent variables that is included in the analysis. The research population can be increased by two methods; by enlarging the study area or by making use of transactions in a number of succeeding years.

Hedonic price analysis does not cope with different market segments. It assumes a homogeneous market with one equilibrium state. The reliability of hedonic price analysis can be improved by enhancing the homogeneity of the research population. Real estate markets are considered local markets and increasing the study area increases the heterogeneity of the market. Enlarging the study area is therefore not considered a valid option to boost the research population.

4.1 Functional hedonic price model forms

The "standard" (linear) hedonic price model is not suited for time series analysis. Translating dynamic data into dummy variables accomplishes that time series analysis can be performed with the "standard" linear regression model. Time series analysis can also be performed by changing the functional form of the hedonic price model. Hedonic price models can take the shape of three functional forms; linear (2), semi-log (3) and logarithmic. There is no strong theoretical basis for choosing the correct functional form of a hedonic regression (Rosen, 1974, Vink, 2004). Linear models are employed to explain value variations whereby the coefficients of the independent variables express the absolute value of the office feature. In the semi-log and logarithmic form the coefficients express the percentages contribution of a variable to the total value. The semi-log and logarithmic form are most commonly used for time series analysis and international comparison (Vink, 2004).

According to Malpezzi (2002) the semi-log form has five features that recommend this form. Two of these features are discussed. First, the semi-log model allows for variations in the financial value of a particular characteristic. The price of one component partly depends on the other property characteristics. The model allows for interaction effects between variables e.g. the value added by a high quality facade is related to the visibility of the object. Second, the coefficients of a semi-log model can be interpreted as approximately the percentage change in the rent or value given a unit change in the independent variable. It determines the relative value of the office property features. By measuring the relative value the semi-log model corrects for average rent changes (market conditions) and can be used for time series analysis.

Choosing the correct model form is usually done by statistical experiments and choosing the model with the best fit. Two methods can be recognised to determine the goodness of fit of a model. By means of selecting the model form on basis of the highest (adjusted) R square or by the Box-Cox transformation. While the Box-Cox method is the more systematic approach, the interpretation of the outcome requires extensive empirical knowledge and the outcome is not clear-cut (Vink, 2004).

The type of analysis and the kind of independent variables used for the analysis influences the choice for the functional model form. Enlarging the study area is not seen as a valid option to realize a large enough research population. Therefore the functional model form must be able to cope with time series analysis. The ultimate selection of the model form is selected by means of the highest R square and only the semi-log model and the linear model are used.

$$R = \beta_0 + \beta_1 B + \beta_2 S + \beta_3 C + \varepsilon \qquad \text{Linear model} \qquad (2)$$

$$\ln R = \beta_0 + \beta_1 B + \beta_2 S + \beta_3 C + \varepsilon \qquad \text{Log-linear model} \quad (3)$$

Whereby R is the rent per square meter lettable floor area, B represents the building features, S the site characteristics and C stands for the contract terms. Regression equations have a constant term and an error term. In linear regression the constant (β_0) is a measure for the influence of all the independent variables that are not incorporated in the analysis. The error term (ε) is a statistical measure, also called estimation error, which indicates the discrepancy between the actual value and the estimated value according to the regression equation. The coefficients (β_1,…., β_n) of the equation in the linear model express the absolute value of the office attributes. In the semi-log form the coefficients express the added value of the variable in percentages of the total value (rent level).

An experiment is also undertaken with a modified linear model as is illustrated in equation four. This method relates office property attributes to the deviation of the rent level from the average rent level in a submarket and can therefore also be employed for time series analysis. It tries to explain out- or underperformance in accordance to the average rent level in a delineated market area. The coefficients express the relative contribution of the attributes to this out- or underperformance.

$$\frac{R - R_{average}}{R_{average}} = \beta_0 + \beta_1 B + \beta_2 S + \beta_3 C + \varepsilon \qquad \text{Modified linear model} \qquad (4)$$

4.2 The dependent variable

Average market rent can be calculated on value weighted base or non value weighted base. The choice for value weighted or non value weighted average rent levels is debatable (Hordijk, 2005). Large transactions can have a considerable influence on the average rent level when a value weighted average rent level is used. This is especially the case when there are few transactions in the study area. The prior defined submarkets are relative small and the risk of "distortions" due to one or two large transactions is genuine. It is uncomplicated to test the above equation with non value weighted average rent level, as well with a value weighted average rent level. Both approaches are employed.

4.3 Independent variables

The value judgement by an office space user regarding an office building or unit involves an assessment of a complex set of both qualitative and quantitative factors. The preferences of the office space user relating to the office property attributes and location characteristics are factors that logically should influence the willingness to pay for an office building. The property attributes and location characteristics are factors that are included, as independent variables, in the hedonic rent analysis. The users' value judgement concerning these office attributes and location characteristics must be quantified for the use of a hedonic price model. Some of the office property attributes and location characteristics can be objectively measured by indicators.

There are a few basic conditions independent variables have to fulfil for the appliance of multiple regression. Qualitative data measured on nominal or ordinal scale must be translated into dummy variables, measured on a dichotomy scale, before it can be included in the analysis. Quantitative data measured on a ratio scale can be directly analysed. The independent variables may not be multicollinear, meaning that the correlation between independent variables must be lower then 90 percent.

If all the indicators are directly included, if necessary after translation in dummy variables, a large number of variables must be included in the hedonic price analysis. A large number of variables complicates the analysis. A solution for this problem may be synthesised quality variables relating to main office property attributes and location characteristics. The Analytical Hierarchy Process (AHP) can help to construct these quality variables (Bender, 1997). Groups of indicators are weighted and together form a value judgement concerning the abstract concepts, such as imago and accessibility etc (see fig. 3). In this manner the value judgement regarding the abstract concepts is included in the hedonic rent analysis and fewer independent variables are included in the analysis. This reduces the multicollinear problem and incorporates a enhanced measurement of the interaction effect into the analysis.

Office property attributes

Regression coefficients	Value judgment	Categories	Weights	Attributes/ indicators	Classification
…	6.2	Imago	0.5 0.2 0.3	Façade type Internal finishes Entrance hall	7 6 5
…	…	…	… …	… …	… …

Fig. 3. Construction of synthesised quality variables

The AHP is a multi-criteria decision analysis method, based on the concept of a value tree, which can quantify abstract factors or value judgements (Kauko, 2002). The AHP consist of three stages: First, the problem (decision process) is structured as a hierarchical value tree, whereby the final goal is split into main-criteria (elements) and henceforward into sub-criteria and attributes (see fig. 4.). Secondly, on each hierarchical level, the relative importance (weight) with respect to the goal of each criterion is established by using a measurement methodology. The measurement methodology requires that the criteria on one particular level are evaluated in pair-wise fashion using an ordinal scale. Most commonly a nine points scale is applied, whereby the number one indicates that the criteria are of equal importance and a nine means that the criteria is of absolute dominance over the other. For each ordinal comparison of a criteria (element) pair the dominate criteria is given a rank on the nine point scale, and the recessive criteria the inverted value of the rank (see table 2).

The coefficients are determined by hedonic price analysis

This is the quality variable of imago that is included in the hedonic price analysis

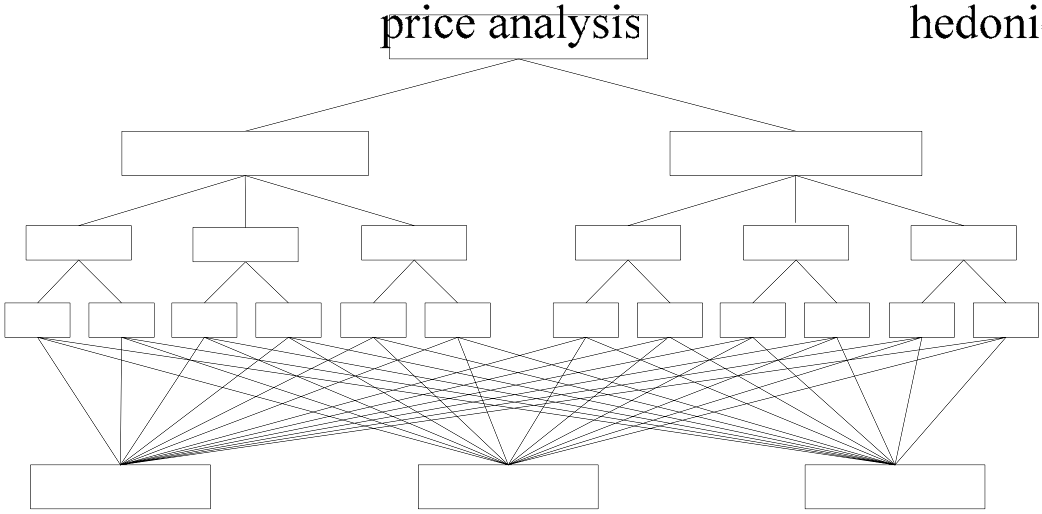

Fig. 4. Selection hierarchy, source: based on Ball (1994)

For operational reasons the ordinal weights on one level are transformed into cardinal weights in the third stage so that the weights sum op to unity. The most common way to achieve this is the "eigenvalue" method from matrix algebra (Kauko, 2002).

For a detailed explanation of this "eigenvalue" method see e.g. Saaty (1990), Ball (1994) and Kauko (2002). Henceforward, local weights, priorities on one hierarchy level, starting at the lowest level are transformed in global weights by weighting them by the local weights of the upper level criteria. The process of transforming local weights is described in the following formula (5).

$$GW = LW_{level\_N} \times LW_{Level\_N-1} \times \ldots \times LW_{level\_1} \qquad \text{Global weights formula} \qquad (5)$$

Whereby GW is the global weight, LW the local weight, level N the lowest hierarchy level and level one the highest level. Different software packages are available to help solve the mathematics employed throughout the Analytical Hierarchy Process.

Table 2. Pair-wise AHP comparison matrix for one hierarchy level and local weights of the eight elements, source: Saaty (1990)

Elements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Local weights**
1	1	5	3	7	6	6	1/3	1/4	0.173
2	1/5	1	1/3	5	3	3	1/5	1/7	0.054
3	1/3	3	1	6	3	4	6	1/5	0.188
4	1/7	1/5	1/6	1	1/3	1/4	1/7	1/8	0.018
5	1/6	1/3	1/3	3	1	1/2	1/5	1/6	0.031
6	1/6	1/3	1/4	4	2	1	1/5	1/6	0.036
7	3	5	1/6	7	5	5	1	1/2	0.167
8	4	7	5	8	6	6	2	1	0.333
Total:									1 (100%)

Experience gained in the course of development and appliance of building evaluation techniques can be a valuable source for selection of the “right” independent variables for the hedonic price analysis and the AHP. A Dutch building evaluation method is the Real Estate Norm (REN) and it has similarities with the AHP method. The REN offers a good starting point for appliance of the AHP method in combination with hedonic regression.

From a review of recent Dutch studies regarding office space users’ preferences the most important site and building preferences are shown in fig. 5. These preferences are supplemented with the categories recognised in two building evaluation techniques (REN and BQA) and the employed independent variables used in previous hedonic rent analysis of offices. The Real Estate Norm (REN) and the Building Quality Assessment (BQA) tools are both expert-based building evaluation techniques that strive to determine the match between organisational requirements and the characteristics of the office building (Bottom, 1998).

In a recent study regarding office accommodation preferences in Amsterdam, parking space, lay-out flexibility and the technical quality of installations are perceived as lacking (Stel, 2005). Generally Amsterdam office space users are satisfied with the accessibility and the image of office property. Office space users express a tendency for multi-tenant office buildings and prefer new constructed or renovated office buildings.

From the previous studies the abstract concepts must be translated in indicators that measure these concepts. Figure 5 shows the main categories of office property attributes and location characteristics. The translation of these abstract concepts to measurable indicators is complicated and is not yet discussed in this paper.

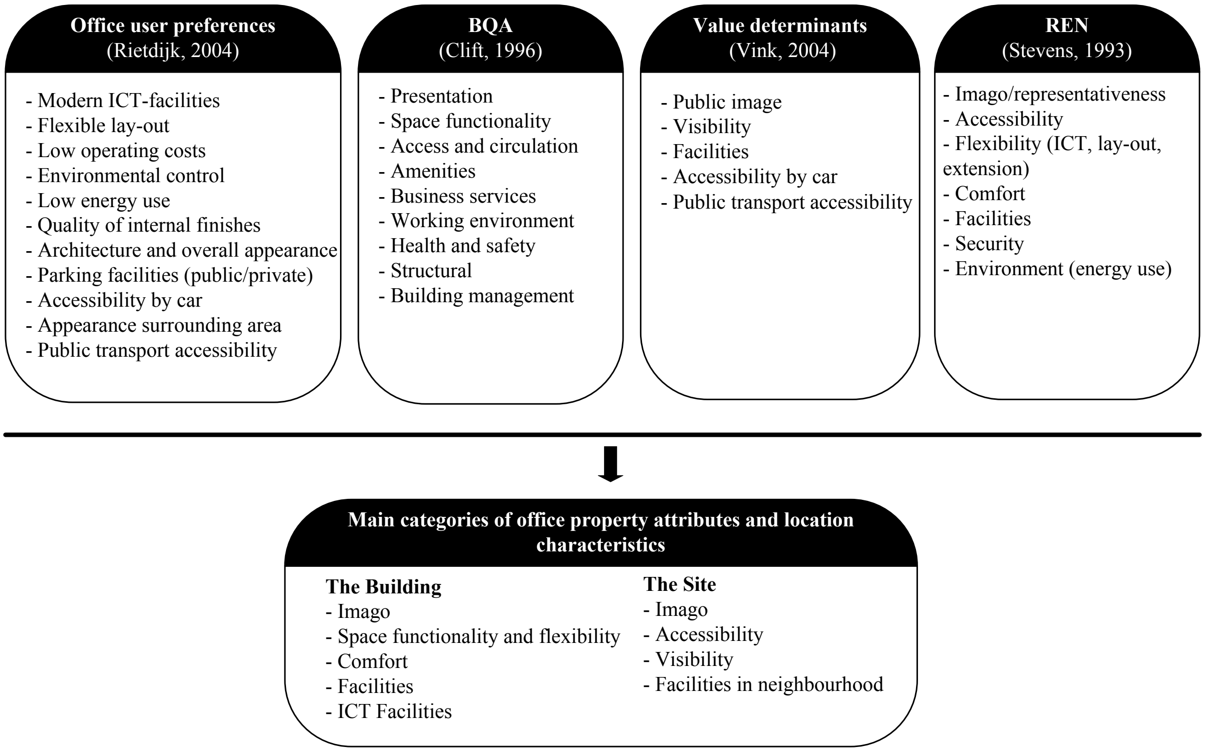

Fig. 5. Foremost preferences concerning the physical office building and its location, source: Vink (2004), Rietdijk (2004), Clift (1996) and Stichting REN (1994)

4.4 Data availability

Amsterdam is the best documented office market in the Netherlands. Data for analysis is gathered from different sources. Two real estate agents are willing to provide transaction data for a number of succeeding years. This data include some basic information about the specific office property object and provides information about the realized rent per square meter, time of the transaction, rented floor area and lease length. Second, information is used from the transaction database of PropertyNL; this database includes some additional information about the object. The taxation database of the ROZ/IPD is used for additional object data and financial indicators. From the investigation of available data it can be concluded that hardly any object specific information is collected in databases. Some object specific information may be gathered from other sources, such as the municipality, corporate real estate management firms and large office property investment funds.

4.5 Interpretation of the hedonic regression results

The interpretation of the hedonic model depends on the functional form that is chosen. If the linear form (2) is chosen, the coefficients represent the implicit, absolute value, of the attributes. With the semi-log form (3) the coefficients express the added value of the variable in percentages of the total value (rent). The coefficients for the modified linear form (4) express the relative contribution of the attributes to the out- or underperformance in comparison with the average rent level.

To determine the degree of influence of a variable on the ultimate rent per square meter, standardised coefficients are compared. Only variables that are at least significant at the 95 percent level are included in the ultimate model. The adjusted R square is a measure for the explanatory power of the total model and can be used to compare models with each other. When the error term is relatively large the values of the regression coefficients should be treated with reservation and viewed critically.

5. CONCLUDING COMMENTS

Office properties are heterogeneous goods and therefore can not be compared directly. Heterogeneous goods consist of a bundle of attributes. By analysing rent variations within metropolitan boundaries, at one moment in time, the added value of office property attributes and site specific characteristics can be obtained. Hedonic price analysis offers the opportunity to determine the implicit price of these office attributes and location characteristics. Analysing the relationships between the bundle of office property elements and the observed market price is most accurately done on the rental market. Market conditions and contract terms should be taken into account throughout the analysis. The hedonic price analysis has a few theoretical and practical drawbacks such as: theoretical shortcomings, the assumption of market equilibrium and the use of secondary data. The Analytical Hierarchy Process (AHP) can help to construct quality variables and reduce the multicollinearity problem and enhance the measurement of the interaction effect. Indicators, that construct the independent variables, can be acutely selected by means of reviewing previous office space user preference studies and building evaluation techniques. The reliability and usefulness of the outcome depend for a great extent on the quality and availability of data. The major challenge is to collect the "right" data and interpret the outcomes correctly.

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ISLAM AND SUSTAINABLE DEVELOPMENT

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ABSTRACT: Sustainable development is not a new concept to Islam, sustainable development principles have existed for centuries in the Holy Qur'an and the Hadith. However, sustainable development concept may have been recently adopted for government and civic society in Islamic world. The Islamic perspective embraces that everything on earth is created for humanity and God's award to people. Islam allows the consumption of the natural environment without involving unnecessary destruction. Shariah views that human activities should support environment, and protection of people's rights, and needs ensuring that human activities do not compromise the essentials of social, economic and natural systems either now or in the future. The aim of this study is to discover the application of Islam in sustainable development debate. Sustainable development in the context of Islamic concept is taken as an opportunity to refresh the relationship between human being and environment. This paper is focusing on literature review.

Keywords: Human needs, *Shariah* take place to value nature

1. INTRODUCTION

The notion of sustainable development is considered as a response to *the human need* to balance environmental protection with a social - economic development. This paper will launch with human needs concept.

2. HUMAN NEEDS

The concept of needs is a subject to various interpretation… by some it is seen as a state of mind, by others as human capability (Chiesure and Groot, 2003). A human need is a variety of different kinds of goods, services as well being in health, education, employment, housing (Sexton, 2000), training, relationships, and include of the conditions for maintaining an acceptable life standard for all people (Khalfan, 2002). Human needs is highlighted by the definition of sustainable development given by World Commission on Environment and Development (WCED, 1987:43)

"Development that meets the needs of the present without compromising the ability of future generations to meet their own need".

This definition gives rise to the importance of temporal dimension. Temporal dimension involves inter and intra generational needs (Brigulio, 2003). Indeed, this is an equitable of benefits distribution of development and gives the right or opportunity of future generations using the same resource to meet their needs (Aburounia and Sexton, 2004).

In an Islamic perspective, the concept of human needs is based on the principles that all the individual components of the surroundings were created by God, and a human being has two basic needs; spiritual needs which is fulfilled through belief or faith in God, and physical needs which is met by making the best use of all resources which God created for him (Ahmed, 2002). Man finds all the essential needs of life such as food, water, air, light, heat, moisture on this planet; the pressure of air, the percentage of oxygen, the elements of soil, are in exact proportion to enable man to live and practice life steadily and orderly (Ibid).

In explanation of physical needs the *Qur'an* says: “Allah (God in English) is He Who created the heavens and the earth and sent down water from the clouds, then brought forth from it fruits as a sustenance for you, and He has made the ships subservient to you to run their course in the sea by His command, and He has made the rivers subservient to you. And He has made subservient to you the sun and the moon, pursuing their courses; and He has made subservient to you the night and the day. And He gives you of all ask of Him, and if you count Allah's favours, you will not be able to number them. Surely man is very unjust, very ungrateful”(Ibrahim (14), 32-34:259-260).

From spiritual need, the *Qur'an* says: “Verily, in the creation of the heavens and the earth, and the alternation of night and day, there are indeed signs for men of understanding. Those who (always) remember God standing, sitting and reclining, and reflect on the creation of the heavens and the earth, (saying): ' Our Lord! You have not created all this in vain (without a purpose), glory be to You, so save us from the torment of Hell-fire” (Aal-e-Imran (3), 190-191:75).

The various mechanisms of the natural environment serve the humanity as one of their functions; this does not imply that the human use is the only reason for their creation. As God created everything for mankind, He also created mankind for him, to thank God for all His favours and bounties, because God did not create, whom to have to serve.

Islamic religion and its contribution to sustainable development debate will now be presented.

3. SUSTAINABILITY OF ENVIRONMENT FROM ISLAMIC POINT VIEW

Islam is the name of religion which arose in what is now known as Saudi Arabia in 610 A.D (Abd-Allah, 2004). Its initiator was the prophet Mohammed (Peace Be upon Him). The message of God revealed to him is contained in the Holy *Qur'an*.

The prophet Mohammed (Peace Be upon Him) taught the Muslim followers some lessons that touch their lives. These lessons have been recorded and compiled in the *Hadith*. Muslims learn from these two books, *Qu'ran* and *Hadith*.

The rules in those two books and the body of legal opinion recorded by Muslims lawyers relating to all facts of social life in Islamic society are called (*Shariah*). *Shariah* covers all areas of economic, social, political and also ecological aspects. Islam is not just religion; it represents an entire sense of community and a way of life. It defines both a world view and a guidance framework for actions in all spheres of life (Ahmed, 1988).

Sustainable development is not a new concept to Muslims. The *Qur'an* and the *Hadith* provide the framework for the spiritual and physical welfare of humanity. There are over 500 verses in the *Qur'a*n giving Muslims guidance on matters relating to the environment and how to deal with it, and there are numerous examples from the prophet Mohammed's life (PBUH) and his sayings, which provide a model for justice and equity (Hassan and Cajee,2002).

The Islamic perspective embraces that everything on the earth was created for humanity and is God's award to people. However, it is an award with conditions and it is unquestionably that carries responsibilities. The earth then is a testing ground of the humankind. The tests are a measure of man's acts of admiration (Khalid, 2002). On this subject *Qur'an* says:

"Allah sends down water from the sky and by it brings the dead earth back to life. There is certainly a Sign in that for people who hear. There is instruction for you in cattle. From the contents of their bellies, from between dung and blood, we give pure milk to drink, easy for drinkers to swallow. And from the fruit of the date palm and the grapevine you derive both intoxicants and wholesome provision. There is certainly a Sign in that for people who use their intellect. Your Lord revealed to the bees: Build dwelling in the mountains and the trees, and also in the structures which men erect. Then eat from every kind of fruit and travel the paths of your Lord, which have been made easy for you to follow. From inside them comes a drink of varying colours, containing healing for mankind. There is certainly a Sign in that for people who reflect" (An-Nahl (16), 65-59:273-274).

Mohammed (PBUH) also asked his followers that: "Not to harm women, children and the infirm, not to harm animals, destroy crops or cut down trees".

This *Hadith* is sort of recognition of the human condition and the value of nature, they never been separated from each other.

4. SHARIAH TAKE PLACE TO VALUE NATURE

The Arabic word *Shariah* means the source of life and contains both legal rules and ethical principles. It is established since the founding of Islam in the 7th century (Cone, 2003:64). *Qur'an* says: "But no, by your Lord they can have no faith until they make you judge in all disputes between them" (An-Nisa (4), 65:88).

"And verily, you (O Muhammad) are indeed guiding (mankind) to the Straight Path" Ash-Shura (42), Verse.52:489).

Narrated An-Nu'man bin Bashir: The Prophet said "Both legal and illegal things are obvious, and in between them are (suspicious) doubtful matters. So who-ever forsakes those doubtful things lest he may commit a sin, will definitely avoid what is clearly illegal; and who-ever indulges in these doubtful things bravely, is likely to commit what is clearly illegal".

Therefore from *Qur'an* and *Hadith* (*Shariah*) teaches human being that there are two purposes of his/her creation (Ahmed, 2002):

- To be God's Vicegerent (*Khalifa*) on earth, even as God said in the *Qur'an*: "It is God who has created for you all that is on earth….And remember when your Lord said to the angels: 'Verily, I am going to place a viceroy (mankind) on earth.' They said: 'Will You place therein those who will make mischief therein and shed blood, -while we glorify You with praise and sanctify You?" God said: 'Verily, I know better what you do not know" (Al-Baqara (2), 29-30:5-6). This last verse refers to the time when God announced to the angels that He was going to create the first man, Adam (PBUH).
- To serve and worship God by fulfilling all acts of worship prescribed by Him, and by keeping good relationship between human beings, even as God said in the *Qur'an*: "I have not created the Jinn and men but to serve me"(Adh-Dhariyat(51), 56:523). This is indicated by the division of the *Shariah* relevant

to human action into four categories as stated by *Shariah* scholars, a Muslim is required to perform those actions:

1. **Obligatory actions (*Wajib*):** it is any act Islam makes obligatory on a *mukaluf* Muslim in a significant way and which under no circumstances can she/he ignore (Ibid). *Shariah* warns against exceeding in using of natural resources. For example, the prophet (PBUH) dedicated specific area in Mecca and Medina as where no natural plants could be uproot and no animals hunted (ISESCO, 2005) “Allah's *Hima* (i.e. private pasture) and whoever pastures (his sheep) near it, is likely to get in it at any moment”. The use of *Hima* system and *haram* zone is still widespread in some Muslims countries especially in rural areas where *Himas* are created to support animals grazing on a more communal basis (Fakir, 2005).
2. **Ethical actions (Mustahab):** a Muslim is encouraged to perform those actions, sustains no adherence, no responsibility of those actions, examples of those actions is protecting the environment (Izzi-Deen, 1990).
   1. The environment is God's creation and to protect it is to preserve its values as a sign of the Creator.
   2. The component parts of nature are entities in continuous admiration of their Creator. “The seven heavens and the earth and all that is therein praise Him, and there is not such a thing but hymneth his praise; but ye understand not their praise. Lo! He is ever Clement, Forgiving” (Al-Isra (17), 44:286).
   3. The law of nature is law made by the Creator and based on the concept the absolute continuity of existence. “Hast thou not seen that unto Allah payeth adoration whosoever is in the heavens and whosoever is in the earth, and the sun, and the moon, and the stars, and the hills, and the trees, and the beasts, and many of mankind”(Al-Hajj(22), 18:334).
   4. The *Shariah* acknowledges that humankind is not the only community to live on the earth. “There is not an animal in the earth, nor a flying creature flying on two wings, but they are peoples like unto you” (Al-Anaam (6), 38:132). “See you not (O Muhammad) that Allah, He it is Whom glorify whosoever is in the heavens and the earth, and the birds with wings out-spread (in their flight)?. Of each one He (Allah) knows indeed his *Salat* (prayer) and his glorification, [or everyone knows his *Salat* (prayer) and his glorification]; and Allah is All-Aware of what they do” (An-Nur (26), Verse41:355).
   5. Islamic environmental ethics is based on the concept that all human relationships are established on justice and equity. “Lo! Allah enjoineth justice and kindness”. And Prophet Mohammed thought: “Verily Allah has prescribed equity in all things”.
   6. The balance of the universe created by God. Functions carefully measured and exactly balanced by the Creator. "Has taught (you mankind) the *Qur,an* (by His Mercy). He created man. He taught him eloquent speech. The sun and the moon run on their fixed courses (exactly) calculated with measured out stages for each (for reckoning, etc.). And the herbs (or stars) and the trees both prostrate. And the heaven He has raised high, and He has set up the Balance. In order that you may not transgress (due) balance, and observe the weight with equity and do not make the balance deficient"(Al-Rahman (55), 1-9:531). “Everything with Him is measured”(Al-Rad (13), 8:250). "There is not a thing but with Us are the stores thereof. And We send it not down save in appointed measure"(Al-Hijr (15), 21:263).
3. **Permission actions (*Mubah*):** a Muslim is given complete freedom of choice within the circle of permission; in terms of environmental point view, the prophet

Mohamed said "whoever brings dead land to life, for him is a reward in it, and whatever any creature seeking food eats of it shall be reckoned as charity from him"(Selleh,1992). Also the prophet claimed about this matter that:

- People who reclaim or revive land have permission to its ownership.
- Land grants may be made by the state for reclamation and development.
- Land may be leased for its usufruct by the state for its reclamation and development.
- Special reserves may be established by the state for use as conservation zones.

4. **Abominable actions (*Makruh*):** those which are morally but not legally wrong, it is preferable to avoid such acts in the interests of self or society (Ibid). The *Shariah* also evolved within these actions a principle, which is a bigger loss cannot be prescribed to ease a smaller loss and a bigger benefit takes precedence over a smaller one. Conversely a smaller harm can be prescribed to avoid a bigger harm and a smaller benefit can be dispensed with in preference to a bigger one (Khalid, 2002).
5. **Prohibited actions (*Muharam*):** It is any act that Islam prohibits the religiously responsible Muslim (Ibid, (2005). Islam allows the consumption of the natural environment without involving unnecessary destruction (Khalid, 2002). "O Children of Adam look to your adornment at every place of worship, and eat and drink, but be not prodigal. Lo! He loves not the prodigals"(Al-Araf (7), 31:154). The environment is not down in the service of the present generation alone. It is rather the gift of God to all generations, past, present and future.
   "He it is Who created for you all that is in the earth"(Al-Baqara (2), 29:5).
   In these Qur'anic verses, eating and drinking refer to the utilization of the sources of life; such utilization is not without controls. The component elements of life have to be protected so that their utilization may continue in a sustainable way (Izzi-Deen, 1990). The forbidden things or acts are limited and whatever else beside, is to enjoy according to a system which preserves the way of life and provides balance and harmony in every human activity (Ibid).
   Khalid, (2002) explains in this matter that the interests of the community have to take precedence over the interests of the individual:
   - Allah is the only owner of the earth and everything in it. People embrace land on usufruct - that is, for its utility value only. There is a restricted right to public property.
   - Mistreatment of rights is prohibited and disciplined.
   - There are rights to the benefits derived from natural resources held in common.
   - Scarce resource utilization is controlled.
   - The common welfare is protected.
   - Benefits are protected and detriments are either reduced or eliminated.

5. SHARIAH TAKE PLACE TO VALUE SOCIETY

There are six elements that are considered by *shariah* to be key unique perspective of Islam in matters of value society; these four elements are social cohesion, responsibility (*Faradh)*, empowerment (*Shura*), equilibrium (*Al'adl wal ihsan*), endowment (*Al-Wqaf*) and almsgiving (Zakat). Those five elements are main indicators of sustainable development agenda.

1. **Social cohesion (*Ummah*)**: Islam has called for society cohesion more than one thousand four hundred years ago (ISESCO, 2005). *shariah* emphasise the inspiration of cohesive society as is the process of developing a society of shared values, shared challenge and equal opportunities. God said: "O mankind! Verily We have created you out of a male and a female, and We have made you into nations and tribes, that you may know one another. Indeed, the noblest of you in the sight of God is the most conscious of Him. Verily, Allah is All-Knowing, All-Aware" (Al-Hujraat (49), Verse.13:517). "And among His signs is the creation of the heavens and the earth, and the difference of your languages and colours, Verily in that are signs for men of sound knowledge" (Ar-Room (30), Verse.22:406).
2. **Responsibility (*Faradh*)**: individual and society have the responsibility to use of welfare in a responsible way (Fakir, 2002). Responsibility from the recognition that comes with human awareness. Humans are responsible as God's vice-regents (*Kalifah)* for the care of the earth God said in the *Qur'an*: "It is God who has created for you all that is on earth….And remember when your Lord said to the angels: 'Verily, I am going to place a viceroy (mankind) on earth.' They said: 'Will You place therein those who will make mischief therein and shed blood, -while we glorify You with praise and sanctify You?" God said: 'Verily, I know better what you do not know" (Al-Baqara (2), 29-30:5-6). The stress on individual responsibility is seen to be realised in the function of understanding of mankind creation. In all circumstances there is a pressure on Muslims to act in accordance with their understanding (*ijtihad*) (Cone, 2003).
3. **Empowerment (*Shura*)**: human beings should fully participate in decision making and implementation in their life (UNDP, 1995). In Islamic perspective the empowerment means the *Shuratic* decision making of all levels of the Islamic society. It applies collectively to the decision making on social matters (Salleh, 1992). Such a cure of *Shura* is closed to its meaning in the *Qur'an*: "And who (conduct) their affairs by mutual consultation" (Ash-Shura (42), Verse.38:487).
4. **Equilibrium (*Al'adl wal ihsan*)**: in which individuals have the freedom to act, but must do so with manner from welfare of the present and future generation (Fakir, 2002), God says: "if you loan God beautiful loan, He will double it in your credit, and He will grant your forgiveness".
5. **Endowment (*Al-Wqaf*)**: Islam has through its principles endeavored to fight against poverty. This fight can either occur through provides a source of income for a person, or through government assistance and unique to Islam and that ensures that man is free from the shackles of poverty (ISESCO, 2005). God said in the *Qur'an*: "Give your kinsman his due, and the needy, and the way-farer, and squander not (your wealth) in wantonness. Indeed, the squanderers are brothers of the devils, and the devil is ever an ingrate to his Lord" (Al-Isra (17), Verse. 26-27: 285).
6. **Alms (Zakat)**: Zakat is one of the five pillars of Islam. Zakat provides a vital mechanism for addressing social welfare issues. In *shariah*; the word zakat refers to the determined share of wealth given by Allah to be distributed among the categories of those allowed to receive it. It is used to mean the action of payment of this share. All Muslims are required to give away at least two and half per cent (2.5%) of their income to the poor people (www.salaam.co.uk/islamicfinance). Zakat enables to fulfill the social and

moral objectives of an Islamic society. It has a moral purpose with respect to the individual. The social objective of Zakat is to eliminate poverty and the desire for personal accumulation at any cost and to encourage socially orientated behavior (Matthews *et al.*, 2003).

6. DEFINITION OF SUSTAINABLE DEVELOPMENT IN ISLAMIC PERSPECTIVE

Based on the above mentioned bases philosophy of sustainable development from the Islamic perspective, can now be defined as sustainable development from Islam seeks to establish a balance between the environment, economic and social dimensions. It means the balanced of consumer welfare, economic efficiency, achievement of ecological balance in the framework of evolutionary knowledge-based, and socially interactive model defining the social justice, *shuratice* process, charity and zakat are two mechanisms to reduce poverty.

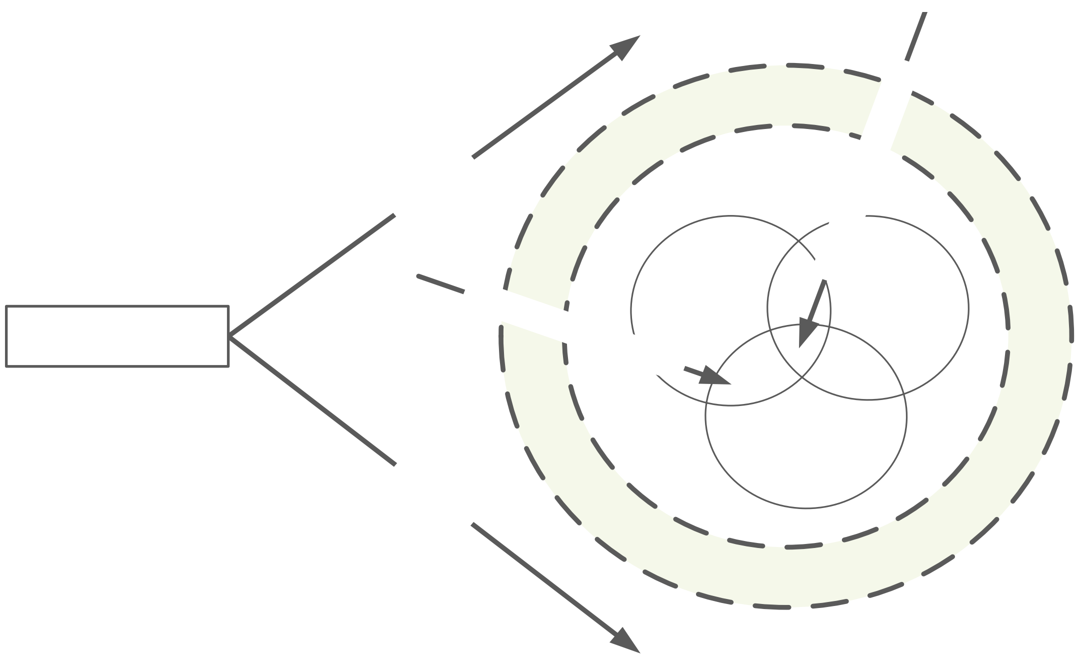

Figure 1: The Islamic System of Sustainable Development

7. CONCLUSION

This study hopes to provide a theoretical background for the present debate on sustainable development from an Islamic perspective. The concept of sustainable development took root in 7th century Islam ideology, however, it was not until 20th century that this ideology was translated into a modern context. Islam, for example, warns in the Holy *Qur'an* and *Hadiths* against excess and over extension of natural resources. Islam calls collective as well as individuals to refer to God's *Shariah*. Islam calls for a sense of responsibility and awareness of the reason of mankind creation. All these are natural outcomes of the *Shariah* rules.

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ASSESSING THE FEASIBILITY OF USING VALUE MANAGEMENT TO ACCELERATE THE IMPLEMENTATION OF SUSTAINABILITY

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ABSTRACT: The present demand for economically viable buildings in the Saudi Public Sector is coupled with the need to maximise the efficient use of Saudi Arabian natural resources. The lack of consideration paid to sustainability issues during the concept phase has resulted in higher consumption of materials and energy during both the construction and operational phases of many building projects. Although there is extensive Value Management (VM) knowledge and experience, many who work in the Saudi Public Sector appear to have less experience of sustainable development, consequently sustainable construction is all too often not a major consideration. This paper is part of an ongoing research which aims to exploit the VM experiences and skills of those in the Saudi Public Sector in order to accelerate the understanding and implementation of sustainable development in the country. It provides an overview of the current situation of VM and sustainability in the Saudi Public Sector by investigating in-depth the: application of VM and sustainability; clients' attitudes towards both subjects; identification of the barriers that impede their application and the determination of the level of existent knowledge about both topics in the Saudi Public Sector.

Keywords: Saudi Arabia, sustainability, value management

1. INTRODUCTION AND BACKGROUND

The quest towards sustainable development throughout the world has put a spotlight on the construction industry. Construction has being defined as *"the broad process/mechanism for the realization of human settlements and the creation of infrastructure that supports development. This includes the extraction and beneficiation of raw materials, the manufacturing of construction materials and components, the construction project cycle from feasibility and design to deconstruction, and the management and operation of the built environment"* (Plessis, 2002). If the construction industry is to provide the required buildings and infrastructure whilst minimising environmental degradation it must adopt more sustainable practices and policies (Ngowi, 2000). The construction industry has both positive and negative impacts on the environment and people. It can contribute to environmental problems through resources depletion; energy consumption; air pollution and waste creation (Ngowi, 2000). Sustainability principles advocate maximising the efficient use of resources and mitigating the negative environmental impacts. The construction industry's fragmentation creates many difficulties for its clients who must procure individual project elements from different sources (Egan, 1998). It is estimated that the construction industry in Europe is responsible for approximately 40% of energy consumption, 30% of CO_2 emissions and 40% of total solid production waste (Hajek, 2002; Sjostrom, 1999). However, the construction industry constitutes 10-12% of GNP to the economy of the European Union (Sjostrom, 1999) and employs approximately 1.5 million people in the United Kingdom. It also contributes to the quality of life for humanity (DETR, 2000).

At the beginning of the 1970s, designers thought that the ability to achieve a task was restricted only by equipment; they thought that if one could invent a way to accomplish a goal, the required resources would be available. In today's economic environment, however, limited resources have again become a dilemma. Thus, effective VM programmes are needed again, as they were with the shortage of materials during World War II (Land, 1997). The combination of economic and environmental assessment tools to obtain "value for money" has the potential to realise a considerable contribution to implement sustainable principles. Financial appraisal of building projects should take into account the whole life cost of building including its design, construction, operating and maintenance and deconstruction, rather than emphasising purely initial design and construction costs. Environmental impact cannot be measured on a monetary scale; it can be quantified by using life-cycle assessment or LCA (Estate Management and Building Service, 2005). The utilisation of VM brings substantial benefits for promoting sustainable construction principles. The principles and techniques of VM can provide the required quality to realise an optimal whole life cost and life-cycle assessment during the process of developing a project.

This paper is part of ongoing PhD research which aims to exploit the VM experiences and skills of those in the Saudi Public Sector to accelerate the understanding and implementation of sustainable development in Saudi Arabia. The scope of this paper is limited to provide an overview of the current situation of VM and sustainability by investigating in-depth the following issues in the Saudi Public Sector: the existing application of VM and sustainability; the clients' attitudes towards both topics; the identification of the barriers that may impede their application, and the knowledge of people who work in the Saudi Public Sector about VM and sustainability.

2. DEFINING SUSTAINABILITY

There has been increased awareness of the importance of sustainable development since the Rio Earth Summit of 1992 within the construction industry. Sustainable development is "*development that meets the needs of the present without compromising the ability of the future generations to meet their own needs*" (WCED, 1987). It integrates a variety of subjects: environmental quality, economic constraints in addition to social equity and cultural issues (Hajek, 2002). Development implies change and should lead to an improvement in the quality of life for humanity. It encompasses not only growth, but also general services and welfare. Furthermore, development involves the transformation of natural resources into productive output. Sustainable development is the balance between economic progress and environmental conservation, given that both are imperative to our future survival. Sustainable development thus implies using renewable natural resources in a way which does not eradicate or degrade them or otherwise decrease their usefulness to future generations. It also implies using non-renewable natural resources at a rate slow enough to ensure a high probability of an orderly societal transition to new alternatives (Langston and Mackley, 1998).

Sustainable construction is generally used to describe the application of sustainable development in the construction industry. In 1994, the Conseil International du Batiment (CIB) defined sustainable construction as *"...creating and operating a healthy built environment based on resources efficient and ecological principles"* (Kibert, 1994). Hill and Bowen (1997) extend the definition to four pillars: social, economic, biophysical and technical. Plessis (2002) defined it as *"a holistic process aiming to restore and maintain harmony between the natural and built environments, and create settlements that affirm human dignity and encourage economic equity"*. The CIB postulated seven principles of sustainable construction which inform decision makers during each stage of the design and construction process persisting throughout the whole life cycle of a building which are: reducing resource consumption; reusing resources; using recyclable resources; protection nature; eliminating toxics; applying life-cycle costing; and emphasising quality (Kibert, 2005). To obtain optimal solutions to current difficult construction and infrastructure problems, it is vital to consider environmental technical, social, political and economic aspects, their synergies and the inevitable balances between them. Sustainability in this way expresses solutions with regard to a whole system, with an entire combination of outcomes as expressed by a variety of comments and conclusions (Ferng and Price, 2005). A sustainable construction industry does not simply mean to continue its business and growth, but also needs to meet the principles of sustainable development, which mean it may need, in some cases, to stop growing or grow in different ways (Plessis, 2002).

3. DEFINING VALUE MANAGEMENT

Value management (VM) originated from value analysis, which was developed by Lawrence Miles during the Second World War due to the shortage of materials. Though there is a difference between VM and other terms such as value engineering (VE) and value analysis (VA), VM in the construction industry is increasingly seen as the approach to delineate the whole process of improving a project value from concept to operation. A number of studies see the terms of VE and VA as a subset of the generic approach of VM. For the sake of ease, VM will be used in this paper as an umbrella that covers all value methodologies whether they are called VA or VE. VM is defined *"as a proactive, creative, problem-solving or problem-seeking service which maximises the functional value of a project by managing its development from concept to use. The process uses structured, team-oriented exercises that make and appraise existing or generated solutions to a problem by reference to the value requirements of the client"* (Male, Kelly *et al*, 1998).

VM has come to be considered as an effective methodology for achieving "best value for money" for clients since its initial application in the construction industry: many countries around the world have observed the successful application of VM in the construction industry (Shen and Liu, 2003). It is an essential mechanism that can be employed in realising sustainable construction in building projects. All stakeholders of the project are brought together in the VM workshop, where diverse views and perspectives can be explicitly discussed; thus many of the problems that typically happen in building projects can be evaded. There are two advantages in applying VM: firstly, the supportive and comprehensive nature of the workshop, which involves individuals discussing with each other and moving in the same direction; and secondly, the systematic process for considering and weighing the alternatives available to the client for a building project. At the present, there is no substitute management approach or technique accessible that can be used for the purpose of VM, or to obtain the benefits gained from rigorous VM processes (Best, 1999).

The clients are increasingly ensuring that their new building projects represent value for money. The advocates of VM claim that its application results in the provision of the required functions with minimal cost without sacrificing the quality and performance (Dell'Isola, 1997; Kelly and Male, 1993; Miles, 1972). VM techniques enable the participants to draw up the project objectives (value for money) and develop appropriate solutions to satisfy the client's requirements and needs. The objectives could be to minimise whole life cost and maximise the efficient use of financial, manpower and material resources. VM comprises a series of processes fluctuating from five to eight phases. The basic difference lies in the synthesis of its phases or splitting them, but the VM job plan remains the same in each (Al-Yami and Price, 2005).

4. THE FEASIBILITY TO IMPLEMENT SUSTAINABILITY IN SAUDI ARABIA

Saudi Arabia is currently experiencing a construction boom due to strong oil prices and ongoing reforms in the country. The boom is also spurred on by major government construction activities and the development of building projects as well as a rapidly expanding tourism sector. The Saudi Arabian construction sector has been a major factor in the non-oil economy. It is accounting for 5.4% of nominal GDP in 2005 (Ministry of Economy and Planning, 2005) and employing 14.4% from 7.3 million of the workforce (Bnoon, 2003).

The present demand for economically viable buildings for the Saudi Public Sector is coupled with the need to maximise the efficient use of Saudi Arabian natural resources. However, awareness of sustainability within the construction industry could be improved within the Saudi Public Sector. Moreover, the lack of consideration paid to sustainability issues during the design process has resulted in higher consumption of materials and energy during both the construction and operational phases of many building projects. Consumption of water and energy will rise significantly over the coming decades and resources become scarce. Extreme economic development in the countries of the Arabian Peninsula has caused a significant imbalance of exist water resources and demand. Between 1980 and 1990, demand was boosted from 9.95 billion to 22.6 billion m^3 of water. If the current situation continues, water demand may reach 35.4 billion m^3 by the year 2010 (Abdulrazzak, 1995). Moreover, the Saudi Government's plan for power calls for the installation of 50,500 MW of additional generating capacity that would require an investment of $117 billion in the next 20 years.

The Saudi Public Sector has considerable VM experience, also VM are mandatory in all projects financed by the Saudi's government. Utilisation of VM brings substantial benefits as a road map to be used for establishing sustainable construction principles. The experience and skills of people who work in the VM sector can be exploited and can be turned to accelerate the understanding and implementing of sustainable development. The principles and techniques of VM can provide the required quality at optimum whole life during the process of developing a project.

5. THE ADVOCACY OF VM TO SUSTAINABILITY

VM is a powerful tool that has the potential to become a crucial means for promoting sustainable issues in a project. VM can support the implementation of sustainability through multidisciplinary teamwork, forums for all stakeholders to exchange ideas and thoughts, systematic job plan can adopt sustainability schema, its tools and techniques which facilitate decisions taking and identify and solve problems, its strategic timing application during the early stages of a project and its aptitude to eliminate unnecessary costs. However, VM has weakness such as: time limitation, costs, the team should have knowledge, experience in both subject and high level skills. Although VM technique has few limitations, its strengths can not be ignored. Thus, implementing sustainability via VM is viable and advisable (Abidin and Pasquire 2003). VM is a dependable approach for creating visions of a new way and purifying objectives towards a platform of desired findings including formulating policy. Function analysis is most important tool to refine needs from wants and very quickly and co-operatively fundamental objectives can be outlined and definitions and principles can be handled. The same methodology of the VM technique can apply to similar themes and needs within sustainability initiative (Yeomans, 2002).

VM can be used to realise the sustainability principles in the construction industry (Abidin and Pasquire, 2005; Barton et al, 2000; Schneider, 1999). It has been confirmed that the consideration of sustainable construction in VM workshops remains an under exploited topic because of a shortage of information. VM is an appropriate technique to diffuse sustainable construction principles amongst its team members. However, sustainable construction is inherent in most VM workshops, but the level of consideration differs from workshop to another (Abidin and Pasquire 2005). The environment of the VM workshop can help to spread the knowledge of sustainability among the team through the facilitator or sustainable construction/environmental instructor; or through sharing the experiences between members.

The VM job plan is systematic approach, which helps team members to identify problems and find the right solutions in a scientific environment. It can help to raise sustainable construction principles during the workshop and there are sufficient tools and techniques to help decision-makers take the appropriate actions in order to realise value for many in a project. Furthermore, the function analysis phase enables the team members to apply sustainability issues in assigning the component of a project; it also helps define the drivers which consequently prioritised and rationalised to achieve Triple Bottom Line (TBL) dimensions. The creativity phase generates many alternatives for accomplishing objectives and avoiding the unsuitable alternatives in terms of sustainability (Yeomans, 2002).

6. RESEARCH METHODS

Interviews with construction industry practitioners play a crucial role during all stages of this research. The data for this study were obtained through conducting semi-structured interviews with twelve practitioners who work in the Saudi Public Sector. The questionnaire combined qualitative and qualitative methods. It comprised three sections: respondent information, VM assessment and sustainable construction exploration. It was designed to obtain an overall picture of the current practice of VM and sustainable construction by investigating in-depth the following issues in the Saudi Public Sector: the existing practice of VM and sustainable construction; the clients' attitudes towards both topics; the identification of the barriers that impede their application and the determination of the level of knowledge of people who work in the Saudi Public Sector about VM and sustainable construction. The logs of interviews fluctuate between 55 minutes to 2:32 hrs. Table 1 illustrates the interviewees' information.

Table 1. Illustrates the interviewees' information

Academic Qualification			Professional qualification			Experience (Av. years)		
PhD	MSc	BSc	CVS	AVS	Others	SPS	VM	SC
5	4	3	7	3	3	13.7	10.6	2.7

CVS: Certified Value Specialist; SPS: Saudi Public Sector; AVS: Associate Value Specialist; SC: Sustainable Construction

7. DATA ANALYSIS (Quantitative Data)

In this paper, only the quantitative data are analysed and reported upon because of time restriction. The figures below are findings of closed ended questions analysed by SPSS. The graphs below provide indications about the existing situation of VM and sustainable construction in the Saudi Public Sector. Figure 1 shows that the frequency of implementation of VM, in the Saudi Public Sector, is always (15%) and often (33%) whereas the frequency of implementation of sustainable construction is occasionally (24%) and rarely (48%). It is concluded that the application of VM is significantly higher than the application of sustainable construction.

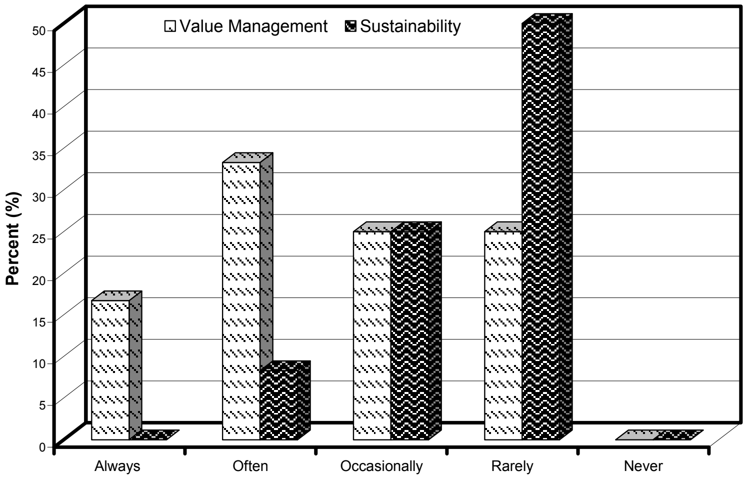

Figure 1. VM application comparison with sustainable construction

Figure 2 elucidates the major barriers that impede the application of VM and sustainability in the Saudi Public Sector. The barriers are ranked according to the interviewees' perspective of their potential impact on the application of VM and sustainability. Five choices written can be selected by the interviewee: "very high=5", "high=4", "moderate=3", "low=2", "very low=1". Thereafter, SPSS software is used to analyse the data by calculating the descriptive variables. The five major obstacles that hinder the application of VM, as they appear in Fig 2, are; lack of information (4.08), leadership (3.83), time (3.75), awareness (3.75) and client commitment (3.67). Whereas, the five major barriers that impede the implementation of sustainable construction are; lack of awareness (4.9), leadership (4.5), client commitment (4.5) information (4.4) and training (4.3). It is clear that all the mean of sustainability barriers are considerably higher than the mean of VM barriers; in other words, the people who work in the Saudi Public Sector are more familiar with VM than sustainability.

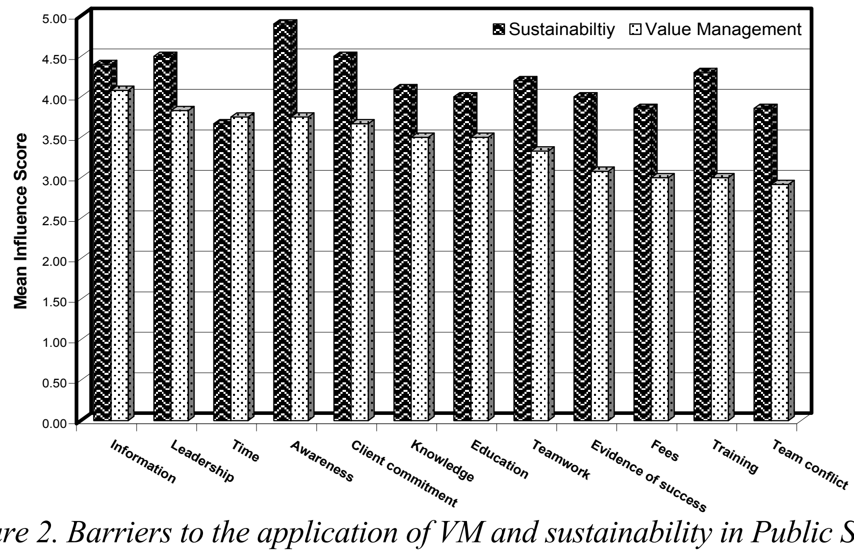

Figure 2. Barriers to the application of VM and sustainability in Public Sector

Figure 3 shows the importance of the application of VM and sustainable construction from the perspective of interviewees for the Saudi Public Sector. It is clear that the implementation of VM and sustainable construction is "very important" and "important" for the Saudi Public Sector.

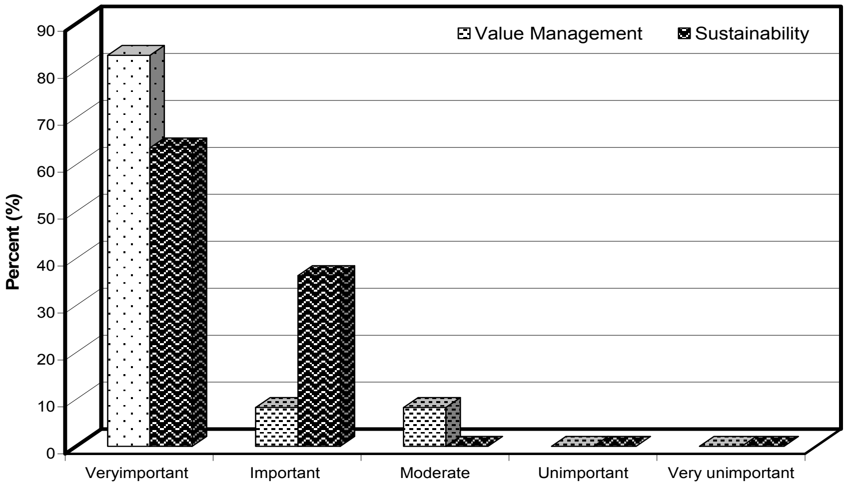

Figure 3. Importance of VM and Sustainable Construction for Saudi Public Sector

Figures 4 and 5 demonstrate the knowledge and satisfaction of people, who work in the Saudi Public Sector, about VM and sustainable construction. Figure 4 shows that the knowledge of people about VM is "very good" and "good", while sustainability is "poor" and "very poor". Although there is extensive VM knowledge and experience, the knowledge of sustainability within the construction industry would appear to be a problem across people who work in the Saudi Arabian Public Sector. Many who work in the Saudi Public Sector appear to have less experience of sustainable development, and sustainable construction is all too often not a major consideration. This can be justified because VM was introduced to Saudi Arabia in 1975 (Al-Yousefi *et al*, 1999) whereas sustainability has not been implemented yet in the Saudi Public Sector. Because of this, it would be extremely beneficial to exploit and turn the VM experiences and skills to accelerate the understanding and implementing of sustainable development in the Saudi Public Sector.

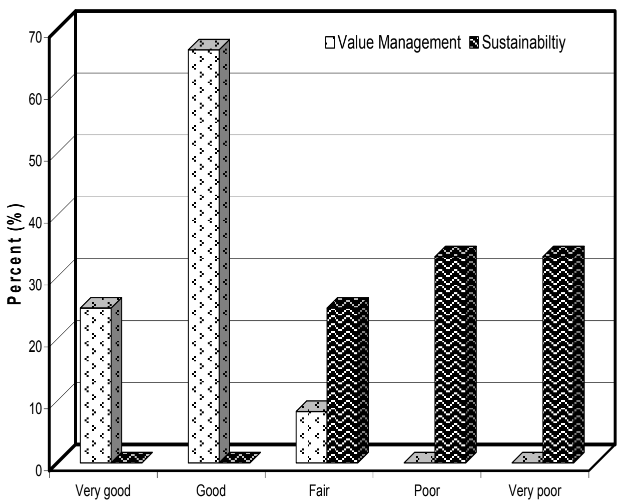

Figure 4. Knowledge of VM and Sustainability

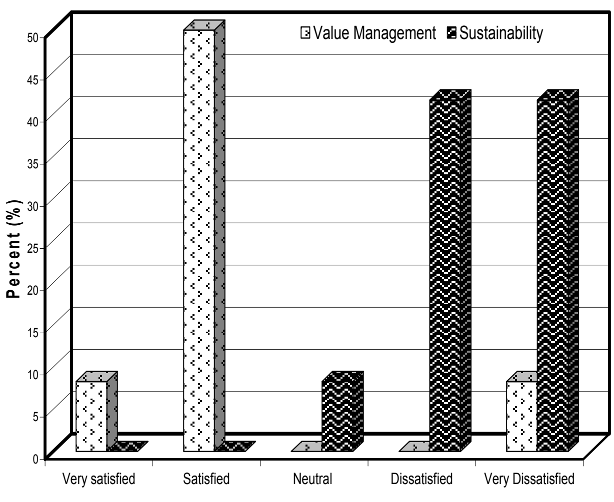

Figure 5. Satisfaction about VM and Sustainability

8. CONCLUSIONS

This paper assesses the feasibility of using VM to accelerate the implementation of sustainability. It provides an overview of the current situation of VM and sustainability in the Saudi Public Sector by investigating in-depth the: application of VM and sustainability; clients' attitudes towards both subjects; identification of the barriers that impede their application and the determination of the level of existent knowledge about both topics in the Saudi Public Sector. It is part of an ongoing research which aims to exploit the VM experiences and skills of those in the Saudi Public Sector in order to accelerate the understanding and implementation of sustainable development in the country

There has been increased awareness of the importance of VM and sustainable development within the construction industry. Both subjects play important roles in realising quality, reliability and durability as well as enhancing performance throughout the life of a project. They also help to improve service-related outcomes within budget constraints, maximise the efficient use of resources; and accomplish an optimal combination of whole-life cost and quality to satisfy the user's requirements and needs. VM is a rigorous approach applied at all stages of a project from concept to deconstruction. Sustainable development implies using renewable natural resources in a way which does not eradicate or degrade them or otherwise decrease their usefulness to future generations. It also implies using non-renewable natural resources at a rate slow enough to ensure a high probability of an orderly societal transition to new alternatives. Sustainable development involves quality of life issues as well as general services and welfare. Integrating sustainable construction themes early in the VM job plan, all processes such as function analysis, ideas evaluation and development can be used to help implement these principles. However, VM has a weakness which should not be treated as significant obstacles of its utilisation to implement and accelerate understanding of sustainability principles.

Data collection was based on questionnaire interviews with people who work in and have experience in the Saudi Public Sector. As pointed out above, the frequency of application of VM in the Saudi Public Sector is “always” and “often”, whereas the frequency of implementation of sustainable construction is “occasionally” and “rarely”. This encourages that sustainable construction principles could be integrated during VM workshop. Thus, it is necessary to overcome the major barriers of the implementation of VM and sustainability. The barriers of VM were; lack of information, leadership, time, awareness and client commitment. On the other hand, the major barriers of the implementation of sustainable construction were: lack of awareness, leadership, client commitment, information and training. The level of knowledge of people who work in the Saudi Public Sector about VM is “very good” and “good”, while sustainability is “poor” and “very poor”.

It appears that there is extensive VM knowledge and experience, whereas the knowledge of sustainability within the construction industry would appear to be a problem across the Saudi Arabian Public Sector. These findings can be explained as having resulted from VM being known in Saudi Arabia for more than two decades whereas sustainability has not been implemented yet in the Saudi Public Sector. Because of this, it could be beneficial to exploit and apply the VM experiences and skills to accelerate the understanding and implementing of sustainable development in the Saudi Public Sector. However, on the basis of the findings of research and related literature, it is clear that several governmental organisations in the Saudi Public Sector, particularly those who have not established divisions of VM and do not have practitioners, have a long way to go, before they can effectively apply VM techniques. Practical solutions to the aforementioned problems from the perspectives of the interviewees require further research, which could involve developing an integrated approach to VM and Sustainability. It involves developing a tool to be used in Evaluation Phase during Value Engineering (VE) to select the sustainable and suitable alternatives as early as possible.

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SUSTAINABLE HOUSING IN INDONESIA

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ABSTRACT: Depletion of environmental quality, especially in dense urban areas, has prompted people to find better ways to build their living space and minimize the damage to the natural environment. This effort has resulted in various forms of ecological houses and environmentally friendly buildings. The attempt to create sustainable domestic facilities has also lead to the production of tools that support the practice of sustainable building and has triggered further research and development of alternative energies and efficient use of water and other natural resources. This research aims to determine *sustainable housing* for Indonesian conditions, by analysing the existing examples of sustainable housing practice in Indonesia. As the result, a set of requirements for Indonesian sustainable housing are proposed, along with recommendations for future investigation.

Keywords – Indonesia, sustainable housing.

1. FROM SUSTAINABLE DEVELOPMENT TO SUSTAINABLE HOUSING

There are various definitions of sustainable housing, but all basically carry out the idea of Principle 15 of the Declaration of the United Nations Conference on the Human Environment: “Planning must be applied to human settlements and urbanization with a view to avoiding adverse effects on the environment and obtaining maximum social, economic and environmental benefits for all” (UNEP, 1972). The definition of sustainable housing by the European Union includes three perspectives: *construction* (e.g. material durability), *social and economic aspects* (e.g. affordability and psychological impacts) and *eco-efficiency* (e.g. efficient use of non-renewable resources) (Mertens, 2005). The IHBC (1998) defines sustainable housing as: “That which effectively integrates low energy design with materials which have minimal environmental or ecological impact (in manufacture, use and disposal) whilst maintaining social diversity”. These definitions present the general point of a “sustainable housing” practice that is applicable under various circumstances, depending on the conditions where it is implemented.

Why would “sustainable housing” be a crucial option for the current housing development in Indonesia? Housing development in Indonesia is especially complicated in dense, vastly growing urban areas. Houses are built in haste, to be able to catch up with the rapidly growing population numbers. Priority is put on quantity instead of quality of the housing. The time is due to make a significant improvement by employing a different viewpoint to look into the whole housing process and environment. Choosing the option of “sustainable housing” would help solving the mentioned problems: preserving natural resources and creating a healthier, more humane domestic environment.

For this paper, the aspects of sustainability that are used to analyze sustainable housing in Indonesia are derived from the six environmental themes of “The National Measures for Sustainable Building” (Hendriks, 2001). These themes are: *energy* (reducing the demand for energy, promoting the use of sustainable energy sources, using energy efficiently), *materials* (more efficient use of materials, reducing waste and removing it responsibly), *water* (reducing water usage, preventing land drying up, protecting water quality), *indoor environment* (improving air quality, improving thermal comfort, reducing noise levels), *surrounding environment* (supporting bio-diversity, strengthening the perception of the environment - including maintaining old townscapes - reducing annoyance/noise, wind, odor) and *miscellaneous* (i.e. improving the flexibility of the home with regard to accommodating new functions, improving safety).

Hendriks' six themes are limited to the environmental aspects of sustainability, while an overall approach should also include *economic* and *social-cultural* aspects of sustainability. These two aspects are added into the list (replacing "miscellaneous"), since they play a crucial role in the decision-making of housing development in Indonesia (Larasati, 2003).

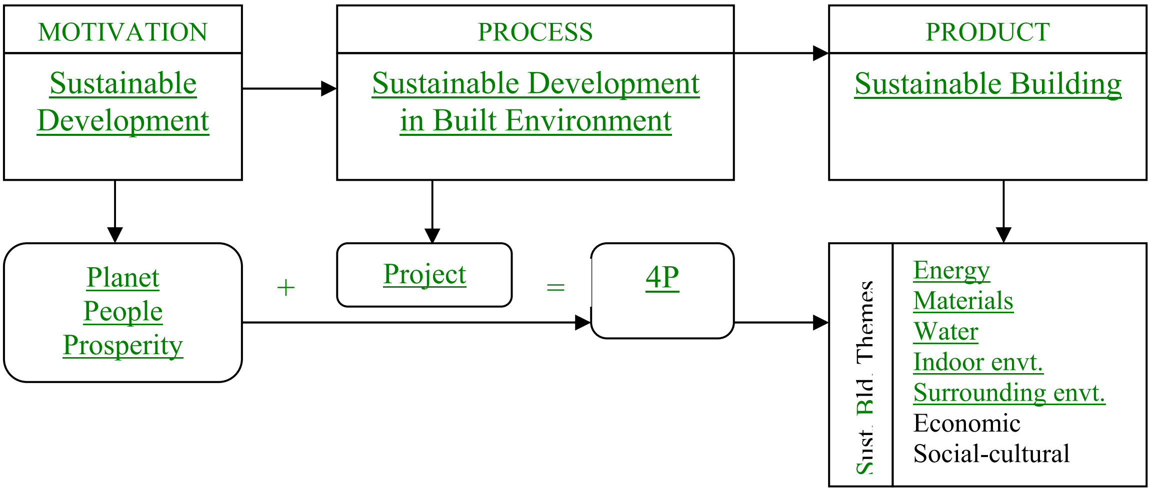

Fig.1. From Sustainable Development to Sustainable Building: The connection between Sustainable Development and Sustainable Building, along with their relation to the 4P's and the Themes for Sustainable Building (modified from Hendriks, 2001).

2. HOUSING CONDITIONS IN INDONESIA

In the fiscal year 1999/2000, the housing sector was allocated 3,8% of the national expenditure. In 2001, 5,983.5 billion Rupiah (equals about 895 million US dollar in March 2nd, 2003) was allocated for settlement and development of regional facilities. Yet, the demand for housing still far exceeds the supply. Only 15% of the need for housing are met by public and private sector construction (The Ministry of Environment, 2002).

In fulfilling the greatly increasing demand on housing, the National Housing Corporation (state-owned) has been assisted by the private sector, which has vastly developed during the last decades. The significant growth of the private sector can be seen from the expansion of the Indonesian real estate organization (REI), which had 33 members in 1972 (from Jakarta only), to more than 2,400 members in 1998 (from all the 27 provinces in Indonesia). About 75% of REI members are small- and medium-scale enterprises and were established in the 80s when the 'economic boom' took place. By 1999, a large number of these enterprises was paralyzed due to the economic crisis (Budihardjo, 1999). These facts show that housing in Indonesia is problematic, especially in urban areas that attract many newcomers because of their reputation of being the source of a better income and a comfortable lifestyle.

Indonesian regional governments face difficulties in predicting the increasing or decreasing population numbers and providing an adequate amount of housing facilities, especially in dense urban areas. This condition has forced city inhabitants, commonly from the low-income groups, to build their own shelters, which are often categorized as illegal settlements. This situation has naturally led to poor living quality (i.e. inferior sanitary, water supply, social interaction), as well as damage to the surrounding environment (i.e. bad garbage disposal, infrastructure, urban planning). In order to cope with the lack of (affordable) housing, the government has provided low-cost housing for these squatters. However, the resulting public housing facilities do not fully fit their purposes, due to economical matters (financial resources and management), resource availability (land), inferior building quality, violation of house ownership regulations, and social/cultural influences (Larasati, 2003). These problems are actually common for housing in Indonesia.

3. SUSTAINABLE HOUSING PRACTICE IN INDONESIA

Efforts to improve domestic environments that are, in fact, sustainable housing practices, have been conducted in Indonesia. For the purpose of this research, examples are taken from programs with various initiators: the *Kampung* Improvement Program/KIP (by the Indonesian government), the ITS eco-house experiment (by an academic institution), the PPLH eco-house resort (by a non-government organization) and a village-scale environmental program (by a self-motivated community).

3.1 *Kampung* Improvement Program (KIP)

KIP is a government-initiated program that started in 1970 with support from The World Bank, and has gained overall positive results, although a number of aspects (e.g. maintenance and inhabitants' participation) need revising. KIP, which aimed to upgrade domestic living quality in slum settlements in dense urban areas, was conducted in growing urban areas, among others Jakarta, Bandung, Surabaya and Denpasar. A report from the Operations Evaluation Department of the World Bank (1996) that evaluated the impact of the KIP projects are outlined according to the sustainable building themes, in the following table.

Table 1. Analysis of KIP, according to the sustainable building themes

Aspects of sustainability	**Analysis of KIP**
Energy	Electricity access are improved, using conventional energy source (the state's electricity grids/"PLN").
Materials	Houses are upgraded by "permanent" or high-quality materials (brick/cement walls, tile/terazzo and cement floors, and tile and zinc roofs).
Water	Access to clean and safe water and better drainage are improved (hence less frequent flooding).
Indoor environment	Residents are familiar with the concept of "Healthy House" (*Dirjen Cipta Karya* – PU, 1999).
Surrounding environment	Several (public) facilities are improved: housing, footpaths, lighting and education and health facilities.
Economic	KIP improved the quality of domestic living in Indonesian urban areas at a low cost of investment.
Social-cultural	Inadequate operation and maintenance: garbage problems (dumped into sewage and drainage), due to unawareness of non-participants. The most important outcome was the spillover effect: the KIP experience served as a prototype for investment and improvement in other areas.

3.2 Eco-House built by *Sepuluh Nopember* Institute of Technology (ITS), Surabaya

The ITS Eco-House project, which was started in 1996 by the Ministry of Construction (MOC) and Infrastructure Development Institute (IDI) of Japan, intended to transfer technologies related to passive solar systems to Indonesia. Research on the eco-house started end of July 1998, when the house was finished and handed over to IDI/ITS. After monitoring devices were installed, an official observation research started in November 1998.

The eco-house was designed as a collective house for Indonesia (for humid tropics climate), which basically refers to the concept of *Kasun* (or *Kampung Susun*, a communal living space that is built vertically instead of horizontally as in a *kampung*/village). The eco-house is not a pilot project but an experiment, which focuses on the thermal conditions of the house. Aspects of this Eco-House that are applicable to housing in a dense urban area are the passive design strategy and the use of local building materials.

Table 2. Analysis of the ITS Eco-House according to the sustainable building themes

Aspects of sustainability	**Analysis of the ITS Eco-House**
Energy	Using passive solar design strategy that minimze the use of energy generating devices.
Materials	Using local materials (i.e. roof of coconut fiber as heat insulator) and concrete floor as a cooling system. Several parts of the eco-house are left unfinished, or made easily re-assembled, for the purpose of observation and research. The house is still used for experiment and research activities.
Water	A spring beneath the building as the resource, then recycled and reused. There are water installations inside each floor to cool the building.
Indoor environment	Comfortable indoor thermal conditions. Disadvantages: hard wind flows, insect/mosquito attacks and high security risks.
Surrounding environment	In an open space, unlike a dense urban area.
Economic	Initiated and funded by the Japanese government, maintained by the host institution (ITS).
Social-cultural	The design emphasize the needs and lifestyles of regional communities.

3.3 Eco-House built by *Pusat Penelitian Lingkungan Hidup*/PPLH (Environmental Education Center) Seloliman, East Java

PPLH Seloliman is an environmental education center, located on the slopes of a volcano in East Java. It was established in 1990 with funding from, among others, the World Wildlife Fund (WWF) and the German government. PPLH, in its 3,7 ha site, consists of eco-buildings with various functions, mostly to support environmental education purposes, such as a library, a seminar 'theatre', simple laboratories, a restaurant and guest houses. It also maintains its own medicinal, spice/herb, fruit and vegetable gardens and applies intermediate technology for energy and wastewater treatment. Aspects of the PPLH Eco-Houses that are applicable to housing in a dense urban area are the cultivation of herbs and fruit trees, the use of water insulation and natural cleaning agents.

Table 3. Analysis of the PPLH Eco-Houses

Aspects of sustainability	**Analysis of the PPLH eco-houses**
Energy	Natural lighting in the daytime, light bulbs in the night, no air conditioner.
Materials	Utilizing local resources.
Water	Taken directly from a spring, has drinking quality, recycled in a simple water insulator.
Indoor environment	No insect repellent (use nets), natural cleaning agents, no noise pollution (due to location).
Surrounding environment	Built in harmony with the landscapes, some were built surrounded by artificial ponds to prevent insects (from entering the building through soil).
Economic	PPLH should support itself financially.
Social-cultural	Fits well with the neighboring villages, whose inhabitants can make extra income by working for/with PPLH.

3.4 Banjarsari Village, Cilandak, Jakarta

Banjarsari, a 1,365 ha village in West Cilandak, was established in 1970. Located next to Pesanggrahan River, Banjarsari is a potential flood area; therefore its inhabitants need to be aware of the importance of keeping a clean, non-polluted, environment. An Environment Committee, emerging from the *Kelompok Wanita Tani* (Farmer Women Group) of Banjarsari, initiated waste management and greening issues for the village. Since 1990, Mrs. Bambang Wahono has been leading her fellow villagers to reduce, re-use and recycle their waste and to replant their surroundings. Banjarsari village has been successfully producing valuable consumer goods made of paper waste and processing compost made of bio-waste. Since 1996, Banjarsari has become a 'model village' for UNESCO.

Table 4. Analysis of Banjarsari Village

Aspects of sustainability	**Analysis of Banjarsari Village**
Energy	Not exceptionally different from other *kampung*s in Jakarta.
Materials	
Water	
Indoor environment	Inhabitants understand and implement the Healthy House concept in their households..
Surrounding environment	Min 20 plants/ household, monthly cleaning (including sewers) and planting trees.
Economic	Activity of handling paper and biowaste is adding the income, a "green kiosk" that sells recycled products and bags of compost and fertilizer.
Social-cultural	Exceptionally solid relationship that supports communal projects. Banjarsari has a very dedicated leader/ motivator

3.5. Overall Analysis

These examples provide an illustration of how a sustainable dwelling in Indonesia could perform. However, the cases of ITS and PPLH are not fully applicable to common housing in dense urban areas, for the following reasons:

- **Security reasons**: the ITS and PPLH houses have ‘open’ designs that invite high security risks if applied to private housing in a crowded city.
- **Surrounding conditions**: the ITS and PPLH houses were not built nearby any road and/or other houses, which could otherwise contribute air and noise pollution.
- **Continuous maintenance**: Maintenance of the ITS eco-house is taken care of by ITS, the hosting university, while PPLH depends on a self-financing system and donators. These systems are different from those of private residence maintenance.

Features that could be succesfully applied to housing in dense urban areas are:

- The use of **passive solar design** strategy for residential buildings. This strategy allows sunlight to light the house in the daytime, and wind or fresh air to circulate within the house and cool the indoor temperature, therefore reducing the use of energy generating devices for lighting and air conditioner.
- The use of **local natural materials** (such as coconut fiber) as heat-insulators. The use of natural materials reduces waste of synthetic materials and the use of local materials reduces the energy due to transportation.
- The **purification and re-use of water** for domestic purposes.
- The use of **natural cleaning agents**.
- The practice of **community participation** in reducing waste and processing garbage into commercial products. A solid community co-operation will lead into a positive development of the domestic environment, and becomes a potential area for communal facilities application.

4. INDONESIAN SUSTAINABLE HOUSING

Based on the analysis of the existing examples, what follows is a set of requirements for sustainable housing that fits the conditions in Indonesia. The set of requirements is presented in a table, followed by its elaboration.

Table 5. Set of Requirements forIndonesian Sustainable Housing

Aspects of sustainability	**Set of requirements for Indonesian Sustainable Housing**
Energy	Applying the passive design strategy Increasing the use of alternative energy sources
Material	Employing construction principles for wet-tropical areas Increasing the use of alternative (local) materials
Water	Re-using water Harvesting rain-water and purifying surface water and soil water
Indoor environment	Popularizing the “Healthy house” campaign
Surrounding environment	Improving housing infrastructure Self-initiated communal activities
Economic	Upgrading facilities of existing settlements Self-supportive financial system
Social-cultural	Considering the gap among the levels of society Taking into account the Indonesian communal way of living

Applying the passive design strategy Attempts to decrease energy use in a domestic environment begin with the design of the building itself. A passive design strategy for warm-humid climates attempts to reduce the use of electricity for lighting and to avoid the use of air conditioners. The design involves the interaction of daylight, radiation and ventilation: the design should allow sunlight and draft into the building while avoiding outdoor heat (Pandjaitan, 1998).

Increasing the use of alternative energy sources Another option is to promote the use of alternative energy sources (other than oil-based). One of the potential alternatives is solar cell technology (photo-voltaic/PV), especially for application in remote areas where electricity grids are not available. 60% of PV components are already made locally, thus the application of PV technology means a job opportunity for local PV components industries. PV is so far the most appropriate alternative since it has low maintenance costs, a durable lifetime and an unlimited source of energy (Dasuki & Djamin, 2001).

Aside from PV, micro-hydro technology, wind power and biomass are also potential alternatives of energy source. The application of alternative energy should consider the availability of potential resources; the whole process should be within budget and maintenance capability of the users (local people).

Employing construction principles for wet-tropical areas According to Santosa (2001), the main construction principles for wet-tropical areas are: construction *materials* that are able to hold heat and then release it and a construction *design* that can release the rest of the heat (i.e. by ventilation). People have preferences in choosing materials for their houses, which are different among low-income populations, higher-income populations and developers (REI, 1991).

Increasing the use of alternative (local) materials A recent research at the Housing Research and Development Center (*Puslitbang Permukiman*) and the Indonesian Agency for the Assessment and Application of Technology (BPPT) on ecological building materials is proposing the use of bamboo as a building material, aimed at low-cost housing. BPPT and the Indonesian Science Institute (LIPI) have been developing bamboo panels for building purposes. Considering the condition of the Indonesian forests that are diminishing due to various causes, alternative materials to supplement or substitute wood are essential. Bamboo is known to be a competent material to supplement wood, regarding its technical and mechanical properties that resemble those of wood (Larasati, 2002). However, further research is necessary in order to investigate the sustainability aspects of the whole bamboo board production process and application.

Re-using water It is important to provide housing areas that can absorb and store water, so the water can be recycled and re-used naturally. But such areas are becoming more scarce, while water quality in some dense urban areas is deteriorating continuously. Water with drinking quality becomes very precious and thus costly. Unless precautions are taken, clean water will become impossible to acquire. Re-using water is one of the proposed solutions. Used water (i.e. from cooking or bathing), or 'gray water', can be used again to flush toilets or to water plants/gardens. According to Yudiarti (2001) water re-use in private residences should be proposed as a regulation. However, the implementation and consequences of water re-use in Indonesia have to be thoroughly investigated, considering the health risks that can occur due to undisciplined operation.

Harvesting rain-water and purifying surface water and soil water Another solution is popularizing rain-water harvesting or purifying surface water (river, dam, lake) and soil water. Simple methods using common tools and materials are available, therefore only promotion and proper management are needed to establish a communal water center for domestic activities.

Popularizing the "Healthy house" campaign According to Wijayanti (2001), research on housing in Indonesia does not yet regard the issue of indoor hazards as a priority, e.g. cooking inside the house without proper ventilation. So far, the “healthy house” campaign - especially directed to the middle- and low-income groups of society - has included the discussion of clean ambient or surrounding air, besides optimal energy and water usage. The control of “healthy house” implementation is most effective at the lowest level of government: at village level, supervised by the village chief.

Improving housing infrastructure It is common that the infrastructure (environmental services, such as site and water) is not planned beforehand and is installed only after the dwellings are built. This condition often causes spontaneously established housing facilities (i.e. private water wells/pumps, electricity grids), which are oftenly unreliable and result in uncontrollable consumption of energy and resources. Therefore a thorough and integrated planning among all involved parties in housing development is essential.

Self-initiated communal activities It is important that communities actively participate in improving their own neighborhoods. An overall healthy environment is easier to achieve if the majority of community members are involved, especially when initiatives come from a fellow villagers.

Upgrading facilities of existing settlements Up to this moment, an urgent problem has been housing provision in high-density population areas, with the stress on eliminating slum settlements. Instead of forcing the inhabitants to move away from their source of income, a potential solution is upgrading facilities of existing slum settlements in urban areas, which has been realized by KIP. KIP requires a low-cost investment (ranging from US$ 118 per person in Jakarta to US$ 23 in smaller cities, 1993 US dollars) (The World Bank, 1995), while improving communities and environments of KIP areas and even having positive impact on non-KIP areas.

Self-supportive financial system If people in a community have a responsibility in (partly) financing the development of their domestic environment, they will have more respect and build a sense of belonging towrds their environment. In order to assist these people, the Indonesian government established agencies whose task is directing development and investment activities: the National Urban Development Corporation (*Perumnas*) which manages low-cost housing development, and the state savings bank (*Bank Tabungan Negara*/BTN) which is allowed to introduce mortgage lending operations.

Considering the gap among the levels of society The gap between the groups of society in Indonesia is quite wide; not only in respect of their economic situation, but also in social behavior and attitudes. They have different mentalities and perceptions towards the same subjects. According to Anwar (2001), the subject ‘ecology’ or ‘ecological housing’ is understood without any problem by the upper-class society (but would they be prepared to pay for a lower ecological impact?), while it is not easily understood by middle- and lower class society. At city level, *knowledge problems* occur: if somebody who used to live in a traditional village brings his habits and lifestyle to an urban house and environment, he will create environmental problems (i.e. throwing garbage right away into the river). At village level, *quality problems* occur: if somebody who used to live in the city brings his habits and lifestyle to his rural house and environment, he will create problems mostly with the facilities that support housing. In short, a house and its surroundings should be able to accommodate the (growing) diversity of needs and lifestyles of their dwellers.

Taking into account the Indonesian communal way of living According to Silas (2001), one of the problems of social housing in Indonesia is the lack or unavailability of communal space, which has a negative impact towards the dwellers’ function in society. Another problem is the location of social housing, which is mostly removed from the city center where the dwellers work, consequencing in extra (transportation) expenses for the dwellers. This condition is a disadvantage to the inhabitants of the social housing and can hardly improve their quality of life. Therefore it is essential to take the cultural factor into account when designing a housing facility, by involving the inhabitants in the planning process. Concerning the location, it is also important to consider improving an established *kampong* inside the city, instead of removing it to the outskirts.

6. CONCLUSIONS & RECOMMENDATIONS

In developed countries sustainable housing concepts have been explored in extent. Indonesia, however, has different conditions, which determine the characteristics of Indonesian sustainable housing.

1. *The warm-humid climate* that allows minimum energy use for housing, if the house employs passive-cooling design strategy. There is also no need for extra material for insulation, provided that the building materials are utilized according to construction principles for wet-tropical areas. Adequate preservation and treatment of building materials are important, in order to achieve optimum durabilty.
2. *The great diversity and quantity of natural resources* that gives opportunities for the development of alternative energy applications. The variation of alternative energy depends on the local capacities where it is applied.
3. *The practice of an informal economy*, whereby people in local communities work together voluntarily, actually reduces the cost of building operations. This is particularly evident when the traditional form of communal activity, called *gotong royong,* is applied. This social behaviour, added by the knowledge provided by the governmental Healthy Housing campaign, is a strong foundation for the establishment of communal facilities and active participation in improving the domestic environment.

Each region of Indonesia has its own characteristics and potentialities; one can be very different from another. Therefore strategies for sustainable housing implementation should be adaptable to the specific characteristics of each area. However, strategies for the general conditions in Indonesia are proposed; as follows:

1. Comprehensive knowlegde and technology disemmination concerning the use of alternative energy resources and building materials, adjusted to local circumstances and characteristics.
2. Development and production of natural substances based on traditional formulas (i.e. cleaning agents, insect repellents), which leads to the cultivation of raw material resources on a household level (as in the case of Banjarsari).
3. Encouraging forms of co-operation (among the government, developers, organizations and potential inhabitants), which accommodate community participation in financing housing projects, which provide a the sense of belonging, responsibility and self-respect.
4. Research consisting of a quantitative comparison between conventional and sustainable housing. Tools such as Life Cycle Assessment/LCA and the Eco-Value Ratio/EVR can be used to calculate the impacts of using e.g. a solar panel as opposed to using a conventional electric supply, or to calculate the impacts from using bamboo (a presumably sustainable building material) compared to using conventional building materials, or to calculate the (dis)advantages of implementing sustainable housing concepts, in currency value. A positive result could trigger housing companies and (financial) sponsors to invest in sustainable housing development.

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SUSTAINABLE – AFFORDABLE HOUSING FOR RURAL KERALA

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ABSTRACT: The current and worsening global shelter situation has become a serious concern, urging the need for scaling up housing supply and has become a focus of policy debate. The reasons and nature of these problems differ from country to country depending on local social, economic and political contexts. The housing situation in Kerala is quite different from other parts of India. Official estimates also predict that if the present trend in house construction continues, by the year 2006 all people in Kerala will have their own houses. However a closer inspection of the current housing scenario in Kerala reveals another side to this overall picture. Despite many positive advances, visible slum like areas still occur in human settlements in rural parts of the state and many inhabitants are deprived of basic facilities like drinking water and sanitation. The shelter problem having a multidimensional nature has its main roots in poverty is aggravated by the scarcity of resources, inadequate institutional capacities and legal and financial framework. It is recognized that adequate shelter for all and sustainable human settlements development cannot be isolated from the broader social and economic development of countries. Also sustainable-affordable housing can not be realized without feasible and environmental friendly technological innovations. This paper reviews the present position of the ongoing PhD research on Sustainable- Affordable housing for rural Kerala and discusses the results so far. It is intend to present a discussion on the following results:

1. The conceptual framework (CF) proposed for analyzing the similarities and differences in the housing problem for developing countries.

2. Review of the present housing situation of the Economically Weaker Section (EWS) in Kerala to understand the problem through a sustainability perspective and analyze the success and failure factors of public intervention for housing the poor.

3. Recommendations for sustainable technological options

Keywords –Affordable housing, CEEF technology, Conceptual framework, Low income housing, Sustainable technology.

1. INTRODUCTION

Kerala, situated on the south- west coast of Indian sub continent is well ahead in the field of social development and better living conditions compared to other parts of India, in spite of its lower per-capita income and a nearly stagnant economic growth rate (Ramachandran, 1997). It is also one of the densely populated States (819 persons/ sq.km) with 3.43% of the total Indian population. The high population density of the state may be mainly due to good climate, fertile land and good rainfall. Over the past couple of decades, Kerala has drawn both international and national attention for its achievements in demographic transition with fertility reaching below replacement level and mortality under five. In terms of per capita income and production, Kerala with an agrarian economy is lagging behind many of the Indian states. However, in terms of Human Development Index and life standard of people Kerala is much ahead of most of other states in India. Also the housing situation in Kerala is quite different from other parts of India. Kerala has got a unique settlement pattern with the dwellings made in individual plots and scattered all over the habitable areas. This is in striking contrast with the nucleated village system prevalent through out the rest of India. The public housing schemes in Kerala were showing greater performance in terms of magnitude in investment and physical achievements, thus considerably reducing the housing gap (fig.1). About eighty percent of the housing support provided by the state during the last three decades has gone for economically weaker section (EWS) housing. The average growth of houses was sixteen percent during the period of 1991-2001 as against the population growth of nine percent (Government of Kerala, 2004).The official estimates predicts that if the present trend in house construction continues, by the year 2006 all people in Kerala will have their own houses (Government of Kerala, Economic Review 2003). Despite many positive advances, visible slum like areas occur in human settlements in rural parts of the state with many inhabitants still deprived of basic facilities like drinking water and sanitation. Even though the magnitude of private and public investments and Governmental assistance so far were sufficient to solve the housing problems of all the socio- economic groups of the state, the lowest sections of the society are still deprived of the basic facilities (Gopikuttan, G 2002). The recent census report of India (Government of India, 2001) shows that among the total population in Kerala 14% has no access to drinking water and 16% has no toilet facilities. This contradictory situation urges the need of a closer evaluation on the various factors preventing the rural poor from satisfying their housing needs in the midst of increased public interventions and favorable environment.

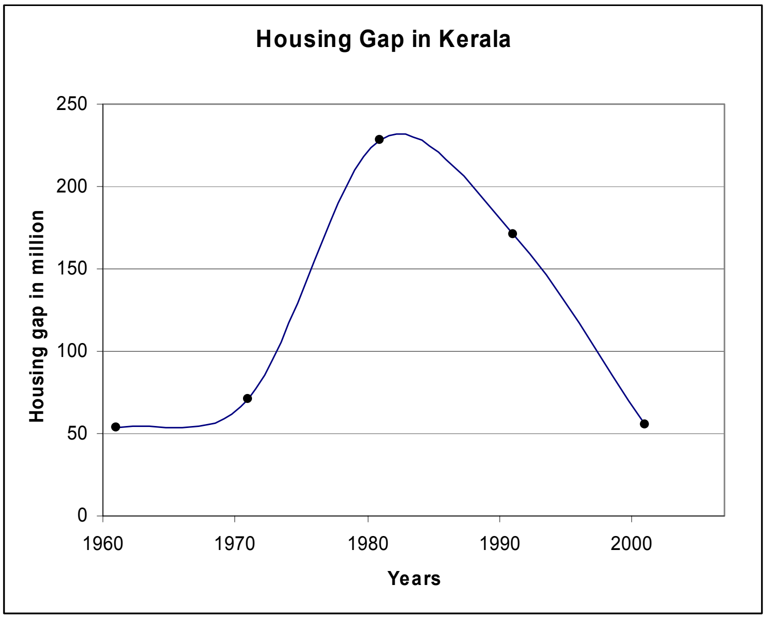

Fig.1. Housing Gap in Kerala 1961-2001

This paper presents a review of the ongoing research on Sustainable Affordable housing for Kerala. It is intended to make a discussion on the various results so far. The paper is organized in five sections. Section 2 introduces a conceptual framework for analyzing the housing problems in developing countries. It helps in defining and analyzing the problems from the perspective of beneficiaries, and supports the formulation of effective policies. A review of the present housing situation of the economically weaker section in Kerala and an analysis of the success and failure factors of public intervention for housing the poor based on this framework are discussed in Section 3. The fourth section presents the results of the evaluation of present building process in Kerala and recommendations for affordable technological solutions. Section 5 is the conclusion.

2. HOUSING ISSUES: A FRAMEWORK FOR CONCEPTUALIZATION

Housing being a basic need of human beings persists globally as a problem irrespective of the economic status of the countries, but differs in its nature and gravity. The perceptions of housing problem vary even from individual to individual, rural to urban and obviously from country to country both in terms of quantity and quality. The concept of homelessness is one that varies greatly among nations and often reflects the political climate rather than the reality of deprivation (Tipple, G. and Speak, S., 2005). The multidimensional nature of housing issues urges the reconciliation of the interests of different stakeholders for being sustainable. Sustainability in housing may be understood in terms of ecological sustainability, economic sustainability, technological sustainability, cultural sustainability and social sustainability (Islam, N., 1996). Value focused thinking can be a useful tool in structuring objectives and criteria. Hence the conceptual framework for sustainable- affordable habitat (fig.1) has been formulated to achieve housing development by balancing social progress, enhancing economic growth, propagating innovative technology along with conserving and protecting the environment and natural resources for future life and development. All these four objectives are interdependent to each other and supposed to have equal importance with respect to Sustainable - Affordable habitat.

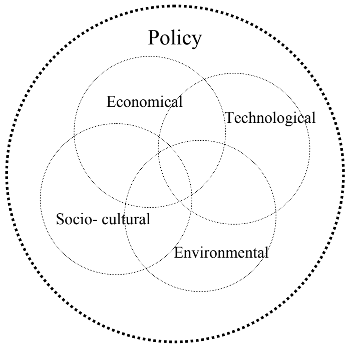

Fig.2. CF: Conceptual Framework for Sustainable – Affordable Habitat

The proposed framework for Sustainable-Affordable habitat (fig.1), figures out the inter relation between the four aspects of sustainability and clarifies the need for an effective policy framework. It describes habitat as a way of developing and maintaining the living environment that support human health (both physical and psychological), satisfying their shelter needs with the help of sustainable technological solutions along with protecting and preserving the nature for future generations. An efficient policy framework is necessary to coordinate the actions of different stakeholders involved. This framework is a combination of two equally important phases. The first phase (CF_1) enlists the requirements and analyses the housing issues based on various criteria corresponding to different aspects of sustainability (Nair, D., et al 2005). The second phase; Strategies for Sustainable - Affordable Housing (CF_2) assist in formulating policy recommendations supporting Sustainable-Affordable habitat based on the guidelines evolved through the analysis of phase one. The succeeding section will be dealing with the second phase in detail.

2.1 Strategies for Sustainable – Affordable Habitat

The problems of sustainable housing concern both formal and informal housing provision, as well as policies that regulate housing provision (Agenda 21). A hard-core policy framework is inevitable to the efficient working of implementation systems, which can optimise the limited resources and integrate the various actors for achieving sustainable- affordable housing. It is also inevitable to co-ordinate the activities of all the actors for creating a ‘pull’ from the side of users rather than a ‘push’ from the authorities. At strategic level, sustainable development principles and approaches should be integrated into policy strategies and the planning process. The second phase of the proposed framework (CF_2) can be considered as a mechanism to achieve the objectives derived from the analysis of phase I (CF_1). It identifies four essential strategies such as: Policy measures for socio- cultural sustainability (PSC), Policy measures for economic sustainability or Affordability (PES), Policy measures for technological sustainability (PTS), Policy measures for environmental sustainability (PEVS) to realize sustainable- affordable housing.

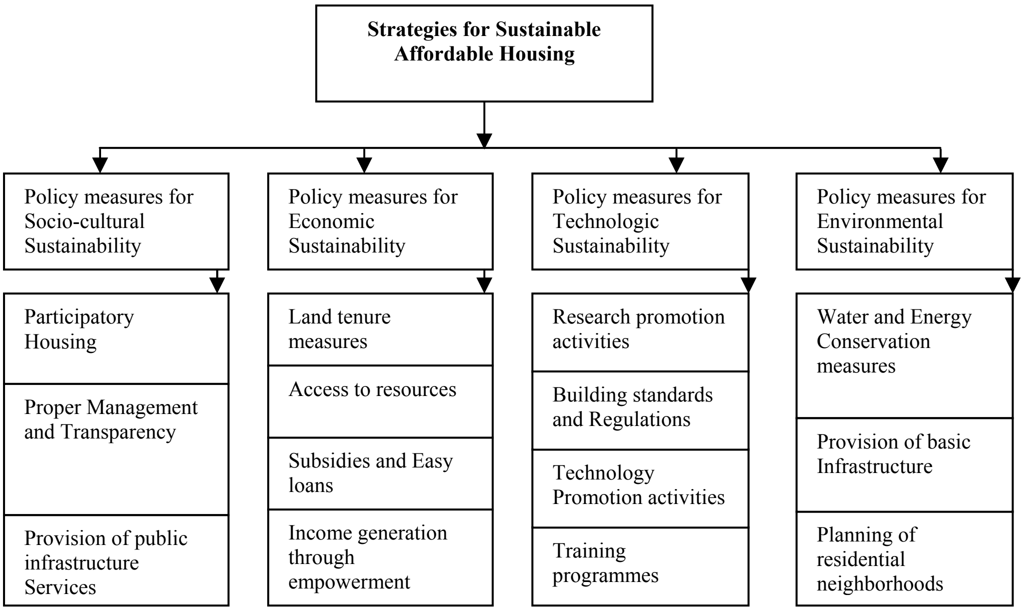

Fig.3. CF_2: Strategies for Sustainable-Affordable housing

Section 3 presents a briefing and evaluation of the public housing schemes in Kerala based on CF_1.

3. PUBLIC HOUSING SCHEMES: KERALA

The public housing approach in India had gone through a series of changes over the years since independence before getting its present form of National Housing and Habitat policy. It exhibits a similar kind of policy shift as in other developing countries from the earlier Public Housing phase (Phase I) to the present whole sector development concept (Phase III) through sites-and-services or aided self help (Phase II). The present phase (from 1994 onwards) in housing policy (NHP-1998) addresses the issues of Sustainable development through housing development. This is truly a mirror image of the whole sector development concept of UN and World Bank and is also well reflected in the present housing schemes (Credit cum subsidy scheme for rural housing, rural building centres, Total housing scheme etc.) of the country. State intervention in the housing sector in Kerala was initiated in 1950. Until 1970 it was limited to implementing the schemes of Central Government and the progress was unimpressive mainly because of the low priority to housing and lack of machinery to implement housing schemes. Now there are as many as twenty agencies implementing housing schemes in the government sector. Rural Development Department, Kerala State Cooperative Housing Federation, Kerala State Co-operative Agricultural and Rural Development Bank and Nationalised Banks are the major Government departments in the housing sector other than Kerala State Housing Board. The first massive housing scheme, The One lakh housing scheme (OLHS) for the poor with community participation was implemented in Kerala during the year 1972-76. This was the pioneering initiative of the State Government and it marked a remarkable change in the low-income housing scenario of Kerala. Later, during the Ninth Five Year Plan (1997-2002) with the decentralization movement, local Governments also started getting involved in different development activities. Total Housing scheme (1998) was introduced during this period with the concept of whole sector development with the local or self Government as the implementing agencies. Despite the positive trend in the housing conditions, a close analysis shows that the poor and lower segments in the society very often do not get the necessary assistance for the actual construction and completion of houses. Though the poor manage to get support, projects often fail due to many reasons. It is difficult to carry out the evaluation of all the schemes due to their enormous numbers and is also not necessary due to the similarities among the schemes. Hence a proper selection has to be done from the major schemes for making the evaluation more meaningful.

3.1 Sustainability Analysis for selected schemes

Three schemes are identified from each phase on the basis of their representative nature in policies with those of the international agencies, their uniqueness in implementing agencies and other peculiar characteristics. The following table gives an overview of the selected schemes. It presents the details including the specification of the schemes with regard to the criteria for beneficiary selection, mode of finance, implementing agencies, type design prescribed and other special characteristics.

The first phase of the conceptual framework (CF_1) discussed in the previous section is employed for the sustainability analysis of the housing schemes. It has been carried out in two stages, such as:

1. **Analysis I (Perspective of Government):** - This has been done to understand the perspective of the Government while formulating the housing programmes. It can be discussed and analysed on the basis of the information from the official reports and documents on the corresponding schemes and from other secondary sources.
2. **Analysis II (Perspective of beneficiaries): -** This has been done to get an insight into the real housing situation of the beneficiaries. Also the mismatch, if any, in the perceptions of the government and beneficiaries can be identified through this analysis.

Analysis II has been done in two stages (IIa and IIb). First stage of this analysis (IIa) is based on the author's observations from the field and the second stage (IIb) is based on the information from the household surveys. The observer's evaluation in Analysis II has been done in order to make a comparative evaluation between both the perspectives using a common tool. Since each household do have their own perception about sustainability, it may not be possible to bring them into a common scale. Instead, an observer's view point can be used to evaluate the real situation using the conceptual framework as in Analysis 1. Whereas the analysis from the user's perspective (Analysis IIb) has been done to assess the real housing problems of the beneficiaries, their needs, requirements, difficulties faced during the building process, feasibility of technology options, and accessibility to resources etc. Case studies from the household surveys and Statistical Package for Social Sciences (SPSS) are employed at this stage of analysis.

Table1. Overview of selected Public Housing Schemes – Kerala

Housing Schemes	Specifications			Remarks
	Type design	**Beneficiary**	**Mode of finance**	
One Lakh Housing Scheme OLHS) 1972-76 Implementing Agency State Government	The type design was unique for the entire state. Each unit has two houses in a back-to-back position with the longer central wall as the common wall between two houses with in a total plinth area of $23m^2$	An Economically weaker section (EWS) household with out house plot was eligible to get a house under this scheme.	Beneficiaries had to pay a nominal amount in eleven equal instalments Government raised the funding by collecting donations from the public, free labour from members of voluntary agencies and the entire people were involved in the project	Based on Provider approach , **Phase I** First scheme implemented by the state government. Poor beneficiary participation. Beneficiaries were shifted from their native places to occupy these houses.
Indira Awaas Yojana **IAY** **1985-96** Implementing Agency Central Government	No type design prescribed for this scheme except that the plinth area of the houses should not be less than 20 square meters. Construction of sanitary latrine and smokeless Chula forms an integral part of IAY houses.	The households were people below poverty line living in rural areas belonging to Scheduled castes (SC) or Scheduled tribes (ST), freed bonded laborers and non-SC/ST.	This is a fully subsidized scheme and under this the entire money was distributed to the beneficiaries in four equal instalments. The beneficiaries were able to receive the instalments only after the completion of each specified stage of construction.	Aided Self- help/ Mutual help approach, **Phase II** This scheme was restricted to the people below poverty line having at least 80 m^2 of land. Due to this a large number of deserving families were not able to get the benefit from this. As this was a centrally sponsored scheme, the scheme was designed by the central Government and was unique for the whole country. It never took considerations of the local conditions. The funding of the Central Government was not sufficient. Even though the sanitary latrine and smokeless Chula were the integral parts of this programme, due to the lack of sufficient funding, most of the interviewed households were not able to construct these.
Total Housing Scheme **1998- 2001** Implementing Agency **Local/Self Government**	Core house concept was adopted and allowances made for future expansion. This core house was roughly worked out to be about $30m^2$, including a living room, a bedroom, a kitchen and a toilet. Beneficiaries had given the freedom to design their own house plans according to their needs.	People below poverty line were identified and beneficiaries were selected based on the selection criteria. Scores were assigned for beneficiaries based on these criteria and the score sheets were submitted in support of selection of beneficiaries.	Financial assistance to the beneficiary households was provided in the form of grant of Rs. 35000 to construct houses costing not less than Rs. 44000. Local self Governments in the districts made an initial deposit of Rs. 10000 per house on the basis of which HUDCO sanctioned a loan of Rs. 35000 per house. The Grama Panchayat (Rs. 7000), Block Panchayat (Rs. 1500) and District Panchayat (Rs. 1500) shared the deposit amount. HUDCO sanctioned the loan amount for a fixed term of 11 years at an annual average interest rate 10 per cent	Facilitator or Habitat development concept, **Phase II** First scheme implemented by the local governments

Fig.4 (i to iv) present a comparative report of the results on various aspects of sustainability of the selected schemes based on both the perspectives. It is interesting to see that the selected schemes show a gradual improvement in the perspective of the Government (AI) towards the problem with respect to total sustainability as it moves from OLHS to THS (1970 to 2000). But the real situation in the field (the observer's perspective, A IIa and A IIb) is quiet different from the concept and only show minor variation between the schemes. This verifies the mismatch between theory and practise. Also the values of sustainability are far less than what was anticipated. Even the Total Housing Scheme, which was formulated with the concept of whole sector development through housing, could not rise to that novel objective of sustainable housing in practise. This shows the inefficiency of policies in bringing concept into practise.

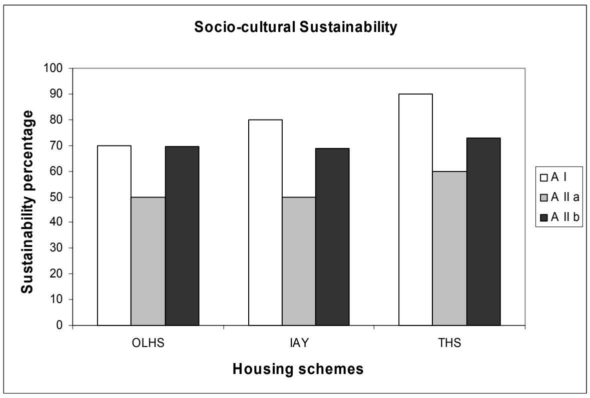

Fig. 4 (i)

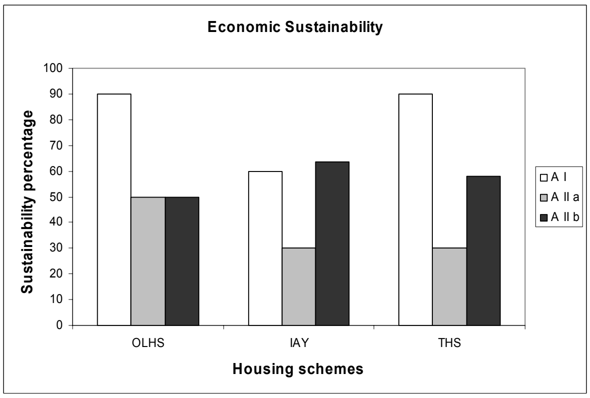

Fig. 4 (ii)

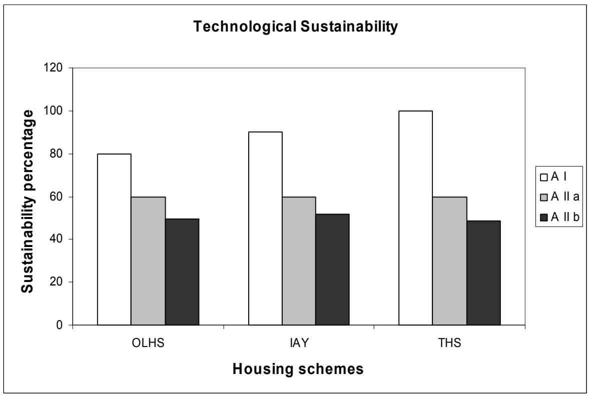

Fig. 4 (iii)

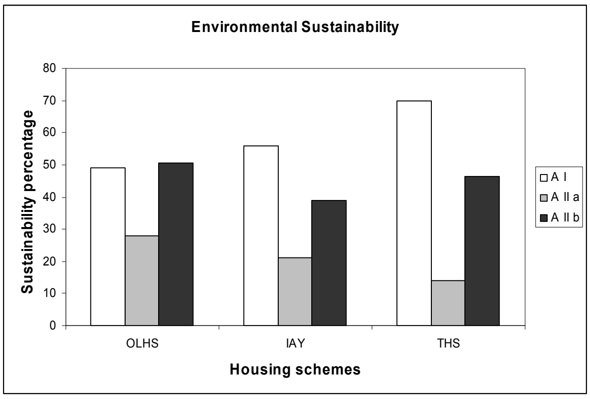

Fig. 4 (iv)

Fig. 4(i, ii, iii and iv) Comparison of different aspects of Sustainability between the housing schemes from the perspectives of Government and users

Based on these results, this study on the evaluation of public housing schemes in Kerala came to certain important conclusions such as:

- All the selected schemes have low values of sustainability and also there is no significant variation in the values between the schemes. This proves that irrespective of the different policies of Government, the representative schemes selected for evaluation from each phase of policy does not show much difference in the end results and all of them seem to have partially failed in achieving their goal of sustainable housing. Along with this mismatch in the perceptions of Government and beneficiaries on the concept of housing programmes were clear and contributed to the failure of programmes.

- The excessive importance of economic sustainability on comparing to the other sustainability aspects shows that total sustainability of the selected schemes has more dependence on the purchasing power or economic status of the households in providing housing over the policy initiatives of the Government. This shows the importance of affordability of the household as well as the inefficiency of policies in the selected schemes for achieving sustainable housing.
- Among the selected schemes, the socio cultural sustainability and technological sustainability do not show significant variations (AIIa and AIIb). This shows that, even though there were different policy approaches over the years (1970 to 2000) for housing the poor in Kerala, they performed in a conventional way in practise rather than their innovative approaches in the concepts especially in the case of socio cultural and technological aspects. And this verifies the need for proper implementation strategies.
- The least significance of environmental sustainability from both the perspective of Government and the beneficiary households is one of the main reasons for the development of slum like human settlements in the rural areas of Kerala.
- The evaluation of the public housing schemes in Kerala also indicates the need for affordable housing solutions with sustainable and feasible technological innovations.

The succeeding section will be the presenting the guidelines for selecting technological options and suggesting recommendations for technological sustainability in housing and affordable options.

4. SUSTAINABLE TECHNOLOGICAL OPTIONS

Traditional building technology in Kerala, based on locally available materials like wood, laterite, thatch and mud give way to the modern technology based on cement, steel and burned brick in a comparably short period of time ranging from thirty to fifty years. Even though the modern materials are more expensive than traditional materials, their easy availability and popularity made the technology more accessible and acceptable. The paradigm shift in the housing policy from a Public housing approach to one based on aided self help during the beginning of 1980's facilitated the introduction of cost effective technology in the housing sector of Kerala. Several non-governmental organizations sprung up in early 1980's with affordable technological options. Mr Laurie Baker, the well known British born architect, settled in Kerala, took the lead in this effort. Based on his principles, alternative technology (AT) initiatives and institutions like Centre of Science and Technology for Rural Development (COSTFORD) and Nirmithi Kendra came up in the eighties to save the poor from the exploitative tendencies of the intermediaries. All these initiatives in Kerala were based on the assumption of abundant supply of labour and availability of indigenous building materials. Their focus was to create maximum employment opportunities and to provide livelihood security to the poor by constructing their own houses. Government of Kerala supported the AT initiatives in the state through financial assistance and providing facilitative environments. But the Cost Effective and Environmentally Friendly (CEEF) technology innovations in Kerala could not gain that momentum and hardly make any changes in the building process, even though they had many affordable options, especially among the poor. The evaluation of the public housing schemes in Kerala shows that despite the continued efforts of CEEF technology institutions in Kerala, the dissemination of these technologies to those houseless people who are in need of affordable solutions has not been very successful. It clearly points towards the ignorance of beneficiaries and their difficulties in the accessibilities towards affordable technological options (Nair, D., et. al 2005). Hence a comprehensive analysis based on the various aspects of sustainability has been done for the selection of the suitable technological options according to the requirements of Kerala. It points towards the need for affordable, environment friendly building materials suitable to the requirements of users. Also sustainable construction in Kerala demands minimum infrastructure, unskilled labour and accessibility to resources. It also demands innovations in renewable resources to make locally available materials sustainable.

The evaluation of the present building process in Kerala put forwards certain guidelines for the selection of sustainable technological options for affordable housing under each aspect of sustainability as follows.

(i) **Socio-cultural Factors** - Acceptance, awareness and feasibility of technological options can be considered as the basic criteria for socio cultural sustainability. The increasing popularity of certain CEEF technology alternatives (hollow or solid concrete blocks, pre cast door and window frames) shows the importance of decentralised production which enables self help or mutual help and improves the feasibility in sustainable constructions. The new alternatives should have the following specifications to support sustainable affordable housing in Kerala. They are:
- It should favour decentralised production with utilisation of local resources.
- Alternative technological options should be able to prove their advantages over prevailing options within a reasonable time period.

(ii) **Economic Considerations** - Technological options which demand minimum infrastructure, basic resources and unskilled labour requirements can improve the affordability of sustainable constructions. Hence the specifications for affordable technology in the context of Kerala can be grouped as:
- Utilization of locally available materials
- Technologies which demand minimum infrastructure, resources and know-how
- Unskilled labour requirements
- Less labour intensive

(iii) **Technological requirements** - Most of the prevailing technological alternatives in Kerala showed good results with regard to technological factors and the un-sustainability of the options were mainly due to other factors. At the same time, the evaluation agrees with the need for innovative technological options from renewable resources.
- Innovations and promotion of technology utilizing renewable resources

(iv) **Environmental considerations** – Similar to technological factors, environmental factors also demand universal specifications more than local criteria. The evaluation of the present building process in Kerala points towards the need for
- More locally produced environmentally friendly alternatives in the building process.
- Utilization of local waste materials
- Utilization of renewable and reusable materials
- Less energy intensive technology

4.1 Choice of sustainable technology options

The evaluation of the prevailing technological options in Kerala suggests the utilization of locally available renewable materials in the building process for both improving the affordability of technological options and making it sustainable (Nair, D., et. al 2006). From the analysis it became clear that laterite; the locally available material is the only present sustainable option for walling. A renewable building alternative from local resources as walling option can be a good choice for affordable housing. The significance of straw bale construction (SB) comes in this respect. Especially in Kerala with more than fifty percent of population depending on agriculture, rice straw is available as a local waste in most of the places. Along with rice straw, rice husk is also a waste product from the paddy fields. The potential of rice husk ash (RHA) as a cement replacement material is excellent. RHA pozzolana can be suggested as an alternate option for cement in secondary building applications.

Why Straw bale and rice husk ash? Utilization of both SB and RHA in the building process will be more promising in another way if it can accelerate the paddy cultivation as it is an immediate necessity in Kerala. Declining paddy cultivation is a growing concern in the State as it results in many of the environmental problems. The area and production of rice which was steadily increasing till the mid seventies had to succumb to economic pressure due to the promotion of cash crops like rubber, banana, and tapioca and also due to the growth of construction sector. This resulted in the decline of more than half a million hectors of area under paddy cultivation during the last two decades (Government of Kerala, 2004). Conversion of paddy fields means abandoning a highly developed and complex wetland agro ecosystem and hence affecting the environmental balance. Long stretches of paddy fields are now kept barren or used for clay mining or developed as house plots in the State. This has created a lot of environmental problems in the neighbourhoods such as water logging, in adequate drainage facilities, non availability of drinking water etc. These factors also support the necessity of finding out more value added products from paddy fields other than rice to retain the environmental balance and protect the natural ecosystem.

Significance of Rice husk ash: A sustainable alternative to cement can provide a significant contribution towards the provision of low cost building materials and consequently to affordable shelter. Each tonne of Portland cement produced releases approximately the same quantity of carbon dioxide (Worrel et al. 2001). Building materials constitute more than half of the total construction cost for an average residential building in Kerala. A substantial part of this is the cost of cement. About 50% of the Portland cement used in building construction is consumed for secondary construction applications such as masonry and plastering. The strength requirements in such works are of the order of 4.0 MPa, while Portland cement is ideally suited for applications with strength requirements in excess of 15.0 MPa. It is also not adequately appreciated that pure Portland cement mortars are harsh and lack the plasticity that is very much needed in masonry construction. Lime-pozzolana cements can replace Portland cement in such secondary construction activities (Jagadish, K, S and Yogananda, M, R, 1988). Experimental research has conducted as part of this research to develop a sustainable affordable alternative from rice husk ash to replace cement for the secondary building applications.

Significance of Straw Bale construction

<u>Significant savings in energy use</u>- Straw bales as building materials enable a significant reduction in energy usage. It can be achieved in two areas such as (i) Energy used to make it available as a building material (embodied energy) and (ii) reducing residential energy consumption for either heating or cooling.

<u>Ease and speed of construction</u>**-** Compared to many other eco-friendly building techniques like, cob and rammed earth, SB is fast and easy. The main advantage is its lesser weight with regard to its larger unit size which allows rapid construction with minimum infrastructure. The finishing of the walls is labour intensive but much easier compared to cob and rammed earth techniques, it replacing.

Structural requirements- The lesser dead weight of straw bale walls compared to the other building techniques necessitates minimum footings only. At the same time they are strong enough to support roof structure without additional beams and posts. Stable straw bale walls are also safe against earth quake forces.
Better insulation properties giving comfortable interior environment- Straw bale wall is superior to most conventional building techniques in thermal insulation(R value 50), fire resistance (90 minutes) and sound insulation (55dA). The combination of the bale mass with plastering on both sides, create a very effective insulation giving good dynamic thermal behaviour.
As straw bale is a permeable material which permits the movement of air on both sides, the quality of air inside the room can be improved by keeping the air fresh. Also it is found that higher moisture retention in straw bale homes leads to a decrease in respiratory disease for residents (McRae 2000).
Unskilled labor - The essential techniques and knowledge required to build a straw bale house can be learned with in a short period of time, even for those who have no building experience. Owners through community workshops build most of the straw bale buildings.
Utilization of a waste material- A large drive for the emergence of SB building in 1980's in California was to avoid the large scale burning of waste rice straw causing environmental problems. For every tonne of grain harvested, about 1.35 tonnes of rice straw remain in the field (Kadam et al 2000). The search for alternative renewable building materials and the problems in waste straw disposal resulted in the current SB revolution.
Adaptability of design - The adaptability of a straw bale technology allows flexibility in design.
Affordability - SB building is equally affordable to all the sections people due to the easy availability of material and unskilled labour requirement.

Building with locally available, unprocessed materials especially wastes, significantly reduces the consumption of energy and secondary resources needed for extraction, processing, fabrication and transportation. SB and RHA are promising in this regard. In Kerala, straw and rice husk being abundantly available as agricultural residues. Promoting these two alternatives in building industry can certainly contribute towards realizing the dream of “shelter for all” and lead to sustainable future.

5. CONCLUSION

Sustainable- Affordable Housing from the user’s perspective can be defined as one that is ‘affordable’ and ‘accessible’ to them to ‘satisfy their housing needs’. The evaluation of the public housing schemes in Kerala advocates the importance of effective policies for making Sustainable housing accessible and affordable to the poor. The dissemination of technological innovations along with newer sustainable technological alternatives is also inevitable and contributes to affordable housing.

The further works remaining in this research is the formulation of region specific strategies based on the conclusions arrived from the analysis for realizing the goal of whole sector development through housing.

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WORKSHOPS FOR SUSTAINABLE INTEGRAL DESIGN

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ABSTRACT: In order to develop support for integral design processes, a designers' working environment in the form of workshops is created. Within this 'learning by doing' approach actual design processes performed by experienced designers are observed and newly developed process models are applied, tested and evaluated while professionally qualified designers carry out several design assignments in repeated series of workshops. Different measurements are done: the type of activity, its occurrence in time and frequency are all registered. The aim is to change the course of design processes, making cooperation between building design disciplines in the conceptual phase of the building design process more effective and efficient. The ultimate goal is a design methodology that provides a suitable foundation for improvement of integration of activities of a building design team as well as integration of sustainable comfort systems in the conceptual phase of the design process. In this paper the research methodology concerning the above is explained in detail.

Keywords – design research, integral design, workshops, sustainability

1. INTRODUCTION

By using sustainable energy in comfort systems for heating, ventilation, air-conditioning (HVAC) and lighting, the focus from the negative effects of energy use can be turned to comfort aspects. Still, the application of sustainable comfort systems in the early stages of building design is currently too low. The main reasons for this are poor availability of information about sustainable comfort systems during the conceptual design phase (building services consultant is for example absent), which together with the complexity of systems themselves makes their integration in building designs too difficult.

In order to achieve this integration of sustainable comfort aspects in buildings, the design team cooperation and integral approach by the design team needs to be improved. The integration has to be developed on the basis of the input from various disciplines that are involved in designing of buildings. To enhance integration of sustainable comfort aspects, both in building as well as in comfort systems (designs), an integral design methodology needs to be defined and tested.

1.1 Building Design Team

Integral solutions are only possible through the unification of different viewpoints on the same topic (Dorst, 1997), in this case comfort in the buildings. In order to achieve integration a single designer has to 'force' himself to look from different viewpoints while designing. Even if he proves that he is able to deploy most of the viewpoints that play a role in building practice, he does not have the knowledge to assess all of them. This is also the reason to assume that the design team view of design, and not the mono-disciplinary view of design, is the only way to pursue integration. The advantage of the design team approach compared to a single designer multi-approach is that different design team members already represent different views on the same topic.

The view that designing is the most central activity in engineering is adopted (Krick, 1967). This leads to a definition of the building design team that should incorporate an architect, structural engineer, building physics and building services consultant. Other disciplines involved during building design, such as managers and constructors, but also the clients, generally speaking do not posses design capabilities. The application of this view should help to overcome the difficult current situation where the present artificial separation between 'design' and 'specialist' activities (architects vs. various advisers) hampers the teamwork between various disciplines.

1.2 Methodical Design

The frame for structuring the actions of team members is found in a model of 'Methodical design' (vd Kroonenberg and Siers, 1992), a collection of methods which are problem oriented and distinguish, based on functional hierarchy, various abstractions and/or complexity levels during different stages and design activities. In order to confront the respective knowledge and viewpoints of design team disciplines the use of the morphological overviews, one of the features of methodical design, is encouraged during the workshops. In short, the aim of the use of morphological overviews is to explore the field of possibilities, leading to more thoroughly considered solution proposals. The method uses a morphological chart where the main task is divided into functions and/or aspects, on different abstraction levels. For each of these (sub) functions/aspects a variety of possible solutions can be generated. Consequently, iterative combination of sub solutions can lead to an overall integral solution proposal. This framework can be seen as a representation of a rational problem solving view of designing (Simon, 1973) that needs to be further developed. The rational problem solving paradigm presumes objective criteria for design. The focus lies on objective interpretation of essentially ill-defined design problems (as they are widely accepted to be); in order to be able to rigidly organize design processes (VDI, 1987).

Instead of objectively describing design assignments (as according to the rational problem solving paradigm), they are subjectively interpreted (through reflective thinking) by the design team. This way the design team creates its own (design) criteria. This interpretation through the definition of criteria is needed in order to be able to effectively structure further actions that need to be taken to achieve integral solutions. Since these interpretations lead to non-universal and automatically non-verifiable definitions, it is scientifically impossible to compare the results of different design teams, even if all design teams use the same assignment. The combination of aspects of reflective practice (Schön, 1983), during the interpretation phase, and rational problem solving methods, during the conceptual design phase, will help to overcome the major obstacle: a definition of 'designer objective' criteria, which is a prerequisite for effective actions during design processes.

1.3 'Learning-By-Doing'

For purpose of further development of this theoretical framework, a designers' working environment in the form of workshops was created. The workshops are seen as a self-evident way of working for the designers that occurs both in practice and during their education, even though they are not the predominant way of working in practice, where most of time the disciplines work separately and only discuss together the mutual proposals and progress. Through use of workshops a support for integral design processes is currently being developed without the time constraints that the actual projects in practice have. The interference of prevailing and always existent office cultures and the financial pressure are also being avoided. Within this ‘learning by doing’ approach the design process models are applied, tested and evaluated while professionally qualified designers carry out several design assignments in the repeated series of workshops.

Although they represent an artificial work environment, it is not experienced as such by the designers themselves. There are a number of advantages that the workshops have regarding to standard office situations: the full line-up of design team, avoidance of a ‘laboratory setting’, the possibility to gather a large number of professionals in a relatively short time, repetition of the same assignment and comparison of different design teams and their results. The openness of participants for new methods is also bigger than during the daily routine, something that can’t be emphasized often enough.

The pursuit of design (activities) integration is based on the integral approach as defined by Quanjel and Zeiler (2003). According to them the integral approach “…represents a broad view on the world around us that continuously needs to be adapted and developed from sound and documented experiences that emerge out of interaction between practice, research and education…”

2. WORKSHOPS

The workshops were organized in cooperation with the Royal Institute of Dutch Architects (BNA), the Dutch Association of Consulting Engineers (ONRI) and the Knowledge Centre Buildings and Systems (KCBS), the cooperation between Technische Universiteit Eindhoven (TU/e) and the Netherlands Organisation for Applied Scientific Research (TNO). They consist of three half-day sessions that take place once a week, meaning that there is a gap of seven days between each session. This configuration is the result of the experiences gained in the previous tryouts during the ‘Integral design’ project that was conducted between 2001-03 by the Dutch Society for Building Services (TVVL), BNA and Delft University of Technology (TUD), where around 200 professionals participated. The four different subjects were treated, through which the research aims can be explained.

Table 1. Workshop series main subjects

Day 1	Day 2	Day 3
Task interpretation	Generation of possible solutions	Selection and solution integration

2.1 Series Set-Up

On the first day the main focus was on the team interpretation of the design tasks. The formation of design teams was random, meaning that none of the participants worked together before, which is often also the case during the daily practice. The crucial aspect for learning in a team is the creation of the shared understanding. This is mostly a slow process that is often based on the social aspects of the interaction between the team members. To avoid these common practice situations where the purpose of the meetings is just to get better acquainted with each other, the teams were asked to directly proceed with the interpretation of the presented design task. The morphological overviews were used to structure this accelerated design process. The background information concerning methodical design and morphological overviews was beforehand sent to all participants. In addition, the lecture about the subject preceded the actual design sessions. Because the basic principle of the workshop set-up was to avoid the ‘laboratory situation’, the teams were not forced to use the overviews. However, they were instructed how to use them, after which the presented design assignment had to be worked out in 90 minutes for a short presentation. The assignment was to design a small ‘pavilion for sustainable architecture’ on the building the workshops were taking place in. After the assignment presentation the design process was only observed and no further intervention took place. At the end of the day the teams had to give short presentations to each other about their conceptual ideas. The first day can be seen as a team building session, but at the same time also as a kind of training for the use of methodical design aspects.

Table 2. Design tasks

Day 1	**Day 2**	**Day 3**
A small pavilion	Zero-energy multifunctional office	

The second day the same design teams were given larger design assignment. The task was to design a zero-energy multifunctional office building on a standard location. This time the focus was on the generation of the possibilities from different viewpoints, as anticipated by different disciplines. Before the generation of possibilities the design teams again had to first come to the mutual interpretation of the assignment. The expectation was that with the experience of the first day the design teams would need less time to effectively do this. For both interpretation and generation the morphological overviews were used. The TNO contributed to the search of the zero-energy solutions by giving an overview lecture on sustainable comfort systems before the start of actual design sessions. In contrast to the first day, at the end of the second day the teams did not have to present the provisional results. Instead they could use the whole 120-minutes design session for the generation of possibilities.

During the last day the design teams had to integrate the proposed sub solutions into an integral office building design. But before making the final choice they had to report to the client what the status of the design was, which choices were made and why, and which were yet to be made based on which assumptions and/or design team proposals. In order to explain the transparency of the design process to the client the same morphological overviews were to be used. This way the use of the overviews for the external communication was also observed. The use of the same tool, in this case the morphological overviews, for both internal as external communication can show the applicability of the use of overviews in structuring and solving the various aspects of the design task.

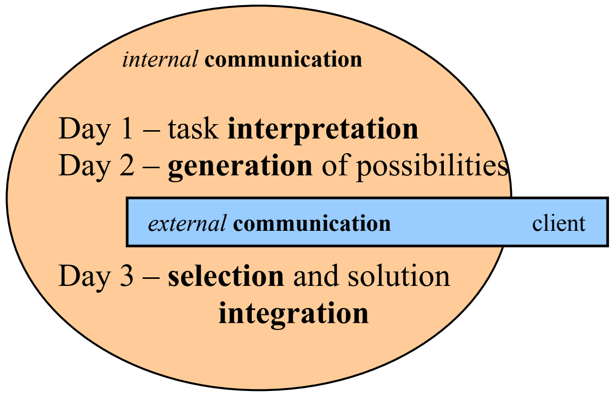


Fig. 1. Design team communication

The team's interpretation and generation are to be achieved through communication, but this aspect of the use of morphological overviews is only explicitly shown during the communication with someone that stands outside the design team itself.

One other aspect, the potential for archiving the solution steps, is emphasised at the same time. This is particularly helpful in relations with various external parties, new team members or for refreshment of memory in the case of long periods of project delays. The client role was 'played' by a representative from either the ONRI or the BNA organisation. After the feedback from the 'client' the design team had to propose the final integral design solution and present it to the other design teams. During short presentations, both on the first and on the final day, the participants rated each other. They did not, however, rated the results of their own design team.

To summarise, each day was dedicated to a certain subject and on the 2^{nd} and 3^{rd} day the participants got the feedback from previous days. The main topics were: 'Methodical design' on the first day, 'Sustainable comfort systems' on the second and the importance of 'The role of the client for the quality of design' on the third and final day.

Table 3. Events sequence during the workshop series

Background information sent to the participants in advance		
Day 1 – interpretation	**Day 2 – generation**	**Day 3 – selection and integration**
C o m m u n i c a t i o n		
- Lecture [methodical design]	- Evaluation day 1	- Evaluation day 2
- Assignment [pavilion]	- Lecture [comfort systems]	- Lecture [client role]
45min design session interpretation / generation	- Assignment [office]	60min design session feedback client / selection
- Pause	60min design session interpretation / generation	- Pause
45min design session selection / integration	- Pause	45min design session integration
- Presentation	60min design session generation	- Presentation

The design teams consisted of professionals who applied for workshops via their organisations. The intention was to have several design teams consisting of all as ‘standard’ defined building design disciplines: architects, structural engineers, building physicians and building services consultants. Ideally, the team line-up should not change and there should be one representative from each discipline. This situation can not always be achieved, something that also in practice is mainly not the case. Therefore the rule was set that the particular representatives of the above mentioned four disciplines could change, as well as their number, and only the presence of the discipline itself was treated as crucial.

2.2 Data Collection

In the workshops the important link between practice, research and education (an essential part of the integral approach) was established through involvement of TU/e students. The students had the role of neutral observers, and were extensively instructed beforehand in order to be able to perform the requested observations. The raw data concerning the team communication and the use of morphological overviews (for the purpose of design and communication), were collected in three different ways: direct observations of the process by the students, various questionnaires for the participants, and by photographically capturing the design process and the produced material.

The type of activity, its occurrence in time and frequency were all registered. Through analysis of all results it was possible to evaluate the effect of the proposed approach. Based on this evaluation the criteria for the next workshop series can be set and the entire iteration cycle can be repeated.

Table 4. Student observations during the workshop series

2 students per same design team during the whole 3-day course					
communication		morphological overviews			
discipline to discipline	team	design		communication	
		report	insight	report	insight

During the workshop series the students were deployed per design team to observe different aspects of the design process. Two things were looked at: the communication between different disciplines and the use of morphological overviews. Both these aspects were observed by one student, with two students being deployed per design team. The students observed the same team during the whole duration of the workshop series. The main communication patterns during intervals of 10 minutes were registered. The communication could take place from one discipline to the other, or it could be team oriented. The morphological overviews could be used either for introducing design solutions or for the communication; both are discerned in reporting and in giving or acquiring insight.

Form for recording the design activities within TEAM ......

Name observer: ....

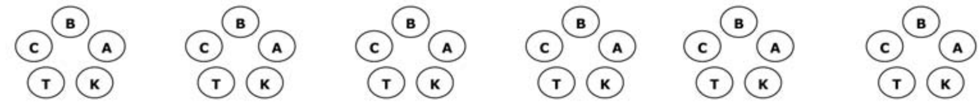
The use of morphological overviews:
The distinction has to be made between the use for designing and for communicating:

Design - report (**Ov**) introduction of the new function, aspect and/or solution proposal from within the own discipline
- insight (**Oi**) a new function, aspect and/or solution proposal based on the already proposed 'standard' solutions

Communication - report (**Cv**) archiving, only structuring the discussed proposals
- insight (**Ci**) uitleggen, verduidelijken van al vastgelegde functie, aspect en/of oplossingsmogelijkheid

	0-10 min	**10-20 min**	**20-30 min**	**30-40 min**	**40-50 min**	**50-60 min**
Architect (A)						
Building physics adviser (B)						
Building services adviser (K)						
Structural engineer (C)						

Communication pattern, [*There can be a couple of them taking place at the same time!*]:



Remarks:

Fig. 2. The form the students were using for observations

Because the design proposals and the amount of integration in designs can not be measured, it was very important to hear how the participants experience the proposed approach and if they thought of it as beneficial. The only way to find out if this was the case was to get first hand information from the designers themselves. For this purpose various questionnaires were used, some of which were repeated after couple of months in order to assess if the proposed approach was used in the further daily practice of the participants. The participants were also asked to rate each others presentation results, in order to get some indication if the measurement results of the observed design processes matched the overall impression one gets of the consequent design processes results.

To further verify the combined results from student observations and participant questionnaires, the design process was photographically captured with a shot of the work of each group every 10 minutes.

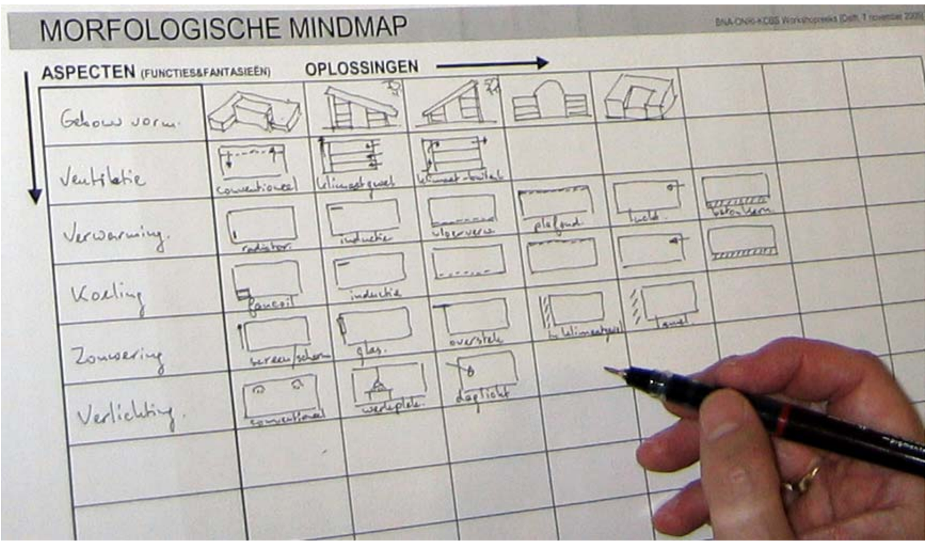


Fig. 3. Morphological overviews

3. RESEARCH QUESTIONS

The first question was what the general communication patterns were, and what was the use of the proposed morphological overviews during the design process? The expectation beforehand was that the team communication would increase during the three days. The second question was if the use of morphological overviews influenced team communication and did that happen in the positive way?

Concerning the use of the morphological overviews the focus of the research was on their application for designing and/or communication during the four different phases (interpretation, generation, selection and integration). Are they more suitable for reporting/archiving or acquiring/giving insight during communication, and in which phase is this most obvious and beneficial? An important note here is that insight is something that also depends on the (design) quality of participants, something that was not taken in account, nor was age and experience.

Regarding the designing the focus was on the relation between the interpretation and generation activities. How was the generation of possibilities influenced by the team interpretation of the design task? Are the two steps dependent on each other, and do they have to be sequentially executed? Does the field of possibilities widens by involving more disciplines and was this helpful in achieving integrated design solutions? Was the use of morphological overviews restricted to the introduction of possible solution proposals from the viewpoint of certain discipline, or could the new design insights indeed be reached by combining the various viewpoints through the proposed approach?

4. OBSERVATION RESULTS

Because the focus of the paper is to present the research methodology involving the use of workshops, only couple of preliminary results from two workshop series in 2005 are discussed. During the first series 4 teams of in total 24 participants were observed, and during the second series 5 teams of in total 19 participants. The particular representatives of the four disciplines changed several times. The big difference was that only one team during the second series had the same line-up as the teams during the first workshop series. However, even that team was without the building physics adviser on the last day. Therefore the distinction between the two workshops based on the differences between teams with four 'standard' and teams with three 'standard' disciplines can be made.

Two results during the both workshop series are very similar: the increase of team communication during the total course and the bigger use of morphological overviews for generation of new design possibilities during the second day. Regarding the use of morphological overviews for communication purposes, the amounts of reporting/archiving (of the results of design processes) are the same for both types of teams, between 10-15% of their total use. The main difference between the design teams is the extent to which the morphological overviews were used for the explanatory communication (giving insight), which is bigger within the 4-discipline team configurations. The amount of team communication is clearly bigger within 3-discipline design teams, suggesting that a mutual understanding is reached faster – leading to less explanatory communication and more new design insights.

The design process was photographically captured each 10 minutes, in order to register the development in time of the number of agreed functions/aspects and proposed alternatives. Through quantitative changes of functions/aspects the interpretation activities of the design teams could be followed. The same can be said for the amount of proposed alternatives and the generation activities. What we are especially interested in is the relation of the interpretation and generation activities. The various observations showed that both 3-discipline and 4-discipline design teams needed the same amount of time to define almost all functions/aspects they worked on (between 35-45 minutes). From then the explosion of possibilities took place. The interesting thing is that the average number of functions/aspects produced by 4-discipline teams was lower than that of 3-discipline teams, while the 'logical' expectation would be the opposite – since theoretically more input results in more output. A possible explanation for this would be that because of the critical judgment of one extra discipline the irrelevant aspects, from the point of view from that discipline, were filtered out. The other interesting thing is that from there on the number of produced alternatives was much bigger then those produced by 3-decipline teams. The expectation of widening the field of possibilities by involving more disciplines was thereby met.

5. CONCLUSIONS

The most important conclusion is that the proposed workshop approach was warmly welcomed be the participants. More than 90% experienced the work in design teams as positive with 84% claiming that it even led to synergy. The negative reactions, 23%, regarded the amount of information in relation to the available time, whereby 27% of participants thought of it as old news. Approximately ¼ of participants indicated that the workshops did not meet their expectations. However, only 6% of participants regarded the proposed approach, with use of morphological overviews, as not relevant to their discipline.

Based on the workshop results, the first conclusion that can be drawn is that (development of) the design team communication was dependent on the number of design disciplines within the design teams. The 3-discipline design teams developed some kind of mutual understanding and agreement faster than 4-discipline design teams. An additional conclusion is that this was not related to the use of morphological overviews for communication purposes. On the contrary, the 4-discipline design teams that internally communicated more on a 1-on-1 basis used morphological overviews more frequently for communication purposes. From these observation results the conclusion can be made that the overviews are indeed helpful in structuring the communication of design teams, especially in more complicated situations. This statement has been backed up by the results of the various questionnaires that all participants were given, regardless of discipline or the design team line-up. However, the influence of morphological overviews in achieving mutual understanding in 3-discipline teams was not separately assessed.

Besides being suitable to provide more insight during communication between team members, morphological overviews were also suitable to archive the discussed proposals. From the preliminary results we can conclude that in 10-15% of the cases they were used for this purpose. This is something that will be looked at more closely in the future in the hope that we can confirm and use this figure as a reference value. Concerning the design aspects of the use of morphological overviews the preliminary conclusion can be made that the overviews are helpful in structuring the design activities of the design teams. The definition of the functions/aspects as the interpretation of the design assignment was especially useful in 4-discipline design teams; therefore it should precede the generation step. If used in that order it can be very helpful in widening the field of relevant possibilities.

The last conclusion, based on the reactions from the participants themselves, is regarding the relation of the proposed approach to the practice. The morphological overviews were seen as relevant for use in practice: they help in communication within a design team configuration, they increase the number of relevant and new alternatives and they raise the awareness of the contribution from other disciplines. These positive aspects do not mean that the use of morphological overviews was always beneficial for the final design proposal; this is something that has to be looked at further.

The main aspects that need to be addressed before the continuation of the research and the organization of the new workshop series are the following. A better distinction between the four main subjects (interpretation, generation, selection and integration) needs to be made in order to be able to more precisely assess the use of the morphological overviews in relation to the communication during those phases. A more direct observation of the client communication has to be conducted in order to be able to compare internal and external design team communication in relation to the selection phase. The observation of various types of defined function/aspects and proposed alternatives (especially in relation to integration) has to be more precise in order to be able to measure the effectiveness of the use of proposed approach.

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AN INVESTIGATION INTO THE USE OF FIBRES IN CONCRETE INDUSTRIAL GROUND-FLOOR SLABS

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ABSTRACT: The concrete industrial ground-floor slab is a key structural element in most industrial enterprises. The art of designing most industrial floors is to provide sufficient reinforcement to control the amount and size of cracks to a level consistent with the intended use of the floor. However, one of the most common causes of cracking in ground-floor slabs is that the tensile stresses imposed on the concrete by external restraint to thermal or shrinkage contraction exceed the tensile strength of the concrete. Therefore, the function of the steel-fabric reinforcement or the fibre-reinforcement is to limit the crack width by preventing micro-cracks from becoming macro-cracks and thus protect concrete from aggressive environmental attack.

The use of fibres in flooring concrete has increased with the development of fast-track construction. In fact nearly 65% of the fibres produced worldwide is currently used in industrial floors, road pavements and other slabs-on-grade. Fibre-reinforced concrete floors offer significant economic and technical advantages over conventional steel-fabric reinforced concrete floors, such as increasing toughness and ductility, tighter crack control and improved load-carrying capacity.

Currently, the use of fibres in concrete, while growing, is not as widespread as its mechanical advantages would suggest it should be. A possible reason for this is the natural hesitancy of engineers and practitioners to use a material for which adequate; experience, experimental data and code provisions have not been well developed. Moreover, the availability of various commercial types and brands of fibres could have added to the difficulty of selecting the proper materials for particular field applications.

This paper reports upon the literature review of using various types of fibres as a replacement to steel-fabric reinforcement in industrial ground floors. A programme of experimental tests on beams and slabs is on the way to provide tests results that can be used as an input data into the finite element analysis programme.

Key words: concrete, fabric-reinforcement, fibres, finite element analysis, ground-floor slab

1. INTRODUCTION

The concrete industrial ground-floor slab is a key structural element in most industrial enterprises. It has two functions: first to sustain the operational loads from loaded racking system, goods stored directly on the floor, fork-lift truck wheel loads and mezzanine floors, and transfers them to the supporting soil without any structural failures or unaccepted settlements; second to provide a suitable wearing surface upon which the operations in the facility may be carried out efficiently and safely. This dual role of industrial ground-floor slab has concentrated attention on its critical contribution to the success of modern commercial facilities (Neal, 2002).

The art of designing most industrial floors is to provide sufficient reinforcement to control the amount and size of cracks to a level consistent with the intended use of the floor (Deacon, 1991). For this purpose, over very many years standardised welded steel fabric has become the traditional choice for the reinforcement of ground floor slabs, but during recent years, with the development of fast-track construction such as laser-screed machines, the use of fibres in flooring concrete has increased. The main purpose of adding any of fibre types to concrete is not to prevent cracking but to control it. The two main types of fibre that have been used around the world for many years in concrete structures, including floor slabs, are polypropylene and steel (Kelly, 1990).

Various fibre-reinforcing materials are available nowadays, but structural applications of fibre-reinforced concrete are mainly made of steel fibre (Meda et al, 2004). More recently, new breeds of structural synthetic equivalents are proving their usefulness. Lighter weight, lower abrasion and better structural performance are making synthetic reinforcement an economic alternative. They are not in common use in floors but are an interesting development in fibre reinforcement technology (Concrete Society, 2003). Due to uncertainty, reflected in current design practice, over the ability of structural synthetic fibre to replace fabric or fibre reinforcement the need for an extensive research programme is identified.

An initial stage of a PhD study on the design and analysis of fibre-reinforced concrete floors using finite element method has been conducted. As a part of the literature review, this paper reports upon the historical development of fibres, describes the various types of fibre that have been used in concrete industrial ground floor slabs and evaluates their influence on concrete properties. Also, a programme of experimental tests on beams and slabs to provide tests results that can be used as an input data into the finite element analysis programme will be presented.

2. HISTORICAL USE OF FIBRES

The use of fibres in brittle matrix materials has a long history going back at least 3500 years when sun-baked bricks reinforced with straw were used to build the 57 m high hill of Aqar Quf near Baghdad (Newman et al, 2003). In addition, horsehair was used to reinforce masonry mortar and plaster (ACI Committee 544.1R, 1996). After that, asbestos fibres have been used to reinforce cement products, such as roofing sheets, for about 100 years. However, primarily due to health hazards associated with asbestos fibres, alternate fibre types were introduced throughout the 1960s and 1970s.

The low tensile strength and brittle character of concrete have been bypassed by the use of reinforcing rods in the tensile zone of the concrete since the middle of the nineteenth century (ACI Committee 544, 1986). Moreover, patents have been granted since the turn of the century for various methods of incorporating discontinuous steel reinforcing elements such as, nails, wire segments or metal chips into concrete.

During the early 1960s in the United States, the first major investigation was made to evaluate the potential of steel fibres as a replacement for steel reinforcing rods in concrete (Romualdi et al, 1963). Since then, a substantial amount of research development, experimentation, and industrial application of steel fibre reinforced concrete has occurred. In the early 1960s, experiments using plastic fibres in concrete with and without steel reinforcement were conducted (Goldfein, 1963). Since 1997 Japanese construction companies have been using structural synthetic fibres to replace steel fibre reinforcement and the technology has since spread into Australia, Europe and North America (Elasto Plastic Concrete, epc).

Over the past 40 years, a number of applications have been recommended for the use of fibre reinforced concrete including road and floor slabs, refractory materials and concrete products (ACI Committee 544, 1986).

3. TYPES OF FIBRES

There are numerous fibre types, in various sizes and shapes, available for commercial and experimental use. The basic fibre categories are steel, glass, synthetic, and natural fibre materials. However, in slabs on grade, steel, polypropylene and structural synthetic fibre reinforced concrete are the three main types of fibre, which are used as a replacement for conventional steel fabric reinforcement.

3.1 Steel Fibres

Industrial floors and pavements are major applications for steel fibre concrete. In the United Kingdom, more than 2 million m^3 of steel fibre reinforced slabs have been installed over the past ten years (ACIFC, 1999). The stresses occurring in a concrete slab are complex depending on the type of load. There are, in addition, stresses that are difficult to quantify, arising from a number of causes such as sharp turns from fork lift trucks, shrinkage and thermal effects, and impact loads (Knapton, 2003). These fibres, compared to traditional fabric reinforcement, have a tensile strength typically 2-3 times greater and a significant greater surface area to develop bond with the concrete matrix (ACIFC, 1999)

3.1.1 Types of Steel Fibres

Many efforts have been made in recent years to optimise the shape of steel fibres to achieve improved fibre-matrix bond characteristics, and to enhance fibre dispersibility in the concrete mix. ASTM A 820 provides a classification for four general types of steel fibres based on the product used in their manufacture (ACI Committee 544.1R, 1996):

- Cold-drawn wire
- Cut sheet
- Melt extracted
- Other fibres

A few of the more common types of steel fibres being shown in figure 1.1 (Knapton, 2003). Rounded, straight steel fibres are produced by cutting or chopping wire, typically having diameter between 0.25mm and 1.0mm. Flat, straight steel fibres having typical cross sections ranging from 0.15mm to 0.41mm thickness by 0.25mm to 1.14mm width are produced by shearing sheet or flattening wire. Crimped and deformed steel fibres are produced either with full length crimping or bent or enlarged at the ends only. Some fibres are deformed by bending or flattening to increase bonding and facilitate handling and mixing (Concrete Society, 1994). Some fibres have been collated into bundles to facilitate handling and mixing. During mixing, the bundles separate into individual fibres. Fibres are also produced from cold drawn wire that has been shaved down in order to make steel wool. Moreover, steel fibres are produced by the melt-extraction process (ACI Committee 544.1R, 1996).

The ultimate tensile strength of steel fibre range from 345-1700 MPa, whereas the length range from 19 to 60mm, the aspect ratio (length/diameter) range from 30 to 100 and the young's modulus is 205 MPa.

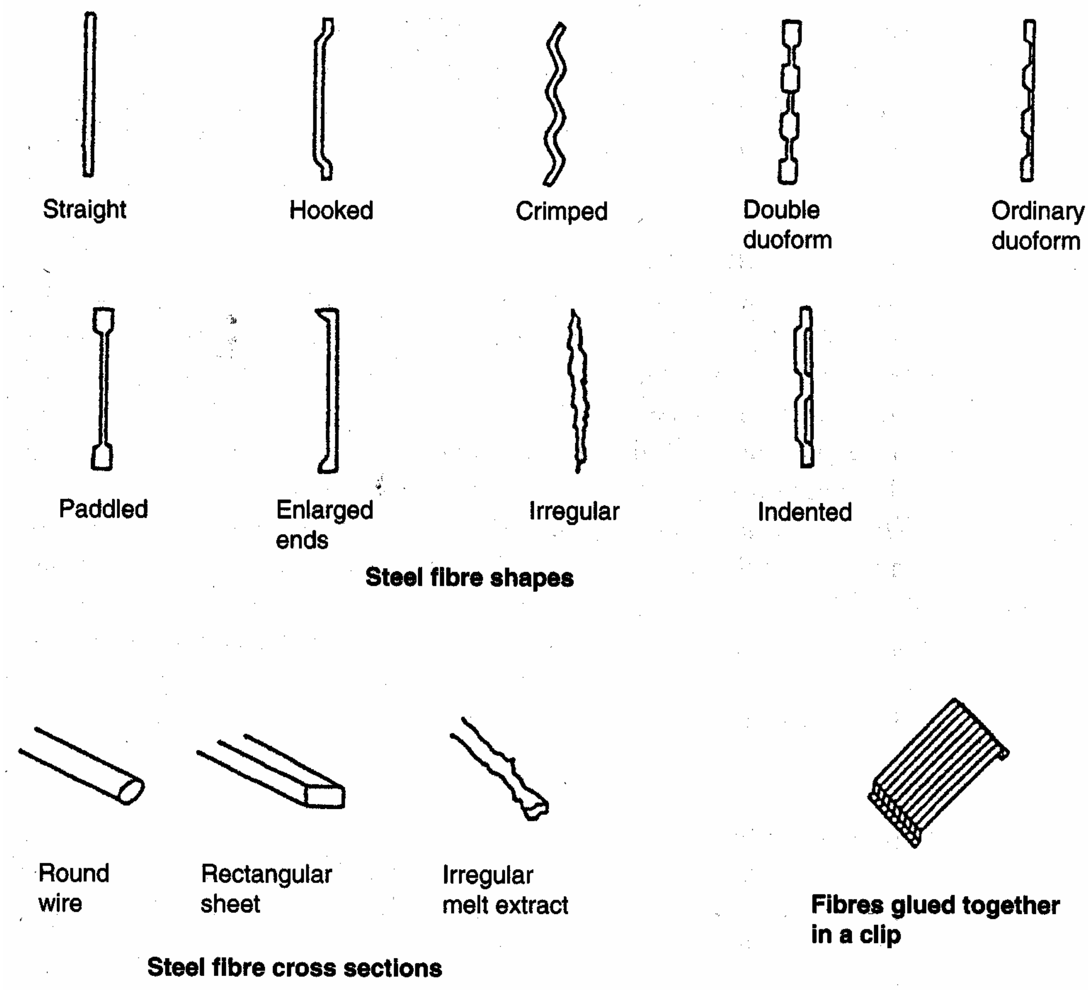

Figure 1.1 Different steel fibre types (Knapton, 2003).

3.2 Synthetic Fibres

Synthetic fibres are man-made fibres resulting from research and development in the petrochemical and textile industries. Synthetic fibre reinforced concrete utilises fibres derived from organic polymers which are available in a variety of formulations (ACI Committee 544.1R, 1996).

Synthetic fibre types that have been tried in Portland cement concrete based matrices are: acrylic, aramid, carbon, nylon, polyester, polyethylene and polypropylene. For many of these fibres there is little reported research or field experience, while others are found in commercial applications and have been the subject of extensive reporting (ACI Committee 544.1R, 1996). Synthetic, organic fibres have low modulus of elasticity and high elongation properties while steel, glass, asbestos and carbon fibres had high modulus of elasticity (Manolis et al, 1997).

The most popular synthetic fibres used in concrete ground floor-slabs are: Polypropylene (micro-synthetic) and structural (macro-synthetic).

3.2.1 Polypropylene Fibres (micro-synthetic fibres)

Polypropylene fibres are gaining in significance due to the low price of the raw polymer material and their high alkaline resistance (Keer, 1984; Maidl, 1995). They are available in two forms i.e. monofilament or fibrillated manufactured in a continuous process by extrusion of a polypropylene homopolymer resin (Keer, 1984; Knapton, 2003). Micro synthetic fibres, based on 100% Polypropylene are used extensively in ground-supported slabs for the purpose of reducing, plastic shrinkage cracking and plastic settlement cracking. These fibres are typically 12mm long by 18μm diameter (Perry, 2003).

3.2.2 Structural Synthetic Fibres (macro-synthetic fibres)

Micro synthetic fibres have been developed during the last seven years. They have the potential to provide concrete with significant ductility. As a result, in concrete floors and slabs, these fibres are able to control cracking caused by thermal movements and long-term drying shrinkage (Concrete Society, 2003). Although these macro-synthetic fibres usually contain some polypropylene, they differ from polypropylene micro-fibres in that they are significantly larger- typically 40-50mm long and 1.0 to 1.5mm wide-, made from selected polymers and used at significantly higher dosage than polypropylene micro-fibres (Perry, 2003). These properties allow synthetic structural fibres to provide a significant level of post-crack control in the same way as that achieved by steel fabric and steel fibres (Clements, 2002)

The following sections discuss the addition, mixing, placing, finishing and curing of steel, polypropylene and structural synthetic fibres. Also, they present the effect of adding theses fibre types on the properties of fresh and hardened concrete

4. STEEL FIBRE REINFORCED CONCRETE

4.1 Composition and Quality

Compared to plain concrete, fibre reinforced concrete mixes generally have higher cement and fine contents and smaller aggregates. The slump decreases as the fibre content increases. (Newman et al, 2003; ACI Committee 544.1R, 1996). So, in order to obtain steel fibre-reinforced concrete that is easy to pump and to work, with minimum shrinkage, a steel wire manufacturer specifies the following (Bekaert, 1990)

- Quantity of cement should be between 320 and 350 kg/m^3
- 750-850 kg/m^3 good quality zero to 4mm well graded sharp sand should be used
- Use a continuous aggregate grading with a maximum size of 28mm for rounded gravel and 32 for crushed stone. Limit the fraction larger than 14mm to 15-20%
- Characteristic compressive strength of at least 25 N/mm^2 should be used
- Water/cement ratio should be about 0.50, and should not exceed 0.55
- The used of super-plasticizer is permitted to obtain the necessary workability

- Admixtures of chloride or chloride containing concrete additives are not permitted

4.2 Addition and Mixing (Steel Fibre)

The recommended dosage rate of steel fibres is usually between 20 and 40kg/m^3. The greater the dosage rate the greater is the flexural strength of the concrete (Knapton, 2003). Generally the fibres are added last to the fresh concrete, care being taken to ensure that no clumps are added and the fibres are rapidly moved from the entry point to the mixer. Alternatively they may be added onto the aggregate on the conveyor belt (Newman et al, 2003). As long as the aspect ratio of the fibre is less than 50, the fibres may be dispensed directly without any risk of balling. With higher aspect ratios some manufacturers employ special packing techniques to reduce the risk (ACI Committee 544.1R, 1996). However, visual inspection during pouring is necessary to check fibre distribution is satisfactory (Knapton, 2003).

4.3 Placing Finishing and Curing

Good quality and economic construction with steel-fibre reinforced concrete requires approved mixing, placing, finishing and quality control procedures be followed (ACI Committee 544.1R, 1996). It is good concrete practice to place concrete as near to its final position as possible. This is ever more true for SFRC because of its reduced flow characteristics (Unwalla, 1982; Swamy, 1974)
Conventional tools, equipment and procedure may satisfactorily be used for placing, finishing and curing steel-fibre reinforced concrete (Knapton, 1999; Killen et al, 1997; Swamy, 1974; ACI Committee 544, 1993). After compaction and levelling, anti-wear products and cement are often spread on top of the concrete surface (Knapton, 2003). SFRC should be cured and protected by the same methods and techniques as plain concrete. Inadequate curing methods can produce plastic and shrinkage cracking encountered in conventional concrete (Knapton, 1999; ACI Committee 544, 1993; Swamy, 1974).

4.4 Mechanical Properties of Fresh Steel Fibre-Reinforced Concrete

Achieving adequate workability is one of the most important problems generated when using steel fibre reinforced concrete. The inclusion of the fibres into the concrete mix, influences its workability, with increasing in the fibre volume and aspect ratio leading to decreased workability (Hannat, 1978; Swamy, 1974). The ACI Committee report in 1996, reported that in the typical ranges of volume fractions used for steel-fibre reinforced concrete (0.25 to 1.5 volume percent), the addition of steel fibres may reduced the measured slump of the composite as compared to plain concrete in the range of 25 to 102mm. Also, since compaction by mechanical vibration is recommended in most SFRC applications, assessing workability of a SFRC mixture with the V-B test, which simulates the effects of vibration, is recommended rather than the conventional slump measurement. Incorporation of superplasticiser is essential to maintain good workability (120-150 mm). In addition to the above consideration the balling of fibres must be avoided.

4.5 Mechanical Properties of Hardened Steel Fibre-Reinforced Concrete

The most significant consequence of fibre addition to concrete is the delay and control of tensile cracking in the composite material (Ramakrishnan, 1988). Through intercept micro-cracks, many of the mechanical properties of the composite are improved. The level of improvement achieved, compared to plain concrete, depends on the dosage rate and type of fibre (ACIFC, 1999). Some of the properties affected will be discussed in this section.

Steel fibres improve the ductility of concrete under all modes of loading. But their effectiveness in improving strength varies among compression, tension, shear, torsion and flexure.

Compressive strength is slightly affected by the presence of fibres, with observed increases ranging from 0 to 15%, on the other hand, direct tension improved significantly, with increases of the order of 30 to 40%, similarly, shear and torsion generally increased although there are little data dealing strictly with the shear and torsion (ACI Committee 544.1R, 1996, Amir, 2002). Much greater effect on flexural strength than on either compressive or tensile strengths, with increase of more than 100% has been reported (Johnston, 1974; Khaloo et al, 2005). The post-crack flexural performance is a most important part of the commercial uses of steel fibre concrete enabling reductions of thickness to be made in sections subject to flexure or point load. Impact strength and toughness, defined as energy absorbed to failure are greatly increased (Hauwaert et al, 1999), the increased in toughness results from the increased of the area under the load deflection curve in tension and flexure (Newman et al, 2003). Increased resistance to dynamic load and fatigue is often claimed (Concrete Society, 1994), it seems to be related to the distribution of the fibres in concrete (Cachim et al, 2002). Also, it has 15% higher resistance to wear than plain concrete.

Modulus of elasticity and Poisson ratio are generally taken as equal to those of similar non-fibrous concrete when the volume percentage of fibre is less than 2% (ACI Committee 544.1R, 1996).

Generally, steel fibre concrete is more durable than plain concrete, having a positive influence on the shrinkage behaviour of concrete by reducing the number and controlling the width of cracks (Concrete Society, 1994; ACI Committee 544.1R, 1996). If the concrete is well compacted the corrosion of fibres will be limited to the surface of the concrete (ACI Committee 544.1R, 1996), these fibres will corrode rapidly in exposed conditions. Fibres also can reduce the deterioration caused by freeze-thaw cycling (ACI Committee 544.1R, 1996), and they also reduces the permeability of cracks even at low volume (Rapoport et al, 2001).

5. POLYPROPYLENE FIBRE-REINFORCED CONCRETE

5.1 Addition and Mixing (Polypropylene)

The addition of polypropylene fibres is at a recommended dosage of approximately 0.90kg/m^3 (0.1% by volume) (Knapton, 2003), the fibre volume is so low that mixing techniques require little or no modification from normal practice (Newman et al, 2003). The fibres may be added at either a conventional batching/mixing plant or by hand to the ready mix truck on site (Knapton, 2003).

5.2 Placing Finishing and Curing (Polypropylene)

Concrete mixes containing polypropylene fibres can be transported by normal methods and flow easily from the hopper outlet. No special precautions are necessary. Conventional means of tamping or vibration to provide the necessary compaction can be used. Curing procedures similar to those specified for conventional concrete should be strictly undertaken. While placed fibre-dosed mixes may be floated and trowelled using all normal hand and poor tools (Knapton, 2003)

5.3 Mechanical Properties of Fresh Fibre-Reinforced Concrete

Knowledge of the fresh concrete properties is considered to be essential for proper design and application of fibre reinforced concrete mixes (Ramakrishnan, 1988).
Polypropylene fibres act mechanically. They impart a cohesive effect by holding water at or near the surface of the concrete, delaying evaporation and increasing cement hydration (Knapton, 2003). The slump of fibre-dosed concrete is not significantly affected by the addition of polypropylene fibres.

5.3.1 Controlling Plastic Shrinkage Cracks in Concrete

The primary role of polypropylene fibres is to modify the properties of the fresh concrete. They increase the homogeneity of the mix, stabilising the movement of solid particles and blocking bleed water channels. This reduces the bleed capacity of the concrete and slows down the bleed rate, helping to reduce plastic settlement.

Plastic cracking may occur in the plastic concrete as a result of drying shrinkage. Plastic cracks are formed within the first 24 hours after the concrete has been placed when the evaporation rate is high and the surface of the concrete dries out rapidly (Knapton, 2003). It is not only affects the appearance of concrete, but also its physical, mechanical and durability properties (Ma et al, 2004). Polypropylene fibres can limit the width of plastic shrinkage cracks. The fibres also endow the concrete with some post-cracking ductility and increased strain capacity at these very early stages, which will have a beneficial effect on plastic shrinkage cracking (Newman et al, 2003).

5.4 Mechanical Properties of Hardened Fibre-Reinforced Concrete

The introduction of polypropylene fibres into the concrete mix has generally no significant effect on the 28-days compressive strength of concrete cubes (Knapton, 2003). Similarly, it has either little or no effects on the flexural strength of concrete (Ramakrishnan, 1987). Moreover, the toughness/energy absorption of the material specially at higher fibre content is increased (ACI Committee 544.1R, 1996). On the other hand, the surface of abrasion resistance and the resistance to frost attack are significantly enhanced by the addition of polypropylene fibres.

They also increase the protection of the steel reinforcement against corrosion and reduce the water permeability of the concrete. But, they do not alter the chemical resistance of concrete (Knapton, 2003). As a result, polypropylene fibres are generally more durable than plain concrete (Concrete Society, 1994).

6. STRUCTURAL SYNTHETIC FIBRES

The lack of design guidelines and available references, for synthetic structural fibres, are the most significant barriers to better understanding to the proper way of its: addition, mixing, placing, compaction, finishing, curing and effect in concrete properties. From limited sources of information, mainly Grace Construction Company, some information in this regard presented below (Grace Construction Company; Perry, 2003; Clements, 2002).

The fibres can be added to the concrete at any point during the patching or mixing processes. Additions rate dependent on the specific application and desired properties and will vary between 1.8 to 7kg/m^3. Their additions require careful attention to both mix design and batching procedures in order to achieve optimum results. Adjustments will generally need to be made to the mix design to ensure the required workability is achieved; in addition, a slight increase in the fine aggregate contents may be needed to coat the fibres fully. This will also assist with rapid placing and efficient finishing of the concrete. However, incorporation of a superplasticiser is essential to achieve medium to high level of workability (120-150mm slump), consequently sufficient pumping will be allowed. The placing of structural synthetic fibres are exactly the same as per normal concrete. While the concrete should be compacted sufficiently to ensure that adequate paste is brought to the surface to allow easy finishing. After compaction, an easy float is usually passed over the concrete to close up the surface. Once the fibre reinforced concrete has been levelled, compacted and floated, it is allowed to cure in accordance with good concreting practice.

Structural synthetic fibre mostly relies on surface friction to achieve anchorage across a crack. It controls plastic shrinkage cracking and cracking due to drying shrinkage of the concrete. Also it improves concrete properties including ductility, fracture toughness, impact and fatigue resistance.

7. FIBRES AS A REINFORCING MATERIAL FOR CONCRETE FLOORS

A major use of fibres is to use them as a replacement for conventional steel mesh in industrial ground-floor slabs (Newman et al, 2003). In fact, nearly 65% of the fibres produced worldwide are currently used in industrial floors, road pavements and other slab-on-grade. In the UK with the advent of fast-track systems in the construction industry, concrete flooring has had to meet quicker construction programmes. With the use of laser screeders, fibres are often specified instead of conventional mesh because of the inconvenience of positioning individual mats of mesh immediately in front of the laser screeding machine as it progresses.

Steel and polypropylene fibres have been used in place of conventional reinforcement for the past 20 years. The polypropylene fibres benefit the concrete during its early life or plastic state and the steel fibres later on in the hardened state. In recent years, new fibres, known as structural synthetic fibres, have been introduced to market. They help to control cracking in both fresh and hardened state of concrete. However, the use of structural synthetic fibres in floors is limited, as they have not yet been widely used.

As this type of fibres is still new, and in order to better understanding of its behaviour in concrete industrial ground floor, further investigation required to ensure that structural synthetic fibres can provide concrete with necessary level of post-crack performance. This could be carried out through simply engineering principles for reinforced concrete design and current testing standards for fibre-reinforced concrete.

8. DESIGN GUIDELINES FOR FIBRE-REINFORCED CONCRETE FLOOR

The existing design methods can hardly be applied to fibre reinforced concrete floor slabs. At the same time, design methods for conventional reinforcement are not suitable because fibres represent a diffused reinforcement and are not localised in defined planes. On the other hand, current design guidelines for ground floor slabs invariably rely on elastic analytical solutions derived in the earlier part of the last century. Plastic design guidelines were introduced to allow for thinner slabs. The main shortcoming of the technique is that it only estimates the collapse load, but does not give any information on the deflections. Elastic methods are usually used to check deflections, but these methods are applicable only up to the first crack and should not be applied thereafter. Also, because fibres start working after cracking of the concrete matrix, where material response is no longer linear, floor slabs can be better analysed by adopting methods based on nonlinear fracture mechanics. It becomes clear, therefore, that a solution that describes the load-deflection history from the start of loading and up to failure is required. This gain suggests the need for modern numerical structural analysis techniques, such as the finite element method, which can better model the true behaviour of the fibre-reinforced slab and can, give a complete loading-deflection history. By using nonlinear finite element analysis, crack development during loading in the slab can be more accurately predicted until a collapse mechanism occurs, with the corresponding load representing the ultimate load of the slab. Due to the outstanding toughness of fibre-reinforced concrete, this load is remarkably higher than the load at which the first crack in the concrete matrix occurs.

9. FLEXURAL PERFORMANCE OF FIBRE-REINFORCED CONCRETE

Recently, the preferred method to compare the relative performance of different fibre products is to measure the post-crack capacity of the fibre-reinforced concrete section. This may be tested by measuring energy absorbed by a concrete section as deflected by an applied load; this energy absorption is called toughness. Toughness has been traditionally measured using concrete beam specimens according to the following standards: ASTM C1399, ASTM C1018, JCE-SF4 and RILEM TC-162. This implies that the post-cracking strength of fibre reinforced concrete can be easily calculated using the equivalent flexural strength determined from the bending test specified in standard tests. This equivalent flexural strength is a strength parameter which characterises the post-cracking resistance. Therefore it can be used for design and stress analysis of fibre reinforced concrete structures.

10. CONCLUSIONS AND THE WAY FORWARD

The use of structural synthetic fibres as a replacement for steel reinforcement in flooring has various advantages: light weight, tight cracks, ease of use, safe handling, rapid dispersion and no corrosion. However, measuring the post-crack capacity of the fibre-reinforced concrete section could compare the relative performance of different fibre products. As a result, comparing post-crack performance of synthetic fibres with steel fibres and mesh will reveal the differences in the way the materials work.

In light of the above, a beam test on reinforced concrete sections incorporating: steel fibres, structural synthetic fibres and steel fabric will be carried out according to ASTM C1018 for two purposes: first to compare the post-crack capacity performance of the three sections and, second, to use the flexural strength parameter resulted from beam tests as an input data into the stress analysis of fibre reinforced concrete floors using non-linear finite element analysis programme. After using the finite element analysis to study the fracture behaviour of ground floor-slabs and in order to validate the numerical analysis, three full-scale tests on slabs incorporating steel fibres, structural synthetic fibres and steel fabric will be performed and the experimental results will be compared with the ones obtained from the numerical analysis.

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REVIEW OF VENTILATION SYSTEMS IN OPERATING ROOMS IN VIEW OF INFECTION CONTROL

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ABSTRACT: The Postoperative Infection Rate (PIR) generally depends on factors such as the type of surgery, the cleanliness of equipment, medical procedures, and the level of microorganisms in the immediate and surrounding environments. Another major factor to consider is the quality of the air in the operating room (OR). The aim of this paper is review different ventilation systems in order to evaluate the of infection control (IC). This review consists of a literature review and observations in OR.

The objective is to assist design engineers in developing more efficient ventilation systems, and to help stakeholders in choosing the "best" system for the particular type of surgery they need to perform. The practical result will be that security aspects of IC will be strengthened, which should lead to lower PIR.

Key words: Indoor air quality, infection control, operating room, ventilation system

1. INTRODUCTION

Many countries suffer high postoperative infection rates (PIR) in their hospitals, especially in developing countries. In Brazil, for example, 15% PIR was reported while in Europe and USA the highest PIR was 5%. (OSPA and OMS, 2001, PREZIES, 2004, and CDC, 2003, respectively). The incidence of PIR depends on many variables, including the type of operating room (OR) ventilation system and the type of surgery performed.

The ventilation system is responsible for keeping good indoor air quality (IAQ) and also for ensuring infection control in the OR, i.e. to protect the patient from becoming infected. In accordance with (ASHRAE, 2002) the IAQ of a space is determined by the level of indoor air pollution and other characteristics, including the air temperature, relative humidity and air speed. Pollutants in an OR include aerosols and anaesthesia gases. A significant consideration is that different types of ventilation systems have different designs, dimensions, applicability and resultant airflow dynamics. According to (Friberg et al., 2003), in some cases the ventilation system can decrease the percentage of infection. Some types of ventilation systems improve infection control, because they provide airflow dynamics that "divide" the OR in different zones, ensuring different protection levels. The examples shown in Figure 1 are: one zone (example A), two zones (example B) and three zones (example C) – this also it is reported by (Mora, English and Athienitis, 2001). Previous studies (Mora, English and Athienitis, 2001, Friberg B, 1998, and Mermarzadeh and Manning, 2002) reported satisfactory results using ventilation systems which resulting in three zones the OR.

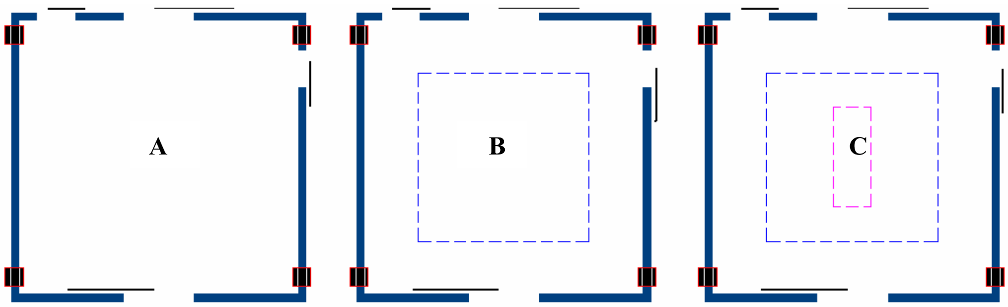

*Figure 1. Zones defined in accordance with the type of ventilation sys*tem

The type of surgery also has a significant influence on the PIR. In some types of surgery, for example implant and orthopedic surgeries, the patient has a great chance of contracting a postoperative infection. An important point is that each particular surgery will determine various details in the OR, for example, the amount, the type and the use of people and equipment. The type surgery will also determine the layout of the OR. That influence in the infection control.

This paper describes and then evaluates different types of ventilation systems. It considers the airflow dynamic, the layout of the OR in accordance with the type of surgery, and the infection control. The structure of this paper consists of an introduction, methods, results and discussion, and conclusion.

2. METHODS

In order to investigate the infection control in accordance with the types of ventilation system and surgery, three things were done: First, academic literature were reviewed; Second, observations of Ors were performed; and Third, interviews with a surgical team and with supporting technical staff were carried out. The purpose of the literature review was to get an overview of how and where different types of ventilation systems were used, and to assess how successful they were in managing the security aspects of infection control. The objective of the interviews with the surgical team was to establish some details about the medical procedure, the limitations of the ventilation system used, and the routines performed in the surgery. The interview with the technical support was conducted in order to understand the power and limitations of the equipment and lights, however, this will be not discussed in this paper. The observations in ORs were recorded on a specially designed form.

The observation of the ORs also had two objectives. The first was to establish how the previously mentioned variables (i.e. the position of the surgical team, the instruments and operating table, and the patient in the OR during the surgery) are dealt with in the real world, as opposed to in the literature. The observed surgeries were performed in the same OR which was equipped with a "Large-plenum" ventilation system. It was evaluated whether or not this ventilation system was suitable for the type of surgery both in terms of coverage of the patient, instruments, operating table and staff, and in the control of relevant security aspects of infection control such as temperature, humidity, air velocity, etc.

The second objective was to "test" the applicability of the special form used to evaluate the infection control, and to determine what questions are most important to consider in future observations. All observed surgeries were orthopaedic (three hip surgeries, hand, ulna, clavicle, foot, tibia and femur) and therefore they used the same layout of the OR. The surgeries took place over three days and the surgical teams were not the same in all surgeries. The observed OR was divided into two zones, as can be seen in Figure 2. The area of each operating room is 36 m^2 (6x6 m). Zone 1 is the space where the patient, the surgeons and their auxiliary and the instrument table should be. Outside this square (2) is Zone 2, occupied by the surgical support staff (anesthesiologist, nurses and technical). The exhausts are located in the four corners, as represented in the figure (4). The diffuser of the Large Plenum ventilation system is smaller than the zone delineated on the floor, as represented by the "dashed line".

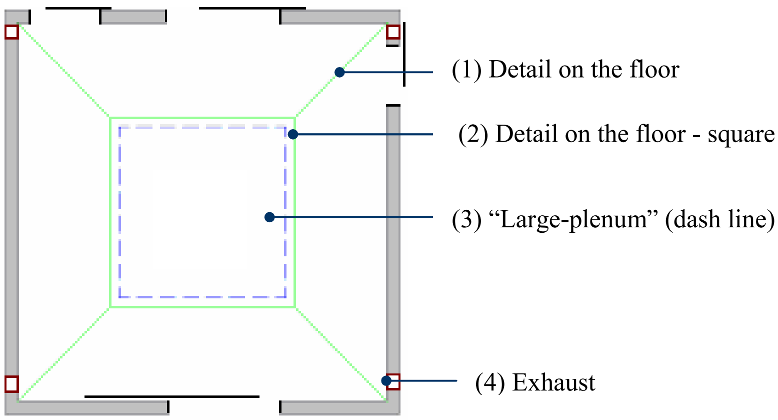

Figure 2. Schematic drawing of the observed operating room

3. RESULTS AND DISCUSSIONS

The literature review was carried out in order to get a clearer picture of how different ventilation systems have been used in different situations, and how successful their use has been in terms of dealing with the security aspects of infection control in the OR. In order to create a clearer picture and to allow a comparison of the different ventilation systems, four separate questions were considered: 1) Which (type of) countries use which systems? 2) Which systems are used for which type(s) of surgery? 3) How many zones each system can create? 4) How successful is each system at dealing with infection control? The ventilation systems that were evaluated are the Conventional ventilation system, the Plenum and the Laminar Air Flow (LAF), and some combining systems. Each system will be discussed below in line with questions raised above.

COVENTIONAL

Conventional (mixing) ventilation systems are used in ORs in old hospitals, which the majorities are located in developing countries. These systems are normally used for general surgeries, for example, Abdominal Surgery. These systems define only one zone in the OR and present turbulent airflow dynamic. The use of this system is not a good option for the OR, mainly in surgeries Class I (ASHARE, 2001), because of turbulence insurance the air is not clean in the area of the patient and on the table of instruments.

This type of ventilation system can present different disposition on the ceiling and some times also on the walls.

PLENUM

Plenum ventilation systems are used in some countries, including the Netherlands they are the most common system in use in ORs. These ventilation systems have been used for different types of surgery. There are different types of Plenum used in the Netherlands: Plenum (1.2mx2.4m and 2.4mx2.4m), Large-plenum (3.0mx3.0m), 3T-plenum and the orthogonal plenum. The 3T plenums and large plenums present the state-of-the-art for newly built or (to be) renovated operating theatres, which have presented satisfactory results in environmental control. The Large-plenum divides the OR in two zones while the 3T-plenum in three thermal zones and two zones of protection.

LAMINAR AIRFLOW

This type of ventilation systems are used in all word, and are recommended for environments which require ultra-clean air, including ORs Class I (ASHRAE, 2001). The Class I involve the orthopaedic, transplant, and other specialised surgeries, isolation rooms, areas of people with burns and laboratories. To have Class I characteristics these ventilation systems are combined with the use of the high-efficiency particulate air filters (HEPA), and a low and uniform velocity. This system, if used alone, can divide the ORs in two zones. There are two types of LAF system, the horizontal and the vertical. The horizontal LAF was developed to overcome the problems associated with vertical airflow. However, the horizontal supply air in ORs usually is disrupted by the surgical team (Dharan and Pittet, 2002). The vertical LAF is more effective in OR than the horizontal, because the clean air is supplied directly over the operating table, and also more effective in accordance with some studies, for example, by (Lidwell, 1982, Friberg, 1998, McCarthy et al, 2000, and Technology Assessment Team, 2001). In accordance with critical review and studies made by (Friberg, 1998), the Ultra clean air system ensures the potential of protection for the patient. The LAF may divide the OR in one zone or in two zones, in accordance with the design of the diffuser. For example, a full ceiling diffuser defines only a zone. Alternatively, examples other cases with diffuser smaller divide the OR in two zones.

(Mermarzadeh and Manning, 2002) made a comparative study of OR ventilation systems. They evaluated the LAF, Unidirectional, conventional and nonaspirating and displacement diffuser types in order of contaminant deposition on an OR and back table. These ventilation systems presented some different parameters, for example, the volume flow rate for each ventilation system. This study objectives to evaluate various parameters, for example, the effects of ventilation flow rate, diffuser type and location, supply temperature and exhaust location. The methodology used was numerical simulation. In Figures 3 and 4 it is possible to observe the airflow in two ORs using conventional ventilation. The difference between Figure 3 and Figure 4 are the number and position of the diffuser's of supply air. This research considered important analyses in terms of infection control. It showed results that identified the LAF ventilation system as the best performance in OR with some care. Another advantage of the LAF was that it results in better ventilation effectiveness. Figure 5 (Mermarzadeh and Manning, 2002) shows a laminar supply with conventional exhaust.

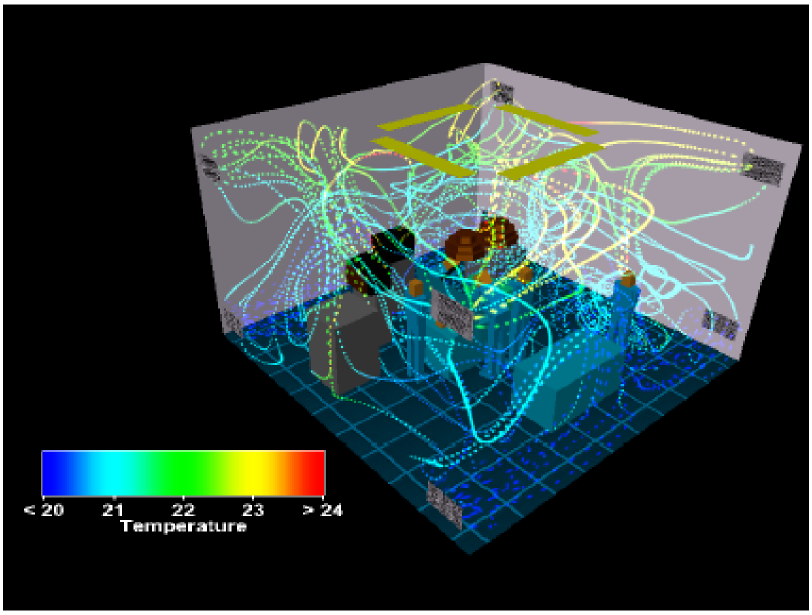

Figure 3. Airflow and temperatures in an OR with conventional ventilation systems (Mermarzadeh and Manning, 2002)

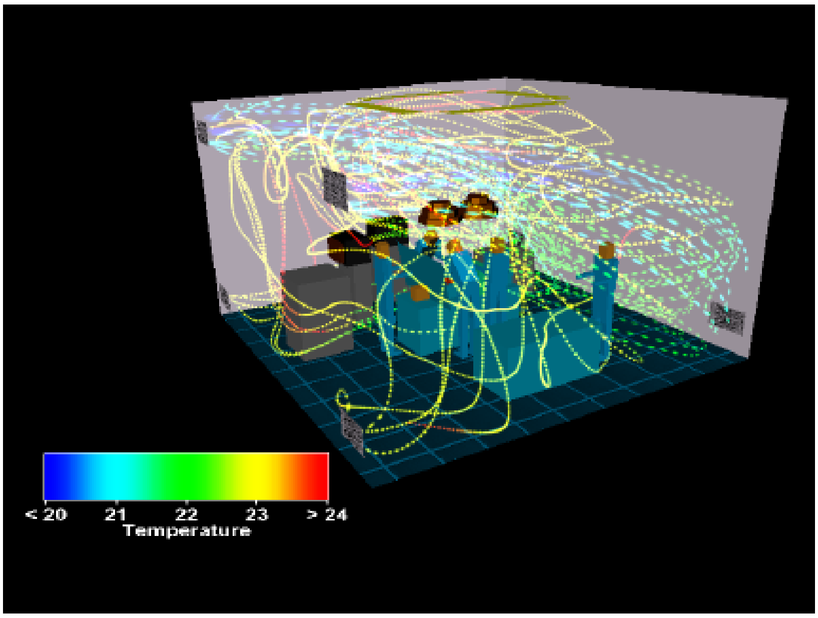

Figure 4. Airflow and temperatures in an OR with conventional ventilation systems (Mermarzadeh and Manning, 2002)

(Buchanan and Dunn-Rankin, 1998) simulated two ventilation systems: cross-flow and “impinging-flow”. The cross-flow presented airflow moved horizontally over the operating table, and the particles were lifted toward the ceiling by strong air currents and then carried to the outlet and removed. In this case the heating source had a little effect in the airflow. The impinging flow was opposed by rising natural convection currents caused by the heating loads that prevented the inlet air from properly ventilating the surgical site and its distribution in the room. Cross-flow was more efficient in the contaminant removal than impinging flow. The results showed that surgical team, patient and lights had great effect on the airflow due heat loads, which had a significant influence in the transport of air contaminants. Other papers also reported these effects in LAF, Unidirectional and Plenum ventilation systems, mainly which present vertical air supply. (Scherrer, 2003, Friberg, 1998, Mukhaiber and Turner, 2004, and Dharan and Pittet, 2002).

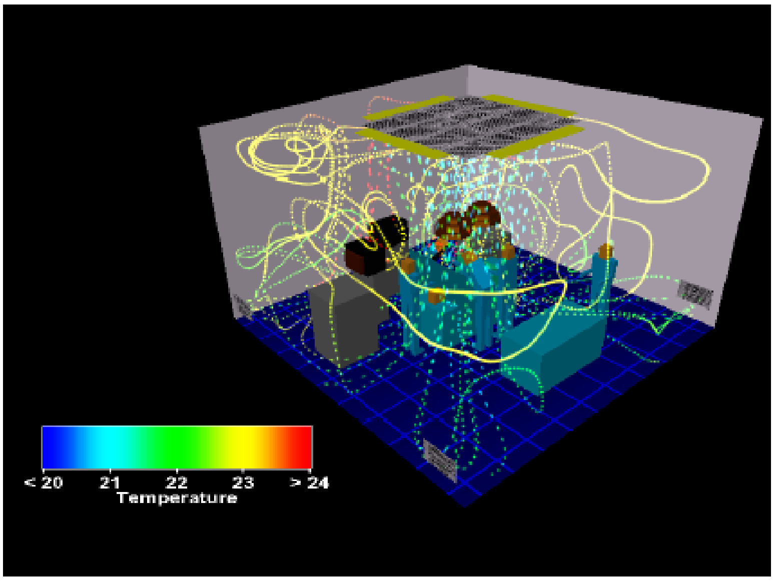

Figure 5. Airflow and temperature in an OR, resulting of a laminar supply (Mermarzadeh and Manning, 2002)

(Wanner et al., 1980), evaluated ORs equipped with a LAF "modern" ("Greenhouse") and with a so called "germ-stop wall". The second system consisted of glass wall with an opening to move in the patient, and which divided the OR in two zones. The first Zone is cleaner than Zone 2, which attend, respectively, the surgical team and another anaesthesiologist and other support staff. The second system reported great results on control of bacteria levels.

The LAF also had significant impact on postoperative infection rate, when combined with other ventilation systems, for example, the Helmet Aspirator System. However, a disadvantage of the body exhaust gowns is the reduced working conditions – freedom of movement, weight, etc. These results were reported in (Friberg et al., 2001, and Lidwell et al., 1987) cited in (Friberg, 1998) and (Technology Assessment Team, 2001). Otherwise, some studies reported a reduction, not significant, to the count of aerobic airborne and sedimenting bacteria-carrying particles in the OR using a mobile LAF screen in addition to conventional (mixing) ventilation system. These same levels were achieved with a LAF with HEPA filters. (Friberg et al., 2003, Napolitano, 2004 and Pasquarella et al. 2003). This subject needs to be investigated in details, because some studies presented different comments for a same type of ventilation system for the same types of surgeries.

COMBINED SYSTEMS

In this topic, some question will not be answered because literatures searched do not present all the information.

Other types of ventilation systems were evaluated and compared in the study of (Friberg et al., 1996). The ventilation systems were: "Floormaster" with the supply air from the floor and exhaust through the ceiling, and the Plenum with the diffuser of supply air inclined and in a wall, while the exhaust at floor level. The conclusions were "that an upward displacement system will lead to increased counts of airborne and sedimenting bacteria and thus increase the risk of postoperative infection in comparison with convention operating room ventilation systems".

Two types of ventilation systems used in Brazil and in other countries are the Unidirectional ventilation system in addition the Linear System. These systems combined define three zones in the OR – Zone 1 (ultra clean) stay the patient, Zone 2 the surgeon, auxiliary nurse and instrument tables, and Zone 3 the anesthesiologist, the circulating nurse and other support staff. The Linear system here "works" like a barrier, dividing the Zone 2 from Zone 3. This barrier does not permit that the less clean air enter in the Zone 2, therefore ensuring satisfactory protection for the instrument table. Hospitals that used these systems in OR have reported lower infection rate. These combined systems are represented in the Figures 6.

Figure 6. Example of Unidirectional and linear systems (TROX do Brazil, 1992 - reported by Melhado, M. 2003)

Reporting the results in visits in OR, it was observed the high complexity involved in this subject, and that it is very difficult to control some variables. In different types of surgery it was observed different layouts. However, in the hip surgeries (OR I and III) the layout of table instruments, position of the operating table, light and people were similar. In all surgeries the instrument table had out if the Zone 1, or in some case between Zone 1 and Zone 2. In all surgeries the anesthesiologist, anesthesiologist residents, nurses and other people stay in Zone 2. In the Figure 6 you can see four examples of layouts and surgeries, in which the security aspects of infection control were not kept for the instrument table and for the patient. The “mayo” table usually was in Zone 1. However, in the cases that the surgeon need more space because the type of surgery, or when it was used the X-Ray, this table was kept between Zone 1 and Zone 2, or totally in the Zone 2. All equipment was kept in the limit Zone 1 in the majority of the surgeries. The position of these can result in disturbed airflow dynamic of the supply air. The people positions are represented in the Figure 6 through numbers: anesthesiologist and respective residents (1), surgeon (2), nurse (3), auxiliary nurse (4), researcher (5), technical X-ray (6), resident surgeon (7), and the other number representing the trashes (8 and 9). The “trashes” always were located closer the instrument table. The “trash”, closer from the doors, always it was in this corner and covering the exhaust. The position of the people and instrument table changed in accordance with the type of surgery.

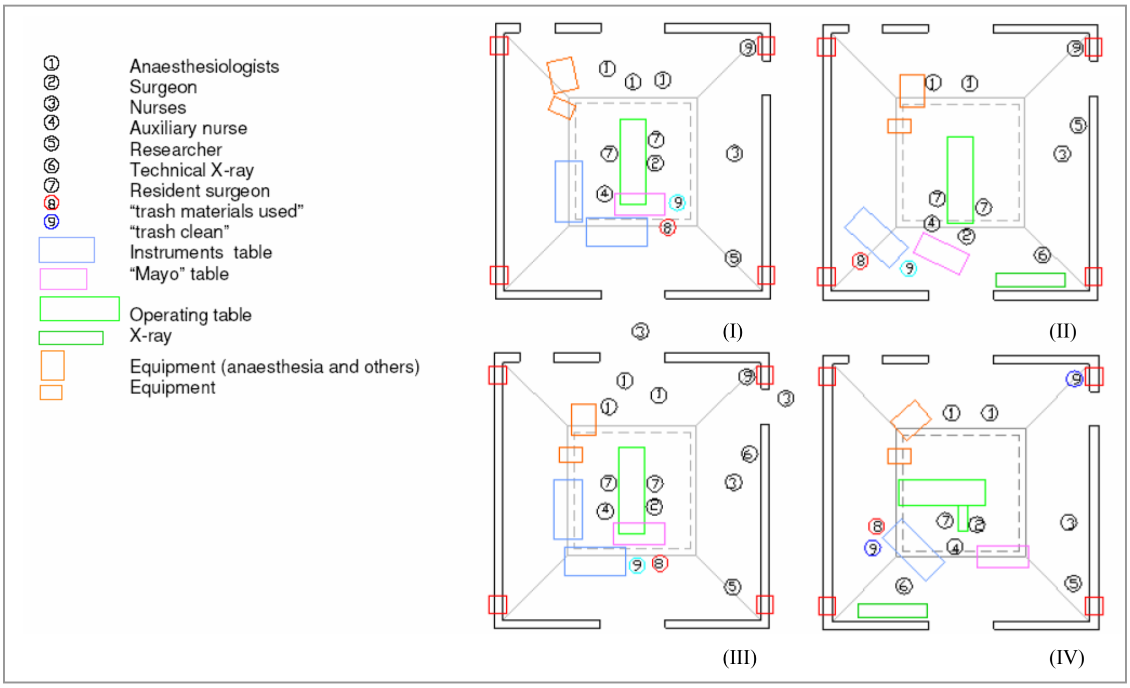

Figure 6. Examples of layout observed during some surgeries

CONCLUSION

The purpose of this paper was to make a comparative of different ventilation systems. The literature shows that the LAF (vertical) is the most efficient system in terms of infection control. Satisfactory results were also reported in the Large-plenum and Unidirectinal x Linear systems. However, it was verified that this efficiency is affected by the heat load in the OR, which, in turn, is affected by the amount and type of equipment, people and lights used. Other variables may also affect the efficiency, for example, the movement of people in the OR, and the occurrence of open doors.

The observations in ORs permitted to see how difficult it is to manage the security aspects of infection control during the surgery, independent of the type of ventilation system used. Usually the instrument table is not kept in an ultra clean zone, which decreases the level of protection against contaminants on the instruments.

The different ventilation systems should be used in different types of surgery, taking into account the different number and type of equipment, lights and people that are necessary. There is a great need for further research in this area. One very important task is to make a review of all the ventilation systems used in reality, and to evaluate their real efficiency. This would permit designers and engineers to develop more efficient ventilation systems, and to clarify to consumers the behaviour of the products. Of course, the primary advantage would be that improved knowledge in this area would lead to improvements in the security aspect of infection control in ORs.

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THE EFFECT OF BUILDING MOPHORLOGY ON FIRE SPREAD IN UK TIMBER-FLOOR HIGH-RISE

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ABSTRACT: In order to engage more use of timber in UK high-rise there by reducing the dependence of the building industry on steel and concrete which consumes fossil energy, there are disadvantages of timber which should be considered, its fire rating. The substitution of timber floors for traditional steel concrete composites is chosen as the unit of analysis for this research. As timber exists as a fuel, this research paper explores the effect of high-rise architectural morphology on the rate of fire spread using simulation. A descriptive case study of the Scotia place building in New Zealand shows the possibility of using timber floors for high-rise and also identifies practical morphological limitations. The FDS code by nist would be used. A simulation validation has been done using a real life fire (TF2000). A small scale exploratory pilot simulation to confirm that the shape of a building has an effect on its rate of fire spread.

Keywords - Architectural Morphology, Fire, Fire Dynamic Simulator, High-rise, Validation.

1. INTRODUCTION

From a survey carried out, the UK's looming energy crises have become the focus of its government policies with various options like nuclear alternatives at the fore front. Fossil fuel constituting 89% of total energy consumption coal 15% oil, 35% gas, 39% in the UK (Dti 2003) makes this an area to consider especially as research findings reveals Europe's current *fossil energy deficit* status see Tables 1, 2 and 3. This problem can be tackled by, 1) Reduction of dependence on fossil energy, 2) Provision of renewable alternatives, This research chose "1" Reduction of dependence on fossil energy (See Fig 1.0).

The building industry being an economic sector that accounts for 36%- 45% of a nations energy consumption, (Yeang, 1999) becomes the area chosen for this research to investigate for possible solution. Steel and concrete as building materials consumes 17% and 16% more energy than wood (CORRIM study) are mostly used in construction especially for large buildings, as timber requires less embodied energy why don't we substitute steel/concrete with timber? This research looks at substituting the floors of a commercial high-rise building as this is one of the fastest growing building type globally and accounts for a heavy dependence on fossil energy.

Substituting timber for steel/concrete composite floors in a high-rise opens a door to multiple research areas of which fire is one (See Fig 1.0b). This research chose to focus the fire aspect (as timber has a higher material flammability property) by seeking to investigate the impact of high-rise morphology on the rate of fire spread which is at the moment a gap in knowledge. This will explore architectural forms, and from findings of generated morphological variations, propose a benchmark high-rise form which will by its shear geometry, mitigate fire spread. This form can then be adopted when timber floors are proposed in a high-rise. The FDS code will be adopted. It has been validated see within text The substitution is feasible see case study Scotia Place Project within text. Forms have an impact on rate of fire spread, see validation experiment within text. For a pictorial view of the research path see *Fig 1.0 parts a and b*.

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Reason for focusing on the effect of high-rise architectural geometry on fire spread rate on substitute timber floor high-rise

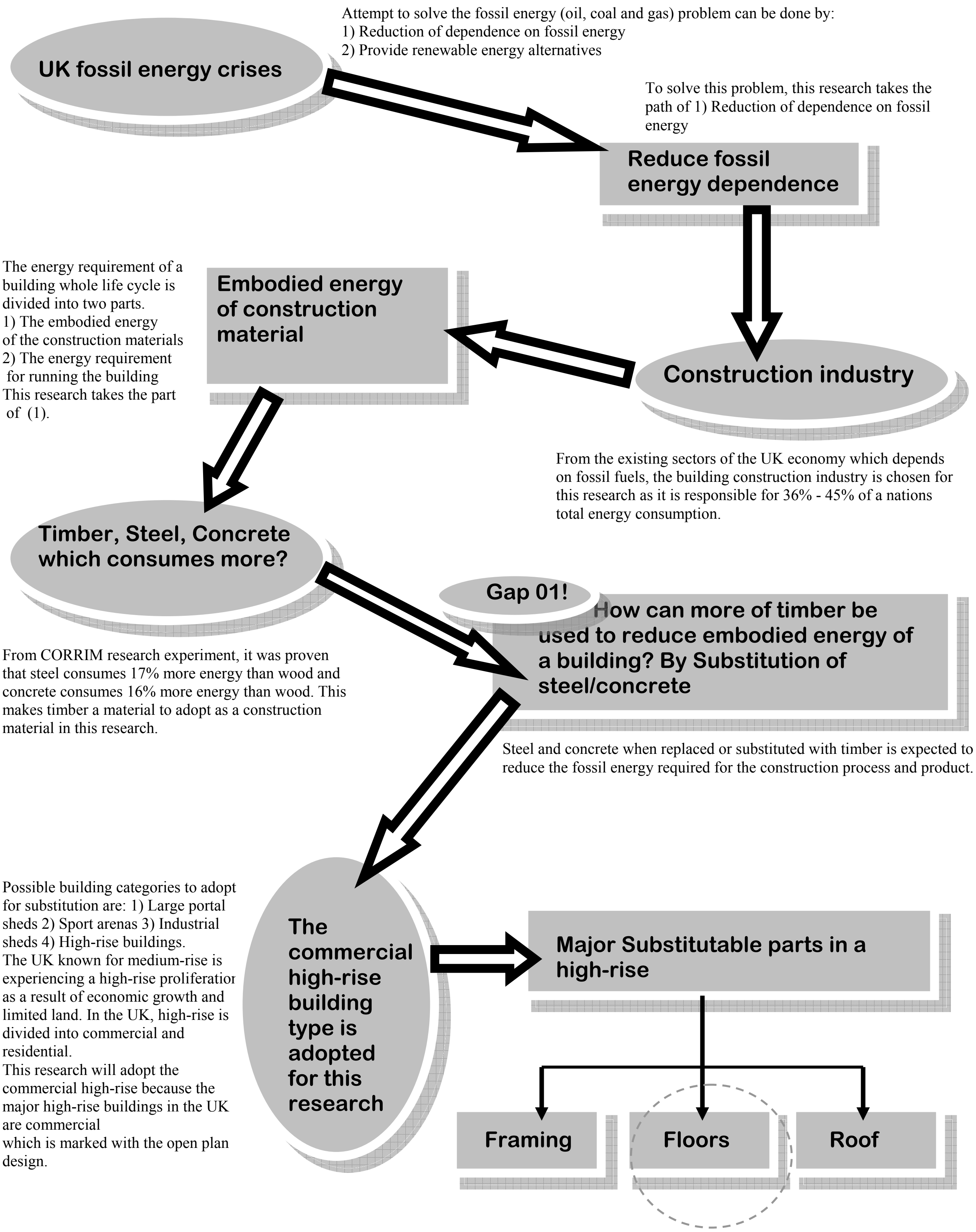
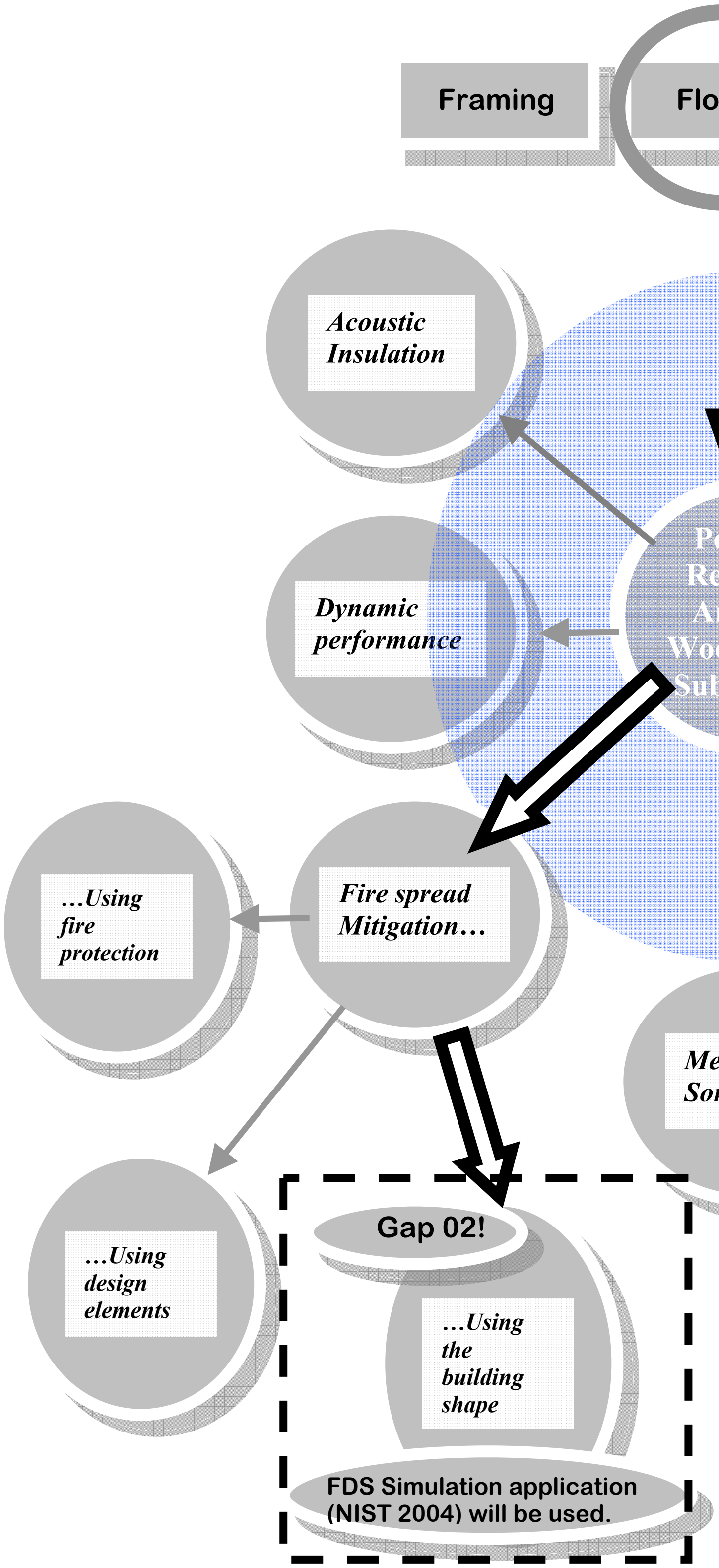


Fig 1a. PhD research proposal summary illustration

The high rise building is a complex structure which thrives on the strength of its materials. The steel frame is the structural frame that holds up the building. From literature reviews and interviews, the steel **frame** of a high rise is requires certain strength properties of which timber tecnonology is yet to conform with.

The high-rise floor does not play a major role in the primary strength axis of the building unlike the frame. It is responsible for diaphragm action.
It has a tendency to multiply depending on how many levels the building has implying volume which will have an impact on total construction energy requirement when substituted.
This makes the floor a suitable area of focus for this research. Investigating

The **roof** of a high-rise only uses a small fraction of the total concrete and steel material required to erect the building this might not significantly affect the building's total amount of embodied energy



According to the British standards, as regards building material, timber is designated class 3 for densities above 400kg/m³ and class 4 (which is the lowest) for below (Desch 1996) . Fire has a known confirmed fire weakness that's why it was chosen as the unit of analysis. During the literature review, a gap in knowledge was identified, in order to mitigate the weakness of timber and explore adopting it as a fossil energy saving material in a high-rise, does the geometry of the buildings affect its rate of fire spread?

Fig 1b. PhD research proposal summary illustration (part b)

Arriving at the knowledge gap 02 *(See Fig 1.0 b)*, the research the research question and purpose becomes clearer which is "exploring mitigation of the weakness of timber (fire) using the building shape so that it can be adopted for its floors as a low energy steel/concrete substitute to save construction energy in a high-rise building".

This work then proceeds to the generation of 30 morphological variations for spread rate analysis in order to explore for the lowest fire spread rate morphology which will be proposed for timber floor high-rise design, increasing use of timber in construction and reducing fossil energy consumption levels.

The research problem which is the UK energy crises was validated in the course of this research adopting data from BP statistical review of world energy.

2. RESEARCH PROBLEM

UK/ Europe Fossil Energy reserve/consumption Analysis and claim validation.

The research problem of this work is based on the UK/ Europe's reserve/ consumption deficit hence a need to validate this claim.

The data used for this analysis was put together by "**BP Statistical Review of World Energy June 2005".**

The three fossil energy categories are individually assessed to ascertain the fossil energy status of the six continents. The unit of analysis is the reserve/consumption relationship of each oil producing region of the world. If a region consumes more than it produces, it will be classified as running a deficit whish will be recorded in negatives value.

The R/P ratio (reserve/production) figures provided by the BP Statistical Review of World Energy June 2005 will not be adopted for this analysis because of the nature of the primary research. Substituting timber for steel in high rise because of the low embodied energy of timber tends towards sustainability which is not a short term scenario.

Table 1. Oil Reserve/ Consumption Analysis

CONTINENTS	R/P RATIO	WORLD SHARE OF OIL RESERVES IN % *END(1984-2004)*	WORLD SHARE OF OIL CONSUMPTION IN % *EN)D(1984-2004*	RESERVE/ CONSUMPTION DEFICIT IN % *EN)D(1984-2004*	CONSUMPTION CHANGE 2004 OVER 2003 IN % *EN)D(1984-2004*
NORTH AMERICA	11.8	5.1	29.8	-24.7	2.8
CENTRAL AMERICA	40.9	8.5	5.9	2.6	3.7
EUROPE & EURASIA	21.6	11.7	25.4	-13.3	1.8
MIDDLE EAST	81.6	61.7	*		5.2
AFRICA	33.1	9.4	3.3	6.1	3.4
ASIA PACIFIC	14.2	3.5	28.9	-25.4	5.2

(Figures from BP Statistical review of world energy June 2005)

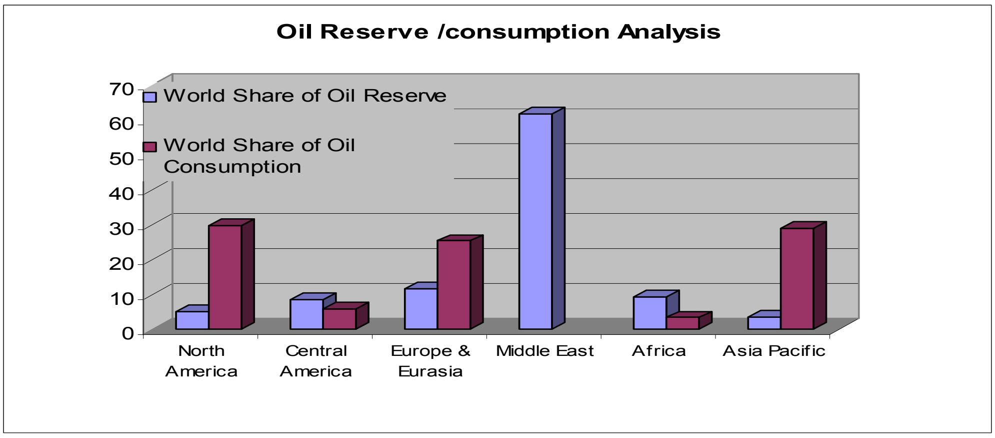


Fig 2. Oil reserve and consumption analysis in percentages

Table 2. Coal Production/ Consumption Analysis

CONTINENTS	WORLD SHARE OF COAL PRODUCTION IN % *END(1994-2004)*	WORLD SHARE OF COAL CONSUMPTION IN % *END(1994-2004)*	PRODUCTION/CONSUMP TION DEFICIT IN %	CONSUMPTION CHANGE 2004 OVER 2003 IN % *EN)D(1984-2004*
NORTH AMERICA	22.2	21.7	0.5	0.3
CENTRAL AMERICA	1.6	0.7	0.9	1.6
EUROPE & EURASIA	15.9	19.3	-3.4	-0.6
MIDDLE EAST	*	0.3	*	1.1
AFRICA	5.1	3.7	1.4	5.7
ASIA PACIFIC	55.1	54.2	0.9	11.9

(Figures from BP Statistical review of world energy June 2005)

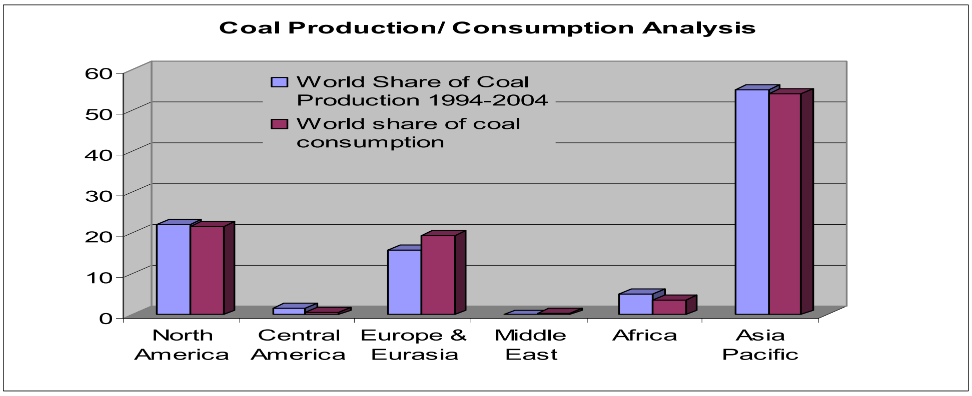


Fig 2. Coal reserve and consumption analysis in percentages

Table 3. Gas Reserve / Consumption Analyisis

CONTINENTS	R/P RATIO	WORLD SHARE OF GAS RESERVES IN % *END(1984-2004)*	WORLD SHARE OF GAS CONSUMPTION IN % *END(1994-2004)*	RESERVE/ CONSUMPTION DEFICIT IN %	CONSUMPTION CHANGE 2004 OVER 2003 IN % *EN)D(1984-2004*
NORTH AMERICA	9.6	4.1	29.2	-25.1	0.1
CENTRAL AMERICA	55.0	4.0	4.4	-0.4	11.4
EUROPE & EURASIA	60.9	35.7	41.2	-5.5	3.1
MIDDLE EAST	*	40.6	9.0	31.6	7.2
AFRICA	96.9	7.8	2.6	5.2	2.9
ASIA PACIFIC	43.9	7.9	13.7	-5.8	6.0

(Figures from BP Statistical review of world energy June 2005)

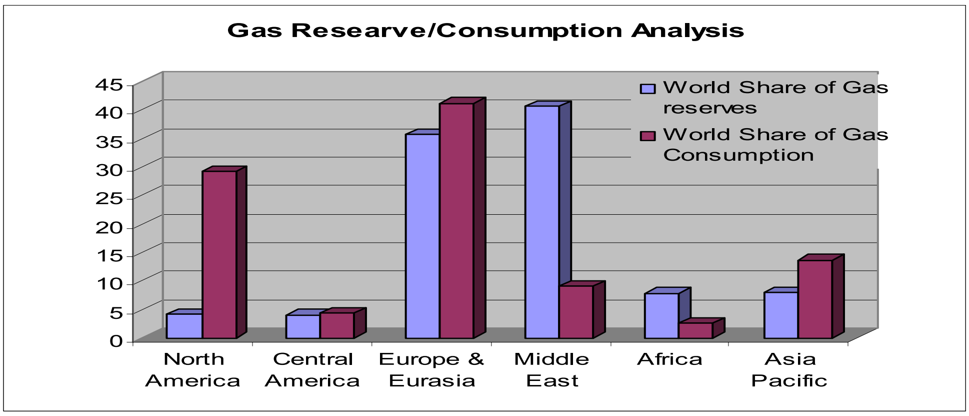


Fig 3 Gas reserve and consumption analysis in percentages

We chose to measure gas and oil *reserves* against *consumption* instead of *reserves* against *production* as “proven reserves” deals with a long term scenario while production levels are primarily about meeting the direct needs of the consumers. As the research concerns a long term scenario, we need the percentage of world share reserve for each regions or Continent. The available data world reserve starts from 1984-2004 while the consumption starts from 1994-2004. (Coal has no reserve value so we used its production value)
The decade difference in the above dates applies to both sides of the equation so they both cancel out in the proposed equation below:

WgR – WgC = RCd

WgR = World Share Of Gas Reserves In %,

WgC = World Share Of Gas Consumption In %,

RCd = Reserve/ Consumption Deficit In %

From tables 1, 2 and 3, Europe has a negative “RCd” value in the 3 fuel categories (oil, coal and gas); this simply means that on a global percentage scale in fossil energy, Europe now consumes more than it can actually produce.

The European Union has resolved to increase the share of renewable in its total energy consumption to 12% by 2010. “Britain ran a record deficit in gas and electricity as well as crude oil in November 2005, according to the latest figures to highlight Britain's growing energy crisis”(Thornton 2006). “Doing nothing about Britain’s energy supply is not an option” (Johnson2006. p2). Two primary ways to check this are: 1) Provide alternatives 2) Reduce consumption.

The nuclear option for an alternative is greeted with mixed feelings “The government should seek public view on whether new nuclear power stations should be built to lessen Britain’s reliability on imported electricity” (Johnson 2006.p2). With this division in the nuclear alternative, why don’t we then explore reduction of dependence on fossil energy consuming materials? As timber (a low embodied energy material) is proposed to tackle this problem can it apply in the context of this research proposal ie taking over traditional steel concrete floors in high-rise? This question led to the case study of the Scotia Place Project in New Zealand.

3. RESEARCH FEASIBILITY CHECK VIA SCOTIA PLACE CASE STUDY:

Scotia Place Project Case Study

On validating the UK energy crisis status there was a need to assess the overall viability of the wooden floor concept and if there were strategic considerations that could limit the generative morphology for this research which will become an input parameter during simulation .The case study model will also be used to cover contextual conditions which might be pertinent to the phenomenon of study (Yin 2003). The most important finding is that of **floor accelerations** as a result of the lightness of thestructure.
Location: The Scotia place project, situated on the edge of Myers Park in the centre of Auckland, New Zealand. It was designed as a studio apartment building. (Moore 2000).

Fig 4. Scotia Place view of the external fire stairs. (Image source

Description: This building is a 12 storey apartment building on a single storey basement which has wood floor diaphragms, and structural steel gravity and lateral load resisting systems (Moore 2000 p. 5.1.3-1).The diamond footprint shape came from its, height restrictions and daylight indicators see Fig 5

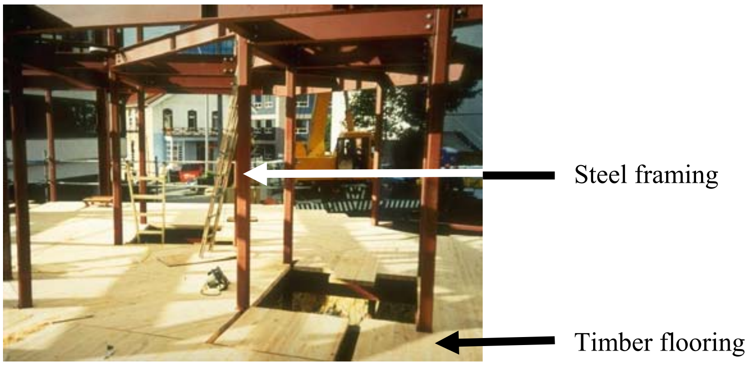


Fig 5. Scotia Place steel frame and timber floor. (Moore 2000)

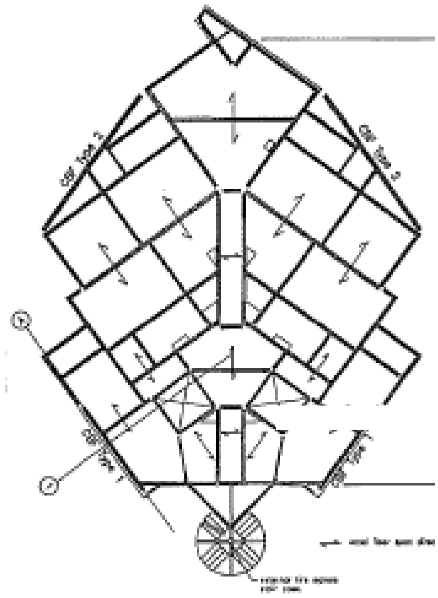


Fig 6. Scotia Place Plan. Right (Moore 2000)

Floor acceleration: The allowable roof lateral deflection (*Ld*) under transverse wind loading is limited to height (*h*) of building divided by 500 as dictated by New Zealand code

$$Ld \leq h/500$$

Because of a lower building density (total weight divided by total volume) as a result of wood floors, the building is expected to experience higher floor accelerations. To offset the increase in floor acceleration, due to low building density, a wood floor to structural steel connection damping 4 times higher than the 0.5 % to 1% of a conventional steel concrete composite floor was provided though <5%. As a result of this case study, the floor acceleration becomes the major consideration when exploring various forms. Flat shapes will be avoided to minimise wind effect. With this useful finding which constrains the morphological options to architectural forms that won't aid wind there was a need to validate the tool that would be used to generate these forms, the FDS code (Grattan 2004).

4. SIMULATION METHODOLOGY

This research will be carried out primarily by simulation, FDS (Fire dynamic simulator).From the case study, the floor acceleration becomes a constraining factor during the exploration of high-rise forms and the effect of fire fire spread. For reliable fire spread results, the FDS simulation program went through a validation process.

4.1 CFD *(Computational Fluid Dynamics)* Program Validation.

The objective of this research phase is to provide empirical data needed to validate the proposed simulation technique for this research. The parametric output data might contain an error factor which will be factored into all subsequent exploratory results by the CFD package. The package used as described in chapter three of this report is FDS (Fire Dynamics Simulator) applicationput together by NIST (National Institute of Standards and Technology) 2004 version which works in synergy with Smokeview (a visualisation software). In order to accept results using this application, a validation process was carried out see below. (Other researchers who adopted this application have carried out various validation exercises for their adoption of the FDS). TF2000 test compartment was chosen for this validation exercise for this research as it deals with timber as its building material.

4.2 Tf2000 Fire Test Compartment And Fds Model Domain Description.

***1) TF2000 Test Compartment Description*:**
The fire test compartment consisted of a single flat in the South West corner on the third level of the building. The walls were built of timber studs, OSBs, plaster board lining, external brickwork cladding. Ceiling lining was made of plasterboard beneath timber floor joist for the flat above, the same arrangement occurred for the floor of the test compartment. The ventilation conditions involved two windows, the living room and kitchen (Lennon, 2000) see fig 1.6b. The fire load was provided by timber cribs spread over the floor area of the flat. Approximate box dimensions 6.0m east, 3.0m south, 2.4m height dimensions. (Deduced from TF2000 second floor plan drawing see fig6.1a)

2) FDS Model Computational Domain:
For this validation exercise the researcher chose the nucleus of the TF2000 fire test (ignition domain) a) the living b) the kitchen and for triangulation purposes also included c) the ceiling void. The ventilation conditions involved two windows, the living room and kitchen. The fire load was provided by upholstery and timber boxes spread over the floor area of the flat. Approximate box dimensions 6.0m east, 3.0m south, 2.4m height dimensions. (Deduced from TF2000 second floor plan drawing see fig6.1a)
Door leading to the TF2000 lobby was present in the compartment but was shut. This door wasn't included in the FDS model because it was shut during the test though the door linings could have acted as vents and contributed to the test result values, but this wasn't done because it would require relatively minute grid cells which might greatly slow down the simulation process for an insignificant difference in empirical output values.

4.3 TF2000 / Validation Model Descriptive Analysis

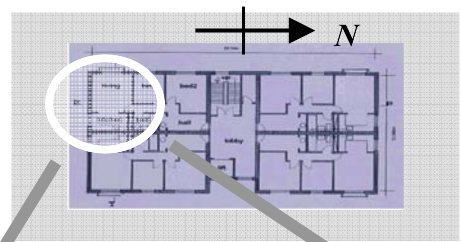


Fig 7. Second Floor Plan TF2000 Experiment Compartment circled. Living room and Kitchen of South West Flat. (Image Source mace. Manchester).

*Fig 8. Research focus BREs TF2000 Compartment Enlarged (Lennon 2000)**(TF2000 PLAN).***

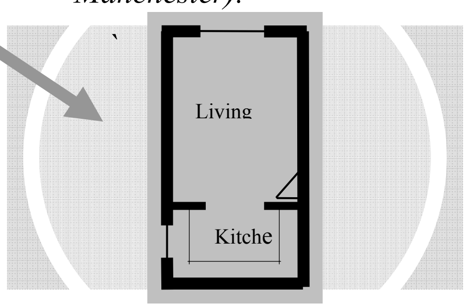


Fig 9. Research focus Simulation Compartment Enlarged ***(FDS PLAN).***

TF2000 PLAN: Initial burning was concentrated in front of the living area closest to the ventilation opening, with flames visible on top of the window frame some twenty minutes into the test (Lennon, 2000).
FDS PLAN: Initial burning was concentrated in front of the living area closest to the ventilation opening, with flames visible on top of the window frame some twenty minutes into the test (Simulation result) See Fig 10.

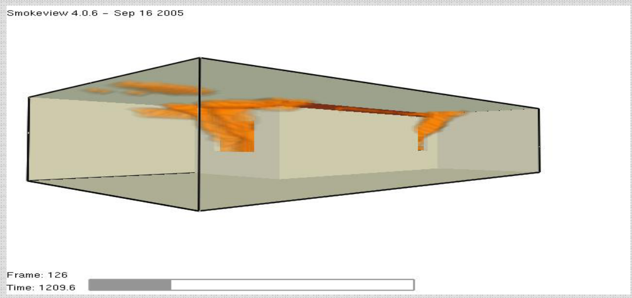


Fig 10. Computation domain showing the fire plume 20 minutes into the simulation gravitating towards the living room and the kitchen window. This agrees with the BRE observation.

4.4 Comparisons Between Validation Model And Tf2000 Test Results

Table 4. Results of TF2000 and FDS test results

TF PLAN / TF 2000 FIRE TEST	FDS PLAN / VALIDATION MODEL
Fire progressed to flashover after 24minutes from ignition	Fire gradually progressed to flashover between 20 and 30 minutes from ignition
Fire Brigade were asked to intervene by breaking single Window pane in kitchen area 21minutes 30secs from ignition	The simulation was stopped at its highest temperature 80 minutes into the simulation (1000degC)
Following flashover, the fireline boards over windows to the floor above were subjected to heat flux of approx. 30kw/m^2	Following flashover the temperatures stayed between 900 and 1000deg C
Window frame in the living area burnt away 35minutes into test	There was no information on the wood input parameter as regards window
Peak temperatures in living area reached 1000°c and remained There until the test was stopped at 64minutes from ignition.	Peak temperatures in living area reached 1000°c and remained there until the test was stopped at 80minutes from ignition
Based on the the measurements taken of fuel mass loss, the peak rate of heat release is estimated as approximately 6MW (MW=Megawatts)	Not yet determined
Ceiling boards began to come down 54minutes into the test	No such observation was made as this research focussed on the temperature
Maximum temperatures in the structural voids forming the Boundaries of the compartment remained below 100°c	Maximum temperatures in the structural voids forming the Boundaries of the compartment remained below 140°c See fig 6.1e above
The coolest temperature recorded close to the window in the TF2000 test exercise. Data demonstrates intense period of heat flux after flashover	The coolest temperature recorded close to the window in the FDS model. data demonstrates intense period of heat flux after flashover

During TF2000 fire test, it was observed that the effect of natural fire is approximately 10% higher that that of a standard (BS476: Part 20 furnace) fire test. (Lennon 2000) Only the test on a real structure under natural fire may evaluate the forthcoming model of the actual temperature development in fire compartment that's why this research seeks to validate the major tool by comparing with a natural fire (TF2000). For this program to be valid the relative differential factor should not exceed 11 %, this percentile is taken from the TF2000 natural fire charring test results analysis when compared with the (BS476: part 20 furnace) charring test results. See table 5 below

Table 5. Results of Charring Analysis (TF2000 and FURNACE tests)

MEASURED DEPTH OF CHARRING (mm)
TF2000 and BS476: part 20 furnace comparison
BRE report (Lennon 2000)

CUBE LOCATION	CUBE TYPE	TF 2000	FURNACE	RELATIVE SEVERITY	PERCENTAGE DIFFERENCE
Living room	H	33	24	1.375	-2.2 %
Living room	S	45	41	1.098	-8.8 %
Kitchen	H	20	23	0.87	15.0 %
Kitchen	S	36	39	0.923	8.3%
Corridor	H	15	23	0.652	53.3%
Corridor	S	26	39	0.667	50.0%

Table 6. Result of analysis of relative severity and percentage magnitude of charring depth

COMPARTMENT	MEAN RELATIVE SEVERITY	PERCENTAGE MAGNITUDE
Living room	1.237	11%
Kitchen	0.897	23.3%
Corridor	0.66	103.3%

THIS VALUES DERIVED FROM THE TF2000 NATURAL FIRE AND BS 476 PART 20 FURNACE STANDARD TEST WILL EMPIRICALLY DEFINE THE NUMERICAL RANGE WITHIN WHICH THE FDS SIMUILATION RESULTS SHOULD FALL FOR THIS RESEARCH TO ADOPT .

Below are graphical illustrations of the results of both tests exercises placed side by side for both visual and numerical comparisons
Three points of time against temperature will be selected and compared for both tests for each of the test criteria and results will be tabulated of which a relative severity factor will be recorded. This method was used in the TF2000 project when test results were compared with that of the BS476:Part20 furnace test (Lennon 2000). These results were comparatively analysed for the validation exercise. As the ignition point for the TF2000 test, the living room was chosen.

Living room temperature

THE LIVING ROOM

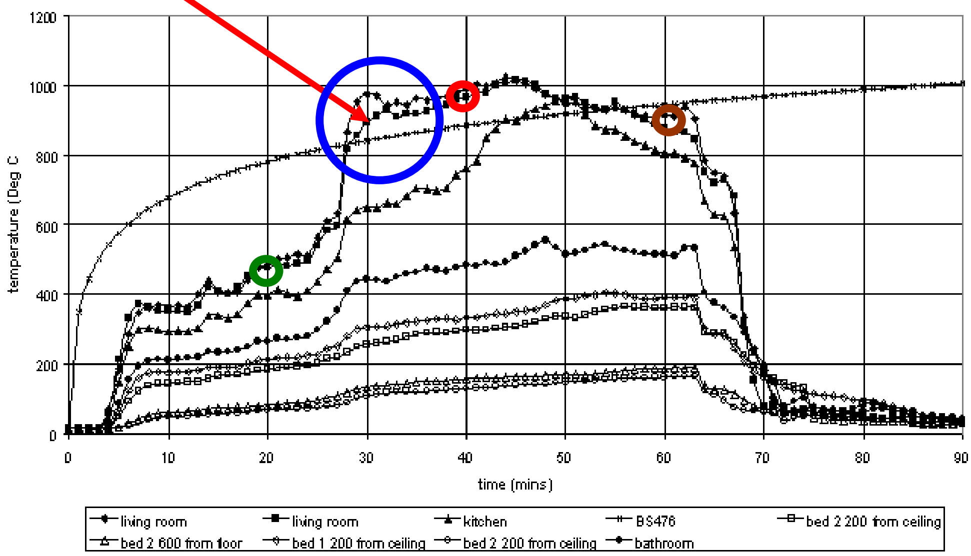


Fig 11. TF2000 Temperature time for Living room and kitchen

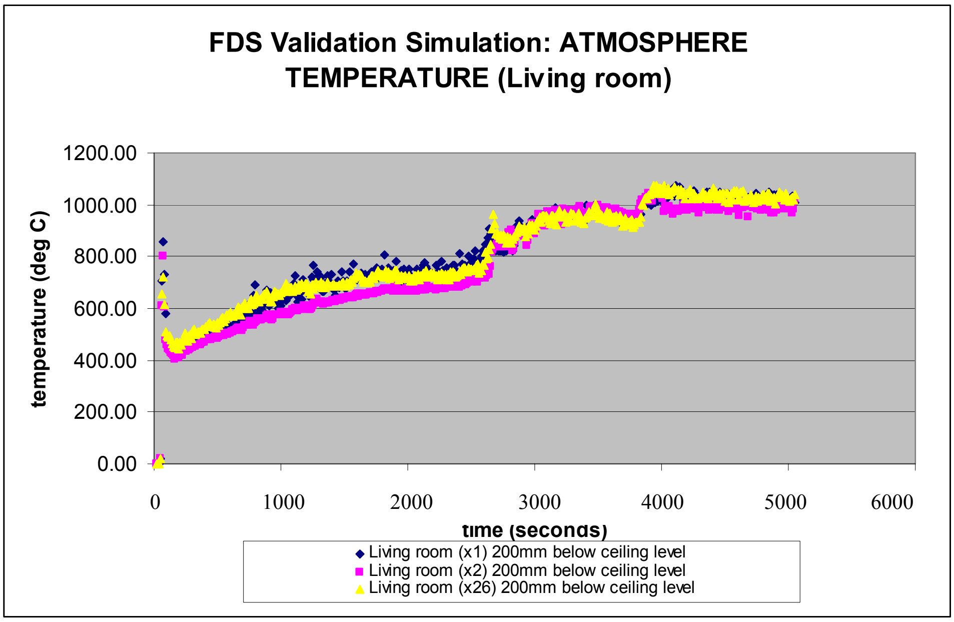


Fig 12. FDS Temperature time for Living room

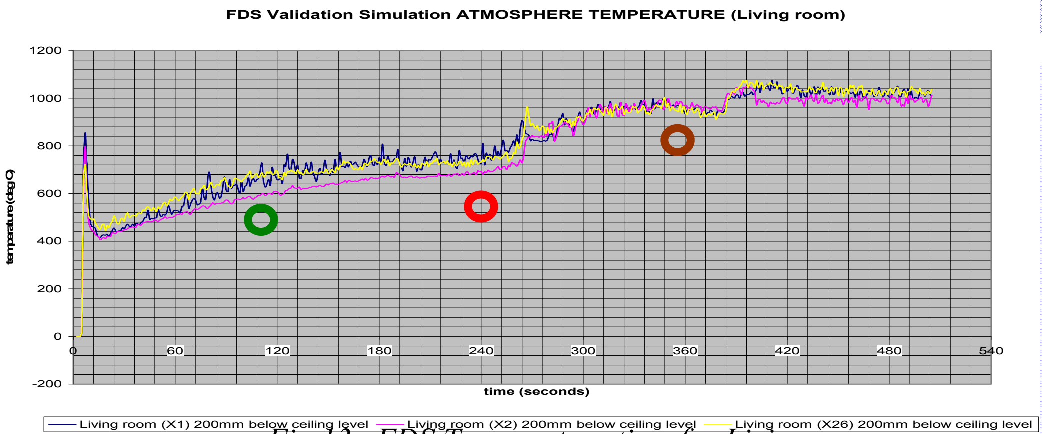


Fig 13. FDS Temperature time for Living room

The TF2000 temperature graph in the living room shows similar flow with that done using the FDS simulator. The major differences lie in the ignition stage where the FDS shows an unstable pattern. This could be accounted for in a) the high heat release rate parametric input as the exact value of the actual test is not yet determined. b) The simulation started with both windows open resulting in high oxygen levels which accounts for the 400degC temperature less than 5minutes into the fire. As a result the flashover was gradual unlike that of the TF2000 where the flame quickly progressed to flashover 24minutes after when a pane of the second window was broken 21minutes 30 seconds into the test. The blue band shows a common undulation of the curve which occurred in both processes. ***The maximum temperature of the TF2000 test was 1000 deg C, that of the FDS model was also exactly 1000 deg C.*** **The temperature of the TF2000 compartment continued at 1000degC until the fire was put out by the fire brigade 64minutes into the test that of the simulation model continued at 1000degC beyond 64minutes until the simulation was stopped 80 minutes from ignition.** An observation was made: the TF2000 fire stoppage showed a gradual decent in the graph temperatures (natural) while that of the Simulation stopped sharply (mechanical).

The graph in Fig 6.2e is the same Living room temperatures put in grid form for data extraction. Temperature values 20minutes, 40 minutes and 60 minutes into the test is adopted for this validation exercise:

FDS
@20mins = 665degC
@40mins = 751degC
@60mins = 943degC

TF2000
@20mins = 480degC
@40mins = 980degC
@60mins = 940degC

The table below shows a comparative parametric data analysis of the FDS and TF2000 test results.

COMPARTMENT	TIME (mins)	FDS (°)	TF2000 (°C)
Living room	20	665 = (t1)	480 = (t4)
	40	751 = (t2)	980 = (t5)
	60	943 = (t3)	940 = (t6)
Kitchen	20	580	400
	40	692	750
	60	774	800

Table 7. Comparative analysis of FDS and TF2000 temperature value results.

Based on TF2000 report review, for simulation to be valid it has to comply with the equation below.

$$\frac{\left(\dfrac{\sum t4 + t5 + t6}{3} - \dfrac{\sum t1 + t2 + t3}{3}\right) \times 100}{\dfrac{\sum t1 + t2 + t3}{3}} \leq 11\%$$

Table 8, Validation equation

Explanation of the equation

The percentage '***difference'*** between the '***mean'*** of the TF2000 readings and the FDS simulation readings should not exceed 11%.
This percentage value was chosen because during the test, the Charing results of TF2000 (natural fire) and BS476 (standard fire test) differed by 11%. See Table 5 and 6.

Mean of temperature readings at 20, 40, and 60 mins into test:
TF2000 = 800, FDS = 786,
Percentage difference

$$= \frac{(800-786) \times 100}{800} = 1.75\ \%$$

Percentage difference = 1.75, this is less than 11%

FDS fire simulation soft ware VALIDATED.

Hence the fire spread rate exploratory research will be carried out using the above program. (See details in appendix).

5. IMPACT OF BUILDING GEOMETRY ON FIRE SPREAD RATE VALIDATION ANALYSIS

With the FDS simulation software validated its subsequent empirical results will be adopted which leads to the next stage, does the geometry of a fire domain have any impact on the rate of fire spread? Apilot simulation was carried out to investigate this. Three test domain were generated. The domain geometry consists of:

- A square 6720 x 6720mm
- A triangle 9500mm height and 9500mm base
- A circle 3790mm radius

As temperature values are closely related to heat fluxes this could be a pointer if the flow field within the domain is identical or not. Therefore differing temperatures within the domain could most likely symbolise difference in fire spread rate. Note: all other computation input parameters remain uniform. *The prime unifying input parameter is the floor area (45m²) and flow field volume (108m³).* There was no ventilation to ensure unaffected plume propagation. Below are temperature readings for the three geometries.

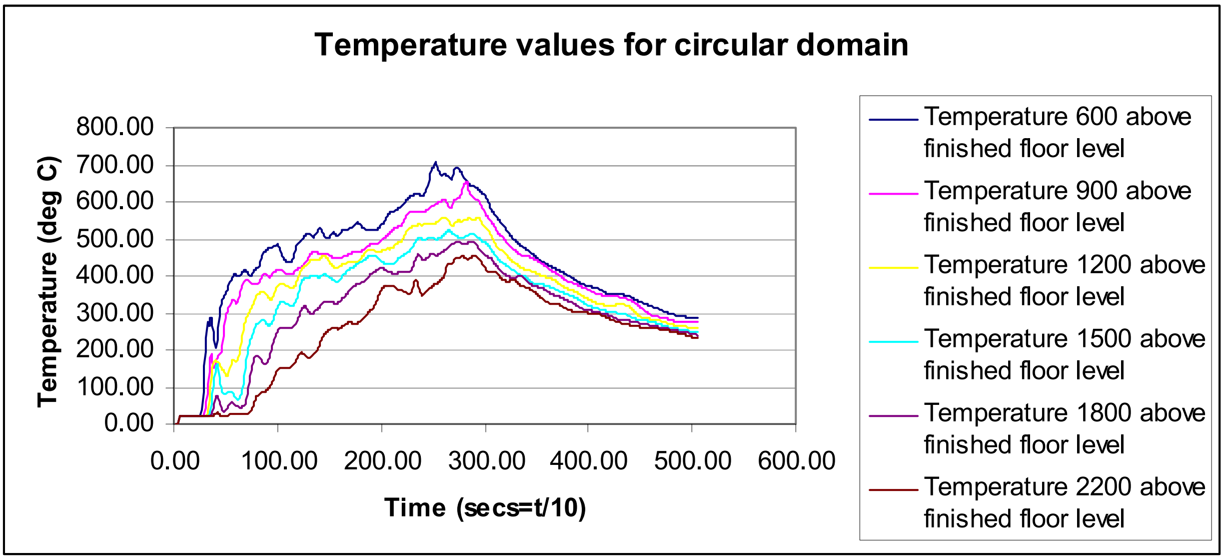


Fig 14. Temperature reading for the circular domain exposed to a 60seconds flame

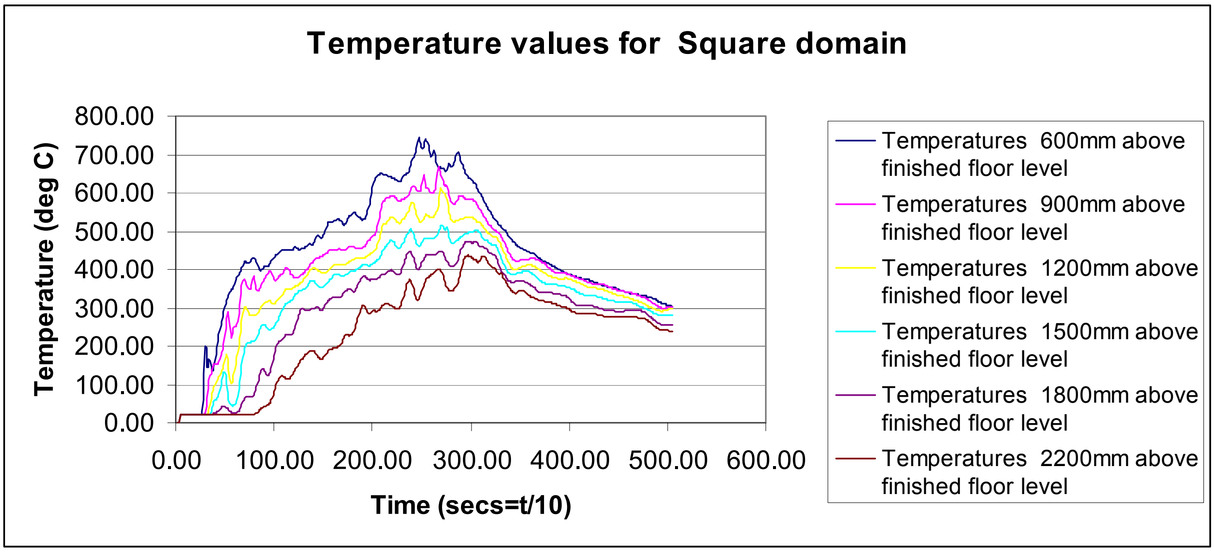


Fig 15. Temperature reading for the square domain exposed to a 60seconds flame

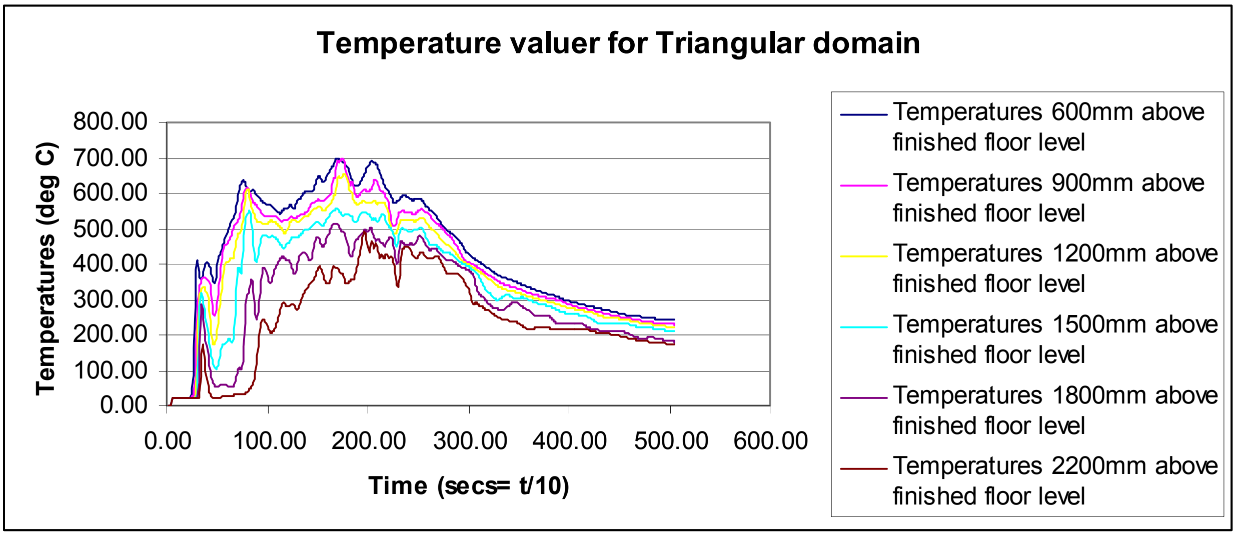


Fig 16. Temperature reading for the Triangular domain exposed to a 60seconds flame

From the output data values there were identical temperature readings for all six thermocouples2 seconds into the fire and though near close readings after the during the decay period of the flame. From the graphs in Figs 14, 15 and 16, this can also be noticed in the pattern.

Analysing these shape one could say hypothetically that the spread rate during the incipient and growth stage of the flame, for the three experiments were identical. This is likely to be as a result of lack of contact of the plumes with the domain boundaries. During the full developed fire stage which for this experiment occurred between 2.5 and 25 seconds into the fire.

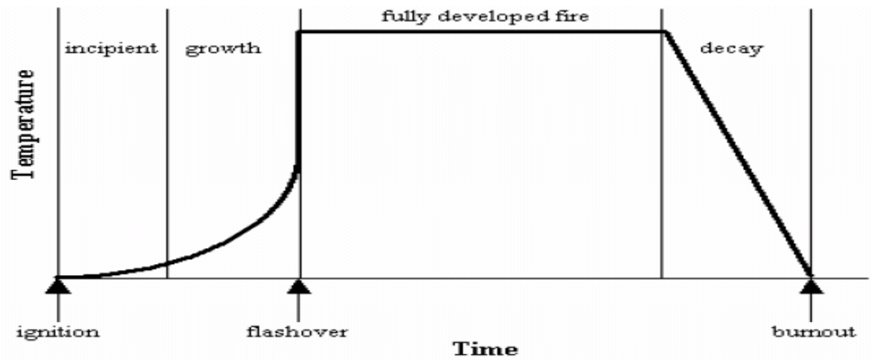


Fig 17. A typical temperature / time fire curve and various stages of fire development

5.1 VISUAL RESULTS OF EXPERIMENT

The test domain was sealed up to control external fire friendly factors
this accounts for the short ignition – burnout time due to O2 depletion.
All three tests from ignition to decay produced a maximum temperature of 820 deg C.
The triangular domain plume burnout time =32.2 seconds from ignition
The circular domain plume burnout time =35.6 seconds from ignition
The square domain plume burnout time =37.0 seconds from ignition
From the visuals with respect to plume spread propensity,

The triangular domain 20seconds from ignition had the fire plume in contact with much surface area of its rear and side left side surfaces (see Fig 16)
The circular domain 20seconds from ignition had a stray fire plume grazeing a small fraction of its surface (see Fig 17).
The square domain 20seconds from ignition, the fire plume did not make any visible contact with its surface. (see Fig 18)
Below are the three basic morphologies which were used for to investigate the effect of the building shell or the compartment shell on fire spread rate.

The arrows show the part of the boundary walls that had come in contact with the fire plume within 20 second from ignition.

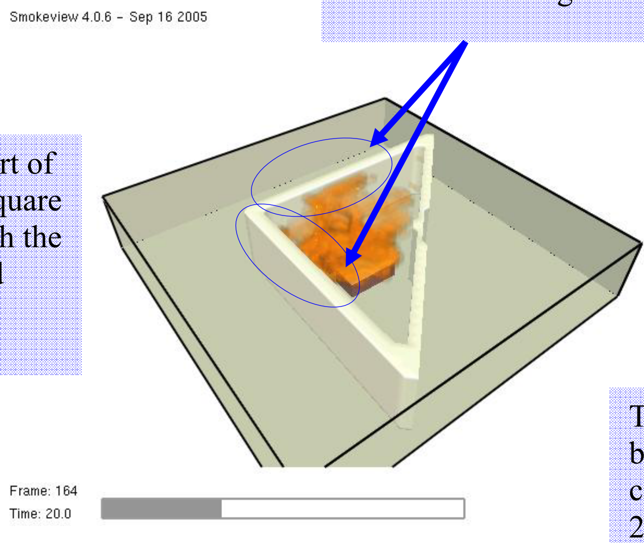


Fig 18. The Triangular domain

The arrows show that no part of the boundary walls of the square domain came in contact with the fire plume within 20 second from ignition.

The arrows show the part of the boundary walls that had come in contact with the fire plume within 20 second from ignition.

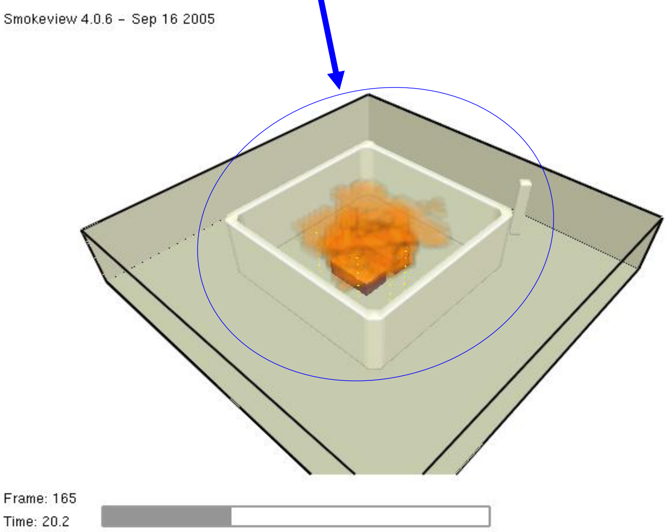


Fig 20. The Square domain

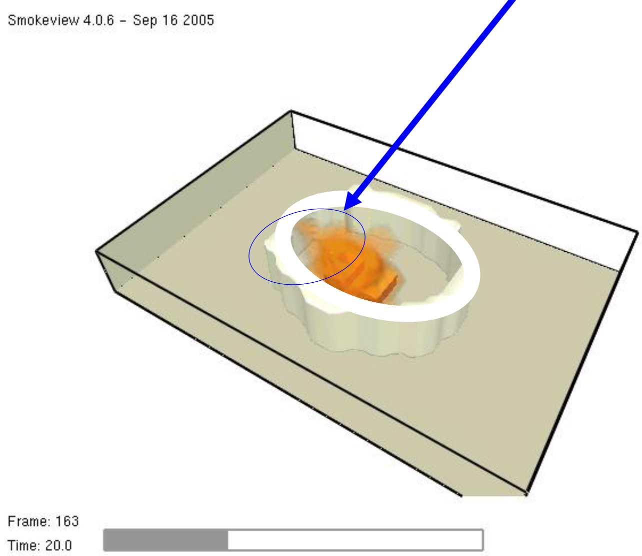


Fig 19. The Circular domain

6. CONCLUSION

With Europe consuming more fossil energy than it actually has spells a looming crisis. There are a number of areas to reduce use of fossil energy but this work chose to look into the building industry for substitution of high fossil energy material for that of lower fossil energy material. Steel/concrete composite for floors became the choice focus area of which substitution with timber was proposed. Timber being a material of high flammability property narrows the focus further to the fire aspect which exposes a gap in knowledge "impact of high-rise morphology on its rate of fire spread". To analyse this, multiple building geometries have to be tested and this cannot be done with a real fire situation so a simulation software had to be used. FDS code was chosen and tested through a validation process where it proved reliable as a result was adopted.

Having validated the tool "FDS code" there was a need to investigate if the geometry of a fire domain actually had an impact on the rate of fire spread which lead to the second FDS experiment. Findings showed that during the incipient and growth stage of the fire test for morphological impact, all three geometries had the same temperature readings. When the fire became fully developed, differences in readings became obvious. During the burn out stage, the readings became close again.

This brings about the assumption that prior to reaching the individual domain boundaries *(incipient/ growth stage),*the fire plume travelled at the same rate, on reaching the boundaries *(fully developed fire stage,)* the difference in geometries caused difference in temperature readings to be observed and when the flame started to extinguish, *(decay/burn out stage)*, the plume left the boundaries as it died out and this would have accounted for the reunification of temperature values.

In order to proceed to the next and final stage of this research, there had to be a difference in temperature readings With the presence of this difference in temperature readings for the three sample geometries, this research proceeds to its final stage which involves generation of 30 samples of high-rise morphological variations, test their individual impact on fire propagation rate within one or more of its floors depending on the form, explore to what degree this takes place. And in a timber floored high-rise will the morphology help mitigate impact of fire during the building's life? Analyse and produce a research design with the highest fire mitigation impact value.

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MODERN METHODS OF CONSTRUCTION AS THE SALVATION OF THE UNDERSUPPLY OF AFFORDABLE HOUSING

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ABSTRACT: The aim of the study is to investigate whether modern methods of construction (MMC) will be used by housing associations (HAs) to address undersupply of affordable housing in the UK. The population is development departments of HAs, to determine answers to two questions: (1) is there an undersupply of affordable housing in the UK, and if so what factors are influencing it?, and (2) what factors are considered when choosing between MMC and traditional methods? The main research instrument is qualitative semi-structured interviews with nine senior development directors, validated by quantitative data obtained from development staff. It is confirmed that there is an undersupply of housing, and that MMCs alone cannot resolve this problem. The main conclusion is that Government needs to address the amount of bureaucracy currently hindering HAs from developing. The study should inform the decision making process at inception stage for housing developers and HAs.

Keywords - Affordable housing, housing associations, modern methods of construction.

1. INTRODUCTION

The reported undersupply of affordable housing is driven by a complex mix of circumstances culminating in the construction industry failing to build enough affordable housing, at the same time that the population is increasing. In addition, the average size of households is in decline caused by a range of demographic factors: increasing life expectancy, more couples divorcing and single parent families. The undersupply of housing seems to go hand in hand with the undersupply of land, at an affordable cost and quantity, in the correct location. The Government has exacerbated the problem with the introduction of a number of bureaucratic policies.

The size of the problem varies depending on which report is read: Egan Report (1998), Department of Environment Transport and the Regions (DETR, quoted McAllister, 2000), The Barker Report (2004), Royal Institution of Chartered Surveyors (RICS, 2004) each confirmed an undersupply however, they could not agree on the extent of the undersupply.

The Office of the Deputy Prime Minister (ODPM) has imposed target numbers to be developed using modern methods of construction (MMC) on housing associations; statistics indicate that institutions and people (such as insurance companies, asset managers) are reluctant to change, wishing to retain traditional methods of construction, they understand due to concerns regarding past problems with maintenance, and the long-term viability associated with off-site manufacture.

The aim of the study is to investigate whether MMC will be used by housing associations (HAs) to address undersupply of affordable housing in the UK. This aim is supported by two research questions: (1) is there an undersupply of affordable housing in the UK, and if so what factors are influencing it? and (2) what factors are considered when choosing between MMC and traditional methods?

2. LITERATURE

2.1 Modern Methods of Construction

MMC is a generic term used by Government for alternative methods of off-site manufacturing (OSM). The Housing Corporation (HC, 2003) sub-divides MMC under five headings:

- Panellised OSM: commonly referred to as 'timber frame' or 'steel frame'.
- Volumetric/Modular OSM: fully manufactured and fully pre-commissioned within a factory environment and transported to site as a kit.
- Hybrid OSM: combination of both panellised and volumetric approaches.
- Sub-Assemblies and components the use of floor or roof cassettes, pre-cast concrete foundation.
- Non OSM, MMC: schemes utilising innovative building techniques, structural systems that fall outside the OSM categories above.

2.2 Historical reasons for using off-site manufacturing

After the First and Second World Wars due to post-war shortages of materials, along with a lack of skilled labour, it became necessary to consider alternative methods of construction to resolve the undersupply of housing. Successive Governments gave generous funding to non-traditional system building methods.

Renewed impetus to use system housing arose due to a combination of social and political pressures, to re-house people displaced by the major slum clearances of the late 1950s and 1960s. The 1970s saw a public reaction against pre-fabricated system buildings, largely as a result of high profile failures such as Ronan Point, East London.

In 1982, 27% of all new houses in the UK were constructed from timber frame (Palmer, 2000). However, a popular investigative television programme, 'World in Action' (1983) destroyed confidence in timber frame construction for housing. It highlighted the vulnerability of poorly constructed timber-frame housing. This caused the market to plummet to 5% of the share in the domestic housing sector overnight.

2.3 Current reasons for using MMC

The reputation of the United Kingdoms' construction industry has been in decline for a number of years. With the under investment, lack of training, the demographic shift and a lack of innovation in the construction industry; the Deputy Prime Minister, John Prescott commissioned the 'Construction Task Force' chaired by Sir John Egan to report on the scope for improving the quality and efficiency of the UK construction industry. The outcome from the review was 'Rethinking Construction' (1998).

The Construction Task Force compared the construction industry with other industries, on quality and efficiency; the outcome was unfavourable. It compared construction with the manufacturing industry as to how that industry had met challenges, and improved in recent years, on the delivery of goods to its customers in both time and quality, increasing its profits in so doing. However, the construction task force team repeatedly heard the claim that construction is different from manufacturing because every product is unique (Egan, 1998).

The team reported that it did not agree with this statement, houses are essentially a repeat product, which can be continually improved on.

Government set itself targets to stabilise the UK's runaway housing market of 2004, and end its boom and bust housing cycles. House prices in the UK have doubled since 1995, with many people unable to get a foothold on to the property ladder. There is in addition a lack of affordable housing, particularly for key workers. This problem of high prices is compounded by the shortage of houses being built. In 2001 house building fell to its lowest level since 1924, excluding the war years and its immediate aftermath.

2.4 The undersupply of affordable housing

The average size of households is in decline caused by divorces and single families. In addition, there is a demand for more housing due to a range of demographic factors along with increasing life expectancy and movement of people to areas with economic growth. With this in mind, The Chancellor and The Deputy Prime Minister set up a review of housing supply in the UK on the 9th April 2003. This culminated in a report, known as 'The Barker Report' published along with the Budget in March 2004.

The provision of social housing in 2004 is one-fifth of what it was twenty years ago (RICS, 2004). Numbers of affordable houses built in the UK fell from 42,700 in 1994/95 to 21,000 in 2002/03; with costs increasing from £800 million in 2001/02 to over £1.4 billion in 2003/04, while the rate of new supply continues to decline (Barker, 2004). Barker attributed part of the costs due to strong land costs and the importance of improving the existing housing stock.

Over the next ten years the 'Barker Report' (2004) estimated the number of affordable houses built would have to increase by at least 17,000 units per year. In addition, if the backlog of the past were to be met, then a further 23,000 houses would need to be constructed (Barker, 2004). For Government to deliver based on the Barker report, it will have to ensure that 61,000 houses are built each year for the next ten years; this would be a three-fold increase overnight. This figure would mean the construction of over half a million homes in a ten year period, which is in excess of Egan's prediction in 'Rethinking Construction' (1998) of one million homes in the next twenty-five years.

In contrast, The Campaign to Protect Rural England (CPRE) cited recent census data to be inaccurate, indicating the population of England and Wales to be 900,000 lower with the country currently having a surplus of dwellings over households. CPRE agenda is to protect the greenbelt from further development, at the same time as developers are pressurising Government to change the current planning policy.

2.5 Skills shortages

The construction industry is one of the UK's largest employers but the shortage of traditional skilled labour is inhibiting the house building sector's ability to meet demand. As a result, there are poor levels of quality control and low productivity; consumers pay too much for their homes that are often very poor value for money (Pickard, 2002). The Barker report (2004) was particularly concerned with the low levels of training undertaken by industry. Levels of training are low compared to other industries and by international standards. However, The Traditional Housing Bureau (THB) refuted that there is an undersupply of skilled labour for masonry construction; workers travel for employment often being multi-skilled, are often absorbed into different areas of the industry when work is scarce.

Labour costs in 2004 have increased between 4.5% and 8.2%, which is approximately twice the average rate of increase for the rest of the UK economy. It was predicted that pay settlements for 2005 will be between 3.3% and 9.5% (Building, 2004). Due to the real issue of skills shortages a number of developers have been tempted to reconsider the use of off-site manufacturing.

2.6 Government bureaucracy

Government action is influencing planning authorities in the way consents are granted. The introduction of 'Planning Policies Guidance 3' (PPG3) on housing, published in March 2000, made fundamental changes to planning for housing. It placed the pursuit of sustainable development at the heart of both forward planning of new housing and the consideration of housing proposals through development control. PPG3 is central to the Government's polices for securing an urban renaissance, protecting the countryside from unnecessary development and meeting the housing needs of all in the community. PPG3 tasked the construction industry to develop well-designed, high-density dwellings.

Build totals have fallen as the industry has struggled to work on complex brownfield sites and planning committees who regarded the guidance's high-density diktat as locally unpalatable (Smit, 2003a,). David Holliday of 'Ward Homes' said that the conundrum now is that we're trying to use off-site manufacturing at a time when sites are getting even more complex and there is a need for attached housing (Smit, 2003b).

Richard Hough of house builders 'Swan Hill' stated that the undersupply fundamentally exists due to the planning system not releasing enough land for building (Hough, 2002). Whereas, David Pretty, Chief Executive of Barratt who constructed 1,256 affordable properties in 2004, said 'there is no shortage of land on this island … just a shortage of planning permission' (Monaghan, 2005).

In recent years there have been several changes to the Building Regulations, to reduce carbon dioxide gases; to comply with the 'Kyoto Treaty' signed in Japan in 1997. This legally binds industrialised nations to reduce worldwide emissions of greenhouse gases, by an average of 5.2% below their 1990 levels, over the next decade. This has brought in many changes to building regulations in a very short space of time, with even more stringent insulation and ventilation amendments proposed over the next couple of years.

The Deputy Prime Minister tasked the Housing Corporation (HC) to take a lead in promoting the use of MMC amongst HAs. At least 25% of the housing that the HC funded in 2004/05 will be expected to be built using MMC (HC, 2003). With the ever-increasing rising costs of housing construction, John Prescott set the toughest possible challenge during the Labour party conference in September 2004, to construct a house for £60,000 ahead of a predicted general election due in May 2005. Many in the construction press feel that its one step too far, with this cost being almost half the current costs in the London area.

Whist Government are exerting pressure on HAs to use MMC; a high profile project CASPAR modular housing scheme in Leeds, completed only six years ago is threatened with demolition following the evacuation of all forty-six residents due to a fear it may collapse in severe weather conditions (Smit and Hay, 2005).

3. METHODOLOGY

Recently there has been an increasing recognition of the value and appropriateness of qualitative studies within management of technology and engineering (Fellow and Liu, 2003).

Fellow and Liu (2003) acknowledged that qualitative studies have a great potential to get beneath the manifestations of problems and issues which are the subject of quantitative studies. For this reason a qualitative research was selected to be the most suitable solution in delivering the aims of this study. The main befits to be gained from this method of research is it uses interviewing techniques for three interrelated purposes: (1) diagnosing a situation; (2) screening alternatives; and (3) the discovery of new ideas' from others (Zikmund, 1997 quoted in Naoum, 2002). However, the limitations of qualitative research will bring forward hunches and hypotheses which can be tested more rigorously by a further quantitative research (Naoum, 2002). For this reason two research methods were undertaken; a qualitative semi structured interview of nine development directors and a quantitative questionnaire survey of development staff working for the directors interviewed; this was undertaken in an attempt to triangulate the findings from the interviews (Fellows and Liu, 2003), also referred to as mixed methods approach, recommended by Creswell (2003). Due to time scales the mixed method research was carried out concurrently as described by Creswell (2003). The questionnaires for the development staff comprised of fifteen closed questions and four open for a qualitative response. These were issued to 100 development staff via e-mail with thirty-four being returned within the allocated time.

The population for research was restricted to HAs being the main provider of new social housing in England. It is the associations' task to deliver quality affordable housing to those in need, whether it is key workers in the South or for the less well off generally in the North. As of 31 March 2003 the HC had 2,004 housing associations registered. The HC is a Non-Departmental Public Body (NDPB), sponsored by the ODPM. It has a board of fifteen members, including the chief executive, who is appointed by the Deputy Prime Minister. All funding of associations is via the HC, which is subject to the provisions of The Housing Act 1996. Based on annual survey March 2003 the HA sector stockholding of properties was 1,762,404 units owned for rent, which provides homes for at least 4 million people in England.

Of the 2,004 associations that manage almost 1.8 million properties the majority are small, owning fewer than 250 homes. However, the largest 7% of associations, those with 2,500 plus homes own 78% of all the sector's homes (HC, 2003). The HC publish a league table of the HAs with the largest housing stock, this research restricted the survey to the top thirty. However, one small association with 900 rented properties was selected for interview; it having a high percentage of its existing stock made up of prefabricated developments from the 1960s. The final sample was in the main restricted to associations in the North of England with two interviewees having responsibility for the whole of England.

4. QUALITATIVE AND QUANTITATIVE DATA ANALYSIS

The basic principal process of analysis is based around the methods recommended by Creswell (2003). All nine interviews were tape-recorded and were transcribed verbatim. In addition, the open questions from the questionnaires were analysed in a similar manner. The first step to reduce the text from the interviews was to systematically analyse them by manual reading, 'making sense out of text' (Creswell, 2003) to draw out common themes; these were coded. All the common themes were organised into 'chunks' of material (Rossman and Rallis quoted in Creswell, 2003) relevant to answer the research questions. The process in selecting the important themes is based on the authors' experience and judgment about what is significant in the transcripts (Seidman, 1998). This process reduced the ninety pages of interview text down to twenty-five pages, as a first stage analysis. The second stage analysis reduced the key points/words into tables, pie and bar charts.

The analysis of the quantitative data was undertaken with the use of a computer rather than manual calculations. However, computer analysis software SPSS (Statistical Package for the Social Sciences) was considered and rejected in favour of Microsoft 'excel'. This is due to the relative small amount of data to be analysed, along with the lead author's extensive experience in the use of excel. Data from the questionnaires was transferred to excel spreadsheets, and findings were represented by bar and pie charts. Results from both methods of research will be summarised in the form of a narrative in section 5.

5. DISCUSSION AND FINDINGS

The following analysis will integrate research for the qualitative interviews and quantitative questionnaire research with that found in the literature. '*Texts shown in italics within inverted commas are direct quotes taken from the interviews'*.

5.1 Is there an undersupply of affordable housing in the UK, if so what factors are influencing the undersupply?

5.1.1 Supply of housing: An overwhelming majority of senior managers and development staff, 100% and 94% respectively were in agreement; currently the UK is experiencing an undersupply of affordable housing. Of those interviewed 78% considered that issue of undersupply to be a far greater problem in the South, with the situation in the North being an issue of undersupply in areas of high economic demand, and an issue of under investment over the years, leading to a need of regeneration in other areas. These findings compare favourably with the literature, however no one in the literature can agree as to how many houses need to be built and where.

5.1.2 Factors for the undersupply: Of those interviewed 81% considered the largest contributing factor leading to the current undersupply of housing to be the need to reform the current planning system. '*The planning system has stifled the production of new housing'; 'certainly planning policy is constricting the supply of land'*. In the North, they identified the restrictions to building on small brownfield sites, of ten to twenty-five properties using MMC not to be cost effective, which in turn restricts and slows down the development process. These findings are supported in the literature; the current planning system is impacting on developers from developing (Monaghan, 2005 and Smit, 2003a).

5.1.3 Government bureaucracy: In an attempt to deliver more housing, the ODPM set a blanket target of 25% for partnering associations to use MMC on all new development projects. All senior managers agreed Government are going about this in the wrong way; they should not make it *'mandatory which will be difficult'*, but should *'give incentives for people to use'* MMC. Conversely, 46% of development staff considered it acceptable for ODPM to set targets on the use of MMC. However, 97% of all development staff said 'don't know' or 'no'; to the question 'does your association have a target number of MMC projects to deliver each year?' The additional pressures placed on associations to consider MMC on small sites in the North is cost prohibitive; this is one additional factor slowing down the development process.

5.1.4 Funding of housing: Should Government want associations to use more MMC, senior management and development staff agreed, 67% and 73% respectively, the requirement for additional grant funding to be made available. Conversely, a number of people contradict this, it would increase the proliferation of the market; *'at the moment the modern methods of construction systems are too fragmented'*. In addition, a couple of senior managers resented the ODPM making associations an *'experimental tool'*, in the use of MMC. Just over half (56%) of senior managers considered the best way for Government to offer incentives by the way of grant, is to select a few tried and tested systems, this would, in time, hopefully reduce the fragmented market.

5.1.5 General issues: A high percentage of Local Authorities in the North have planning moratoriums on the numbers of new private houses that can be built. These moratoriums are to balance the supply and demand of houses. However, this causes a knock on effect; if private developers cannot build this restricts associations working with developers, under planning section 106 agreements.

Associations are weighted down by more regulations than the private developers, a great many being bureaucratic rules and forms. The latest standard introduced by the HC is Eco-Homes, an environmental assessment devised by the BRE. One of its main purposes is to increase sustainability to reduce carbon dioxide omissions for Government to comply with the Kyoto agreement. However, private developers will soon have to contend with this issue through proposed changes to the building regulations.

The reported lack of skilled labour, at present, did not have an impact in building houses, but it has without doubt increased costs. Reasons given for lack of available labour, is Government's desire to have more students gaining 'A' levels and going to universities. Two people reported that the undersupply of labour is not just in construction trades, it is in the whole industry, management, local authority planning and building control departments. However, both Egan and Smith of the NHBC considered that changing to MMC would get over the problem of low supply of labour (Bachelor, 2003). A number of people commented during the interviews that it is folly to encourage certain students to attend university if all they achieve is poor grade. Many employers do not employ these students; they would be better advised, due to their academic ability, to go via an apprenticeship route.

5.2 To determine what factors housing associations take into account in selecting which method of construction to use.

5.2.1 Influence associations have: When a new development opportunity arises 56% and 52% of senior management and development staff respectively, considered that the method of construction should be considered at feasibility. For the economic use of most MMC, systems manufacturers need to be aware of projects as early as possible, and be appointed; without this, the overall project programme from inception to completion will be lengthened, increasing costs. The findings found that almost half associations did not consider this important; it is therefore assumed the automatic choice would be to use traditional constructional methods. This could be explained by the fact that very often nowadays associations are not the lead developer. A third of senior managers confirmed that a great deal of their projects come on the back of planning section 106 agreements. These planning agreements are to ensure that private constructors deliver mixed developments; with a portion of all new properties being affordable.

The research and the literature concur that presently not enough is known about the alternative systems of MMC available; this inhibits designers, clients in being able to confidently specify at an early stage of a new project. In the judgement of the authors most people in development are happy in securing a new opportunity to develop; the method of construction is secondary. A lack of knowledge of MMC, along with higher costs, makes traditional construction on the small sites in the North the automatic choice.

5.2.2 Advantages of MMC over traditional: The three main advantages of MMC came down to time, quality and sustainability:

Time: Over two thirds (67%) of senior managers with 43% of their staff confirmed a reduction of construction time on site.

Quality: 81% of senior managers and 47% of development staff considered quality to be better with MMC housing, this is due to constant quality of manufactured components from a factory. However, 25% of development staff were of the view the method of construction did not have a direct influence on quality. Seven of the nine senior managers considered one of the main advantages of MMC is it delivers *'better degree of quality control'*. With two selecting volumetric *'I guess the most tight quality control you can get in volumetric manufacturing'*. The authors' judgement why MMC received high scores for quality is; people considered a high percentage of work being carried out in dry controlled factory conditions, which is the case with volumetric. However, in the use of timber frame, a very high percentage of overall works is still carried out on site; therefore, anecdotal evidence on quality is reduced to less shrinkage cracking to plaster after completion.

Sustainability: The research found that on average 60% of people selected panellised construction to be the most economical method of construction currently available in delivering sustainable housing, compared to only 3% selecting traditional construction to be best. However, four of the senior managers considered during the interviews, that the word sustainability was in fact a long-term issue, 'durability' and 'longevity' (Clarke, 2004). Therefore, for that reason alone traditional construction would be the best long-term solution, being tried and tested.

5.2.3 Disadvantages with MMC over traditional: From research there are far more disadvantages than advantages, each area is considered separately:

Past failures with prefabrication: Without the interviewer asking a direct question about the past history of pre-fabrication, 78% interviewees' raised the issue of past failures of various methods of off-site prefabrication. A number drew comparison to high demand for new housing in the 1960s, with that of today, and how Government had exerted pressure on councils and the construction industry to deliver alternative methods of building. Typical comments were: *'We should not leap headfirst into covering it all using modern methods of technology because we will be looking at repeats of the mistakes of the past'*. *'We are actually knocking down failed old system building stuff to replace it with current MMC'*. Association staff had concerns of the past, genuinely keen not to make similar mistakes councils made in the 1960s and 70s.

Mortgages and insurances: From the research three interviewees had experienced problems obtaining mortgages, with two relating to difficulties in obtaining insurance cover on certain types of MMC. Problems with insurance cover came to light during the literature review. The Barker report 2004, recommended that the NHBC, the provider of cover for most new housing, should work in conjunction with The House Building Federation, to agree quality standards in MMC projects.

Value for money: All senior managers considered various MMC cost more than traditional forms of construction to build, the average on-cost being in the region of 12%. This figure quoted by interviewees is in agreement with the literature at between 8 to 15%. Almost two thirds (61%) of those completing the questionnaires agreed, MMC cost more than traditional methods. However, 34% considered there to be no difference in costs between MMC and traditional, with a further 15% having a view MMC cost less. Additionally, development staff voted 64% to 36% against MMC being value for money in the short term, up to 5 years. However, when considering the long-term these figures slightly improved from 57% to 43%. Cost savings are not available particularly in the North due to, (1) small sites and (2) too many manufacturers, having spent research and development money, recouping their investments. Egan agreed currently that costs are likely to be higher in using MMC, but costs should be less volatile than in traditional construction (CABE, 2004).

Commercial risk: In the open quantitative questionnaires the largest concern people had is procurement through the supply chain (34%), *'too many horror stories of long lead in times due to suppliers being too busy and unable to meet demands. The client becomes too reliant on one supplier placing all your eggs in one basket'.* Senior managers raised similar concerns, using the same phrase *'all your eggs in one basket'* leading to clients being held to ransom. Typical comments from senior managers were *'no we should not take any more risks than anybody else'.*

Maintenance: When asked do they consider long-term maintenance costs of various methods of construction, it drew conflicting replies. Senior managers and development staff considered that 34% and 65% respectively considered that traditional methods would deliver less defects. From the replies to the qualitative interviews, it became quite apparent to the author that this information is either unknown or that more than likely no one had considered the long-term costs.

Flexibility: Senior managers and development staff 56% and 59% respectively, confirmed in their views traditional construction to be the most flexible method of construction; with 26% percent of development staff considering panellised construction to be the second most adaptable. The remaining four senior managers stated they were unsure which system to be the most flexible in terms of future adaptation, as they were not technically qualified to comment. Clarke (2004) concurs with the above findings that traditional housing construction is the best option to provide 'lifetime homes' it is also 'easy to alter in an economical and hassle-free manner'. However, others in the literature expressed the flexibility of design to be very impressive using MMC (Hart, 2004).

5.2.4 General issues:

Standardisation: of components and manufacturing. All nine senior managers and 89% of development staff agreed, more standardisation would bring cost effective housing, however one stated *'you can't answer no to that even though I would like to'*, where as one confirmed that *'I am not convinced that that is a major issue'*. These findings concurred with that discovered in the literature, that standardisation with more use will bring continual improvement (CIRIA 176, 1999). However, in the authors' experience there is some reluctance to standardisation, due possibly to the misconception that everything will look the same.

6. CONCLUSIONS AND RECOMMENDATIONS

Research established by interview, questionnaires and during the literature review concurred that without any doubt the UK is currently experiencing an undersupply of affordable housing. Of those interviewed 78% considered the undersupply to be far worst in the South than the North. With the North having an undersupply in areas of high economic activity, and possibly an oversupply of poor maintained housing, in other areas where people no longer desire to live.

Having established there to be an undersupply of housing, the second element of the first question is to determine current factors leading to the undersupply of affordable housing. Of those interviewed 81% considered the main reason for the undersupply, is Government bureaucracy, the main culprit being the planning system. In addition, associations are weighted down by more regulations than the private developers. Currently, Government via the HC have a 25% target of all new developments, to be built using MMC, for partnering associations. Of those interviewed, 100% considered it unacceptable to have a blanket fixed target, for all parts of the country. The majority interviewed considered that the undersupply of construction labour brings increasing construction costs, due to the laws of supply and demand.

Conclusion 1: Government to address the amount of bureaucracy, in particularly planning legislation, currently hindering housing associations from developing.

The second research question considered the thoughts and processes associations go through, in selecting a particular method of construction. The findings to this question are extensive (see 5.2 above).

Conclusion 2: It is the responsibility of development staff, and their clients to work together, as project teams, to consider all issues, for the circumstances presenting themselves, for each project; selecting the best method of construction for a particular project. Consideration should be given to each of the following: Commercial risk, time, quality, flexibility, maintenance, standardisation, sustainability, available labour, location and size of development, ground conditions, finally costs and value for money in the short and long term.

There are two recommendations, one of which is directed at Government to take action. The second, involves development departments; Government could also drive this via the Housing Corporation. Recommendation (1) is that Government appoint an independent research company to investigate the amount of bureaucracy that associations have to contend with in the development process, making development uneconomic with a view to streamlining the process. Recommendation (2) is that all development staff to be given training on current best practice, related to various methods of construction.

The authors conclude that the use of MMC alone will not be the salvation of the current undersupply of affordable housing.

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DETERMINANTS IN THE PROCESS OF TECHNOLOGY DEVELOPMENT AND ADOPTION IN THE PUBLIC DOMAIN: A MULTIPLE CASE STUDY

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ABSTRACT: Most studies on technology development processes and adoption have been limited to environments of consumer goods, such as electronics and software. This study addresses the public domain, specifically infrastructure. A distinct difference between aforementioned consumer industries and infrastructure is the often determinative role of government. This study examines the effects of the different roles and responsibilities of government on the development and adoption of technology. We used a multiple case study design to collect our findings. Our findings suggest that different roles and responsibilities of government frustrate the development and adoption of new technology in infrastructure. First, competing roles and tasks lead to discontinuous policies. Second, government encourages competition between different design solutions at an early stage of development. Third, government stimulates technology development projects for which they do not have a projected purpose. We conclude our paper with a discussion of policy and managerial implications.

Keywords – Infrastructure, innovation, technology adoption

1. INTRODUCTION

Most studies on technology development and adoption have been limited to environments of consumer goods, such as pharmaceuticals, electronics and software (Brown and Eisenhardt, 1995; Rogers, 2003). These industries are considered to be volatile and unpredictable and are characterized by rapidly succeeding technologies. Although valuable, these studies have their limitations precisely because they draw their empirical data from these industries.

This study addresses the public domain and more specifically infrastructure. A distinct difference between aforementioned consumer industries and infrastructure is the often determinative role of government. In consumer industries firms often develop new technology for other firms or for anonymous markets with many potential customers. In infrastructure, government is the only customer. Developing technology for government adds to the complexity of the development and adoption of technology in several ways. In addition to being a customer, government often has more roles and responsibilities that influence the development and adoption of technology. Government is often also regulator and hence influences the market conditions through economic and administrative rules (Morris and Hough, 1987). In addition, government can be a product champion in challenging firms to develop new technologies and absorbing part of the (financial) risks. The Channel Tunnel Link and the development of the Concorde are examples of support by government leading to radically new technologies (Morris and Hough, 1987).

While the importance of the influence of government on technology development and adoption in the public domain has been recognized, little is known about the effects of this influence (Morris and Hough, 1987). Most studies on the influence of government on technology development and adoption are limited to the effects of regulatory uncertainty (Marcus, 1981). In construction several studies have addressed the influence of regulation on the development and adoption of technology (Blackley and Shephard, 1996; Oster and Quigley, 1977). These studies focus on the firm as the organization adopting a new technology instead of government. Only few studies seem to consider the adoption behavior of government (Bingham, 1978).

This study examines how different roles and responsibilities of government interact in technology development and adoption and what strategies firms use in developing and implementing new technology.

In the next section we will start with a short overview of the existing literature regarding managerial aspects of technology development and adoption. Subsequently, the research framework is introduced, followed by the research methodology. We used a multiple case study design to collect our findings and will give a brief description of the cases. Finally, we will discuss our findings and their implications and limitations are addressed.

2. THEORETICAL BACKGROUND

Research on technology development and adoption shows that the development process and adoption of technology are interrelated. Based on the integrative work of Schilling (1998), Brown and Eisenhardt (1995) and Griffin and Hauser (1996) we have summarized important factors influencing the management of technology development and adoption (see table 1). In addition, we have used the findings of Morris and Hough (1987) to describe how different roles of government can affect technology development and adoption (see table 2).

2.1 Important factors in managing technology development and adoption

Variety in information and skills is perceived as an important success factor of cross-functional teams (Brown and Eisenhardt, 1995; Griffin and Hauser, 1996). The amount and variety of information and skills in cross-functional teams help to understand the design process more quickly and fully from a variety of perspectives. Increasing the variety of resources and skills is also a major incentive for inter-firm collaboration (Powell et al., 1996). Inter-firm collaboration helps to catch downstream problems, such as manufacturing difficulties or compatibility issues or market mismatch (Brown and Eisenhardt, 1995). Collaborating with customers can make customers more amenable to the implementation of a new technical system (Leonard, 1995). Moreover, when there is little experience with a technology, customers can provide additional knowledge from their operational experience, especially in testing and implementing new technology (Slaughter, 1993). Customers can also help to find the right balance between performance and price, which is important for standard setting (Tether, 2002). If a firm fails to invest in technology development its existing skills and resources can become rigidities that prevent a firm from diverging into new technologies (Leonard, 1995). Technology development, therefore, expands the knowledge base of a firm and enables a firm to obtain access to new markets and technologies and attract complementary resources and skills. Therefore, continuous investment in developing capabilities can prevent a firm from being locked-out (Schilling, 1998).

Fast-cycle development processes with frequent iterations increase the opportunities for a ‘hit’, particularly when predictable paths do not exist. Fast-cycle development processes enable the designers to understand the sensitivity of parameters and provide a baseline for comparison, which speeds up the development process (Eisenhardt and Tabrizi, 1995). Fast cycle development processes allow developers to discover errors in the design early in the process (Eisenhardt & Tabrizi, 1995). Frequent milestones enable the project team to reassess the current state of progress. Frequent review forces the project team to look if actions are still on course. In addition, frequent milestones can be effective in confronting current actions with the evolving context (Eisenhardt and Tabrizi, 1995). Fast-cycle times give firms strategic flexibility in timing of entry and offer the opportunity to develop complementary goods. Being first or second on the market enables firms to influence early choices of users and perception of opinion leaders. In addition, user experience can be used to further develop and refine the technology. Thereby, offering a revised version of the technology that better fits customer needs (Schilling, 1998).

Senior management provides the resources for the project (Brown and Eisenhardt, 1995). More resources (e.g. budget, personnel, and equipment) enable a project team to perform better. Senior management support is important in competing with other projects for resources. Stronger support in terms of resources speeds up the development process. Senior management contributes to performance by ensuring consistency with corporate strategy, intended performance and corporate capabilities (Brown & Eisenhardt, 1995). Furthermore, senior management can affect the project by their influence on working procedures, project team composition and the involvement of suppliers, customers and partners (Bonner et al., 2002). In addition, senior management is important in the strategic choices regarding inter-firm linkages to encourage or sponsor the availability of complementary goods, bundling arrangements and licensing (Schilling, 1998).

In table 1 we summarize the important factors that affect technology development and adoption. Pooling and developing a variety of capabilities enables a firm to offer and diverge into new technology. Fast-cycle development processes speed up the development and offer the flexibility to be a first or second mover. Senior management is important in facilitating the development and adoption of technology through inter-firm linkages and by directing the development of corporate capabilities.

Table 1. Important factors in managing Technology Development and Technology Adoption

Determinant	Technology development	Technology adoption	Authors
Variety in information and capabilities	Diverse capabilities and resources lead to shorter development time and better compliance with design specifications	Renewal and continuous investment in technology development enables a firm to respond to changing technologies and prevent lock-out of its own technology	Brown & Eisenhardt, 1995; Griffin & Hauser, 1996; Leonard, 1995; Powell et al., 1996; Schilling, 1998 Tether, 2002
Fast-cycle development processes	Frequent iterations enhances understanding of critical parameters, discovery of errors and reassessment of progress and external developments	Firm with fast-cycle development process can benefit from first and second mover advantages and has opportunity to sponsor availability of complementary goods	Eisenhardt & Tabrizi, 1995; Moore, 1991; Schilling, 1998
Senior management support	Provides resources and aligns project with corporate strategy; Effects working procedures and project team composition	Influences choices regarding patenting, licensing, inter-firm linkages, development of capabilities and timing of entry	Bonner et al., 2002; Brown & Eisenhardt, 1995; Schilling, 1998

2.2 Roles of government in technology development and adoption

In this study we focus on the public domain and the different roles of government in technology development and adoption. Especially in infrastructure, government is a major player with diverse roles. Because government is a major player in infrastructure it is likely that government will have a substantial effect on technology development and adoption. Morris and Hough (1987) have studied the reasons for the success and failure of eight major technology projects. They concluded that government is an important factor in the success and failure of these projects, because government had several roles. They identified four roles of government through which government affects the success of technology projects: sponsor, champion, regulator and customer. Based on the findings of Morris and Hough (1987) we study how different roles and responsibilities of government can have a beneficial or impeding effect on development and adoption. In table 2 we have inferred the potential effects of these different roles on technology development and adoption.

Table 2. Effects of roles of government on technology development and adoption

Role of government	Effect on Technology Development	Effect on Technology Adoption	Authors
Sponsor	Speeding up development through financial support of new technology	Slowing down adoption through public scrutiny and technically unqualified decision-makers	Morris & Hough, 1987 Moon & Bretschneider, 1997
Champion	Speeding up development through absorbing risks, changing regulations and financial aid	Speeding up adoption through launch aids, sales assistance, pre-ordering, providing subsidies	Morris & Hough, 1987
Regulator	Slowing down development through procedures and economic and administrative regulations	Speeding up adoption through inducing a dominant design	Morris & Hough, 1987; Schilling, 1998
Customer	Slowing down development through commitments without proper investigation of consequences	Slowing down adoption through canceling projects without study of consequences and inconsistent behavior through changes in policy	Morris & Hough, 1987

3. RESEARCH METHODOLOGY

For this research we choose a multiple case study approach to gain insight in the effects of different responsibilities of government agencies on technology development and adoption. A case study is more suitable when the object under study is difficult to quantify, as in our case. Second, case studies are well suited for understanding the how and why of phenomena in their natural setting (Yin, 2003). We used a multiple case study design because it is generally regarded as more robust than a single case study (Halman, Hofer and Van Vuuren, 2003). We conducted three in-depth case studies of technology development projects in the Dutch infrastructure.

The studied projects were carried out by Heijmans Infrastructure, our focal firm. Heijmans Infrastructure is a division of Heijmans a large contractor with a turnover of over 2 billion euros and over 9,000 employees. The division Heijmans Infrastructure is responsible for about a quarter of the annual turnover. Heijmans is listed in the top five of largest construction firms in the Netherlands.

For this research we used a research protocol (Yin, 2003). This protocol enabled us to make a structured examination of the three projects and to compare findings. We interviewed 28 persons and in total we did 35 interviews varying from 50 to 150 minutes. The average interview took about 90 minutes. Prior to the interview the questionnaire was sent to the interviewee for him or her to prepare the interview. We used semi-structured interviews to probe deeper in the why and how of their perception of the technology development process. For each interviewee the questionnaire was adapted to his or her specific role in the technology development project and his or her contextual setting. The interviewees were members of senior management, project team members and members of the involved government agencies, suppliers and partners. The interview transcripts were sent by e-mail to the interviewee for remarks and consent. Besides the individual consent of the interviewees we also had regular meetings with senior R&D managers of our focal firm to discuss findings and preliminary analyses. Our final conclusions of all three projects were discussed with the managing directors and senior R&D managers in a workshop. Our conclusions were supported by the managing directors and senior R&D managers and contributed to ongoing changes in our focal firm to reorganize their development processes.

4. FINDINGS

4.1 TCU

The first project concerns the development of a Thermal Conversion Unit (TCU) for thermal conversion of tar-containing asphalt (TCA). This project was initiated by the Dutch ministry of Transport (MT) and ministry of Environment (ME) to stimulate an environmental friendly re-use of tar-containing asphalt. The main incentives for this technology were related to environment and health, because tar contains polycyclic aromatic hydrocarbons. Details are described in table 3.

Table 3. Case TCU

Roles of government	**Technology Development**	**Technology Adoption**
Champion	Central government urged firms to develop technology for cleaning tar-containing asphalt and integrated diverse government agencies (Transport, Environment, local government)	Central government allowed inferior alternatives such as temporary storage and soil cleaners; central government paid a subsidy to local government for higher costs of thermal conversion
Regulator	Central government made thermal conversion mandatory	Central government allowed inferior alternatives, such as soil cleaners, temporary storage and transfer abroad
Customer	Local government was main customer and felt little commitment	Local government preferred low-priced alternatives
Policy implementer	Local government had to execute national regulations and monitor its effecting	Local government had to bear cost of national regulations
Choices of firm		
Capabilities	Cooperation with competitors induced by government to spread risk; cooperation with central government to direct regulations and market conditions	Failed to renew their knowledge on inferior alternatives
Development cycles	Progress in development mainly determined by government's regulatory decisions	Because of technical problems firms failed to benefit from first mover advantage; in addition market conditions were changed
Senior management	Focused on central government as regulator setting standards and market conditions	Timing of entry to soon, because of technical problems and insufficient understanding of needs of customer

In the case of Thermal Conversion Unit (TCU) Heijmans Infrastructure worked with competitors, because government thought that Heijmans Infrastructure would be unable to ensure the necessary processing capacity by itself. During the development process senior management of Heijmans Infrastructure tried to convince government of the technical and economic feasibility of the TCU and in turn demanded guarantees concerning supply of tar-containing asphalt and regulations. Paradoxically, the technical and economic feasibility of the TCU depended on the conditions set by government. If the environmental benefits of the TCU (no waste, energy saving) would not be valued the TCU would not be competitive compared to existing technology.

Heijmans Infrastructure thought they bought a nearly operational TCU, while in fact they were starting with a first shot of the engineering firm. Furthermore, initial plans for testing were far too optimistic. Early estimates in 1999 for testing comprised 1000 hours a year. In 2001 and 2002 Heijmans Infrastructure had only tested for about 700 hours. This slowed down the development of the TCU even further.

4.2 Dynamic Road Marking

The second project, Dynamic Road Marking, started in 1998 as an innovation contest of the road administrator to celebrate its 200th anniversary. This program was meant to show what technologies would be used in the year 2027. Dynamic Road Marking (DRM) would be used to replace existing road marking and enables the road administrator to increase the number of lanes on a roadway by switching lights on or off. Details of this case are described in table 4.

Table 4. Case Dynamic Road Marking

Roles of government	**Technology Development**	**Technology Adoption**
Champion	Central government issued a contest for development of DRM; Central government offered a test location	Alternatives (hard shoulder as third lane) were considered to be effective, economical and more reliable
Regulator	Set specifications for dynamic marking to allow industry to develop a product	Specs were downgraded twice; Products designed for guidance became competitive
Customer	Issued contest and pilot project without proper investigation of financial and technical costs	Changed application of DRM; Invited additional firms to develop a product for DRM
Facilitator	Providing test locations	
Choices of firm		
Capabilities	Heijmans Infrastructure collaborated with large electronics firm; Electronics firm invited government to make government aware of potential applications	Continuous investment led to changes in design to comply with customer needs; revisions entailed permeability, noise
Development cycles	Frequent design iterations were made; major revision after first pilot project; At least 5 modifications of revised product were tested	First mover advantage created problems with perceived reliability; Government used peak lanes (hard shoulder as third lane) as alternative
Senior management	Senior management had clear vision about benefits of DRM regarding mobility issues; new business in lighting division of electronics firm	Timing of entry was to soon because of uncertainty about design specs and lack of complementary goods

After the first pilot project, the different specialists of the road administrator did not agree on the specifications. The changing specifications of government and limited number of pilots made it hard for Heijmans Infrastructure to test and refine its technology. Senior management of the electronics firm considered DRM to be a potentially major market of the lighting division. The electronics firm envisioned the use of the product worldwide to solve problems of immobility and congested infrastructure. For Heijmans Infrastructure dynamic marking would be a logical complementary product besides conventional marking.

4.3 Re-use

The third project was a project initiated by a Heijmans Infrastructure to improve the re-use of scrap material from reconstructed roads. Large amounts of scrap material were temporary stored at asphalt production plants creating high storage costs and the need for additional storage capacity. Therefore, Heijmans Infrastructure looked for ways to increase the re-use of scrap material in asphalt production and road construction. Details are described in table 5.

Table 5. Case Re-use of scrap material

Roles of government	**Technology Development**	**Technology Adoption**
Regulator	Approve new mixtures as a standard; Change regulations and design specifications for new asphalt mixtures	After testing new mixtures are qualified for specific applications
Customer	Needs to be convinced of equivalence of new mixtures	Does not use new mixtures before they are approved by regulator
Choices of firm		
Capabilities	Capabilities are present within organization; Frequent meetings with regulator are held to inform regulator of benefits and performance of new mixtures	Recombination of existing capabilities and resources; Investment to reduce costs and efficient re-use of raw materials
Development cycles	Development as ad hoc problem-solving rather than formal development process; No formal milestones	Continuous improvement; incremental technology with little relative advantage for customer besides cost
Senior management	Supplies enough resources; little control	SBU have to implement and apply new mixtures

Heijmans Infrastructure consulted central government as the design specifications of central government are used as a reference for tenders. Changes in design specifications have to be tested and transformed into formal policy.

5. CROSS-CASE ANALYSIS

5.1 Roles of government

The application of a new technology are influenced by design specifications and regulations of central government. These design specifications and regulations often have to be abolished or revised for a new technology to be successful. In two of the three cases central government was inconsistent in effecting its revised or new regulations. Due to these changes technologies were either redesigned (DRM and Re-use) or locked-out (TCU).

In two of the three cases central government acted as champion. In both cases central government helped firms during their early development stages by providing test locations or integrating the diverse government parties. In the two cases government proved inconsistent in their support of new technology. As alternatives became known government opted for the inferior, but economical option.

In all three cases government was the targeted customer. In the cases initiated by government (TCU and DRM) the customer showed little commitment to adopt the technology. In the case of TCU local government opted for inferior and low-priced alternatives. In the case of DRM the customer started with high expectations -replacing conventional marking- but confined the application of DRM to entry and exit lanes. In the case of TCU and DRM government revised their preferences without proper investigation of the financial and technical consequences.

In addition to these roles we discerned a fourth role in the case TCU. The fourth role concerns the execution of national regulations by local government. Often the implementation of policy is left to lower levels of government and is separated from policy making. The execution of these regulations by local government is often complicated because local government also has to enforce the proper execution of regulations. In the case of TCU we saw that policy execution and enforcement can conflict with other priorities of local government.

The fifth role of government identified in the case of DRM is facilitator. A facilitator provides opportunities for real-life testing of new technologies. Offering these opportunities is important for the refinement of technology, but also in demonstrating the technology to other potential users and other departments within government.

5.2 Strategies of focal firm in managing technology development and adoption

In all three cases Heijmans Infrastructure involved the customer at an early stage of development in its technology development process. In the case of TCU and DRM this was a consequence of the initiating role of the customer. In the case of Re-use Heijmans Infrastructure considered it necessary to consult government in its role as regulator because design specifications needed to be revised.

In two of the three cases Heijmans Infrastructure involved parties with additional and/or complementary capabilities in their development process. In the case of TCU the involvement of competitors with largely identical capabilities was enforced by government. On the upside, Heijmans Infrastructure was able to spread risks and investments. On the downside, this collaboration meant that Heijmans Infrastructure could not discern itself from its competitors. In the case of DRM, Heijmans Infrastructure collaborated with a large electronics firm. This electronics firm would develop and sell the actual dynamic marker and Heijmans Infrastructure would develop the complementary technology to install the marker in the asphalt road.

In all cases, Heijmans Infrastructure seemed to be aiming at first mover advantages. In all three cases Heijmans Infrastructure tried to influence regulations and market conditions to favor its product. In two cases this strategy was insufficient in securing market share. The case of TCU and DRM show that being first mover with a technology under development fails. Government seems to opt for a reliable and low-cost product. In addition, the case of TCU and DRM illustrate that government had no clear ideas about its preferences and the potential application of new technology, even when government itself initiated the development.

Senior management has an important influence in two of the three cases. In TCU and DRM senior management had a clear strategy in dealing with the different roles of government. In the case of TCU senior management focused on central government and the revision of regulations, before investing in the new technology. Consequently, Heijmans Infrastructure was unprepared for the revision of regulations on tar-containing material, because it had not yet understood the critical design parameters of its technology. In the case of DRM senior management tried to persuade government to set a standard and commit to the application of DRM.

6. DISCUSSION

The three cases show that customer involvement seems necessary in infrastructure in the adoption of new technology. The dominance of government as a *customer* forces firms to contact and involve this customer in their development process. Furthermore, this customer has additional roles that influence the development and adoption of technology. As a *regulator*, government sets standards and design specifications. These standards and design specifications facilitate the development of a dominant design. If firms fail to influence the process of standardization their own technology can be locked-out. Therefore it is important for firms to be early on the market and convince the regulator of the benefits of their technology. As a *champion*, government directly stimulates the development of specific technologies. Influencing and directing technological change seems obvious from the perspective of a dominant customer, but government seems unable to provide the necessary consistency. A fourth role is the *implementer* of new technology. This role is mainly left to local government and this role seems to be neglected by central government and firms. At the local level, government often has conflicting interests and responsibilities imposed by central government. Furthermore, local government has a certain freedom in executing regulations. Therefore, local government does not always adopt the technology propagated by central government. The role of implementer is a consequence of the sharp distinction between policy makers and policy implementers in public administration (Ring and Perry, 1985). A fifth role of government in infrastructure is *facilitator*. Real-life testing is a necessary stage in the development of a technology. Government as the road administrator is necessary in providing these test locations.

For successful adoption of technology, targeting a specific niche is considered an important strategy (Moore, 1991). After the market niche is secured and market leadership is obtained, firms should expand their market and target for a larger user group. In this view adoption is a communication process in which firm and adopter try to establish a mutual understanding of the relative advantage of the new technology (Rogers, 2003). This process benefits from a specific niche with self-referencing users (Moore, 1991). In the studied cases the targeted niche market consists of only one user, central government. In consumer markets there are many potential users and market niches. In addition, this single user consists of many different departments and agencies with different responsibilities. These different departments and agencies all need to be convinced of the benefits of the new technology. Hence, adoption of new ideas in public administration is a process of coalition building that often involves diverse and competing interests (Ring and Perry, 1985). Second, government is bounded by regulatory and procurement policies. As a consequence, regulatory and procurement policies affect the direction of technological change (Gann and Salter, 2000). Furthermore, the cases show that government is hesitant in adopting new technologies without proper assessment of reliability and quality issues. Government seems to opt for inferior but proven technology instead of new and superior technology, especially when it is visible to the public eye (Bingham, 1978), because government is subjected to ‘public scrutiny’ in accounting for their decisions (Ring and Perry, 1985).

The planning of the development and diffusion of a technology is very much affected by government. In all three cases the different roles of government, its risk-averse nature and the distinction between policy-makers and policy implementers has a substantial influence on the timing of new technologies. In the nearly completed cases government has taken more than seven years to define its preferences. During this period government created uncertainty about design specifications, market conditions and application. Furthermore, these factors make first-mover strategies disadvantageous. The technologies of nearly completed cases failed to set the standard and are both locked-out by low-cost and inferior technologies.

Involving government in its diverse roles seems complicated. Involving government as regulator or champion seems important in early stages of development while involving government as customer is important at later stages. Moreover, government as facilitator is important in the testing stage of development. In the adoption of new technology early involvement of the regulator is also important, because regulations often determine the emergence of a dominant design (Schilling, 1998). All projects show that the opinion of government as opinion leader is important in the acceptance of a new technology. The dominant position of this opinion leader makes it essential to convince this opinion leader of the benefits and feasibility of the technology. Furthermore, in securing the support of government involving and collaborating with competitors can be an important strategy. R&D collaboration can create the legitimacy of actions in situations of political uncertainty (Nakamura et al., 2003).

As Morris and Hough (1987) have also pointed out, consistency in public policy is important for successful development and adoption of technology. Government plays an important role in infrastructure in stimulating new technology, but has difficulty in adopting these technologies. Government should be more aware of its diverse roles and responsibilities. Integrating these diverse roles in central government seems a necessary step to ensure consistency. Finding a champion as Morris and Hough (1987) suggest is not enough as our cases showed. Champions within government seem technology-driven and not application-driven. Champions might therefore light the wrong path. Government, especially in infrastructure, should develop a roadmap of technologies if it wants direct technological developments. These roadmaps should be based on themes that will consistently occupy the agenda of government. These themes should guide the choice of technologies that must be developed.

Our findings suggest that competing roles and responsibilities of government agencies frustrate the development and adoption of new technology in road construction in a number of ways. First, competing roles and tasks lead to discontinuous policies and changing strategies in setting product standards. This creates uncertainty in product and design specifications. Second, government agencies encourage competition between different design solutions at an early stage of development. Consequently, firms are forced to consider cost and manufacturing issues when design parameters are still undetermined. Third, government agencies stimulate technology development projects for which they do not have a projected purpose or use. As a result, public administrative issues and policy changes seriously affect market application and potential returns.

This research has several limitations. In this study we have analyzed three cases. This number makes it difficult to generalize findings. This research is limited to cases aimed at central government. Furthermore, two of the cases studied were initiated by central government. The identified roles of central government and their effects on development and adoption might be different at local levels. At the local level there are more potential users and local government probably has less expertise. Moreover, the distinction between policy-makers and policy implementers may be less sharp at local government.

Future research can be directed at the development and adoption of technology that was initiated by firms instead of central government. In addition, future research can look at projects aimed at local government.

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MOTIVATING INNOVATION TO ACHIEVE WIDER POLICY OBJECTIVES IN PUBLIC SECTOR CONSTRUCTION

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ABSTRACT: The need for innovation to improve the performance of public sector construction has been recognised by the British government. However, there has been little explicit investigation of how constructors can be motivated to innovate in the context of public sector construction. This article describes research designed to address this knowledge gap. The research presented here is based on the case study investigation of one public sector client's attempts to motivate developers to implement a specific innovation. The case study revealed that the client articulated its demand for innovation to manage the attention of constructors and motivate innovation implementation. The research also found that the client was prepared to innovate themselves to encourage the innovation effort of private sector developers. Finally, the case study revealed the strong belief of public sector managers in incentivised key performance indicators as being the most powerful means to motivate developers towards the implementation of innovations.

Keywords: innovation; local labour; motivation; public procurement.

1. INTRODUCTION

Public sector construction procurement in the UK has been subject to extensive change over the last decade. New procurement strategies have been developed that emphasise the potential of innovation to satisfy the needs of public sector clients and to provide better value for money to taxpayers. The public sector currently purchases over 40% of the construction industry's output (DTI, 2005) and the need for innovation to improve the performance of this expenditure has been recognised by government (DTI, 2003; 2005; OGC, 2004). Innovation in public sector construction procurement can enable project teams to meet the main procurement parameters of cost, time, quality and predictability, and also enable the government's wider economic and social policy objectives to be achieved. Conversely, poor levels of innovation in public construction can result in government and taxpayers paying higher prices for their public facilities and services (Nam and Tatum, 1992).

However, with some exceptions (Nam and Tatum, 1992; Ive et al., 2000) there has been limited explicit investigation of innovation in public sector construction by researchers. Consequently, little is known about how innovations emerge, the process by which they develop, and how public sector clients can motivate suppliers towards innovation. In this article we describe research that has been designed to address the knowledge gap of how public sector clients motivate constructors towards innovation. The research presented here is based on the case study investigation of a public sector procurement programme where the local authority client wanted a specific innovation to be implemented by its developers.

The innovation was designed to address wider social and economic policy objectives and concerned the employment of labour from within the local authority's vicinity during the construction process. The local authority client had not used a local labour approach in its construction previously because they believed that it was prohibited under EU procurement regulations. However, research identified that, contrary to common perceptions, public sector clients could operate a local labour approach within the existing legal and policy frameworks (Macfarlane, 2000). On recognising this the client decided to innovate in its procurement and adopt a local labour approach. The success of the local labour approach would depend on the extent that private sector developers used local labour. To increase the likelihood of success the client set out to motivate the developers towards implementing the local labour innovation. The different ways that the client attempted to motivate developers are explored in this article.

The article is structured as follows. In the next section a review of the literature on clients driving innovation is presented to provide a theoretical backdrop to the research. This is followed by a description of the methodology used in the empirical research, after which the case study is presented. The main findings of the research are discussed and finally, conclusions drawn.

2. LITERATURE REVIEW

2.1 Defining Innovation

The notion that innovation involves the implementation of something new or novel to the unit of adoption is prevalent throughout most definitions of the phenomenon used in the construction literature (e.g. Slaughter, 2000; Kumaraswamy et al., 2004). Sexton and Barrett (2003) extend this notion of innovation by emphasising, in a definition developed with practitioners, that the outcome of innovation should enhance overall firm performance. Ling (2003) also refers to the outcomes of innovation and suggests that although innovation will have the intention of deriving benefits, risks and uncertainties will be associated with the implementation of a new idea. In this research instead of a presenting a formal definition of innovation, several statements about innovation are offered. These statements are based on key innovation characteristics identified in both the construction innovation literature and generic innovation literature (King and Anderson, 1995). Innovation in this research is therefore characterised as follows:

- An innovation must be an implemented process, product, policy or practice;
- An innovation must be new to the unit of adoption within which it is introduced (e.g. job role, project team or whole organisation);
- An innovation must be more substantial than routine or trivial change;
- An innovation must be aimed at producing benefit for the individual, project, organisation or other stakeholders.

2.2 Literature Review of Motivators to Innovation

The following literature review section discusses a number of potential ways for clients to motivate constructors towards innovation. The motivators of innovation presented here have been identified from a review of construction innovation literature, generic public procurement literature and British government best practice guidance. Table 1 presents a list of potential motivators of innovation and shows if there was reference to each of them in the respective literature bodies. The list of motivators is not an exhaustive catalogue of every potential motivator of innovation in construction, instead it focuses on the most frequently discussed motivators of innovation that clients can strongly influence. An outline of each motivator follows the table.

Table 1: Client-side Motivators of Innovation

Motivator of innovation	Construction innovation literature	Public sector procurement literature	Government policy guidance
Innovative demands	✓	✓	✓
Market power	✓	✓	✓
Time for development of innovative solutions	✓		
Positive weightings to innovative solutions	✓		✓
Integrated procurement systems	✓		
Open and flexible contracts	✓		✓
Fair management of risk	✓	✓	✓
Sharing of rewards	✓		✓
Outcome and performance specifications	✓	✓	✓
Client technical competency	✓	✓	
Client-constructor working relationship	✓	✓	✓
Coordination of project teams	✓		
Coordination of innovation effort	✓	✓	

Innovative demands: An innovation demanding client has been identified as a significant driver of innovation (Nam and Tatum, 1992; Gann and Salter, 2000). Public sector clients must be effective in articulating their innovation requirements to suppliers to stimulate innovation (Rothwell, 1984; Edquist and Hommen, 2000). In particular, to increase the likelihood of industry investment over the long-term to meet the public sector's needs, direct and accurate communication on likely future requirements and plans is essential (Williams and Smellie, 1985; OGC, 2004).

Market power: The pressure for innovation in construction is often strongest when there is significant demand (Gann and Salter, 2000). In the generic public procurement literature Dalpe (1994) argued that the market power of clients influences their ability to get suppliers to satisfy their requirements. A significant contract with the public sector can reduce the supplier's risk of innovating (Dalpe, 1994). Suppliers can also commit more resources towards innovation for the public sector when they recognise that the client's presence in the market is long-term rather than short-term (Rothwell, 1984).

Time for the development of innovative solutions: Clients can stimulate innovation when they allow sufficient time at the tendering stage for the development of new ideas and innovative proposals (Ive et al., 2000; Dulaimi et al., 2002). However, overriding time and cost pressures in construction projects frequently leave little room for experimentation with innovative ideas in construction (Kumaraswamy and Dulaimi, 2001).

Positive weightings to innovative solutions: Innovation can be encouraged at the bid evaluation stage of procurement when clients give positive weightings to innovative proposals. Public sector clients can promote innovation by deciding to allow variant bids (OGC, 2004). Although innovations may be proposed to improve the bidder's chances of winning the contract, there is the risk that innovation-seeking time and effort will have to be written off if the bid is unsuccessful (Ive et al., 2000).

Integrated procurement systems: The separation of design and production during procurement tends to work against innovation (Winch, 1998). The integration of design and production has therefore been considered fundamental to the realisation of innovation (Dulaimi et al., 2002). The public sector can set an example to industry by demonstrating alternative integrated procurement relations (Morizzo and Dewick, 2002).

Open and flexible contracts: Conventional locked contracts are not flexible to innovation and often only permit work to be undertaken within established industry standards of knowledge (Kumaraswamy and Dulaimi, 2001). The risk that penalties may accrue to a party who strays beyond standard practice in the industry stifles creative solutions (Kumaraswamy and Dulaimi, 2001). It has been argued that for innovation to occur in public sector construction, clients must be willing to give flexibility in contracts so that the private sector has the 'freedom to innovate' when required (Lemos et al., 2003). The government recommends that provision for innovation over the life of a contract should be built into contracts from day one (OGC, 2004).

Fair management of risk: The public sector does not usually have the means to tolerate the high levels of risk often associated with innovation (Nam and Tatum, 1992). However, it has been argued if clients are to stimulate suppliers to innovate, public authorities must learn to accept the necessary level of risk (Rothwell, 1984). The government has recognised that even-handed risk management is critical to innovation success, with risks being fairly apportioned (OGC, 2004).

Sharing of rewards: Innovation is more likely to be successful if firms are optimistic about the results of innovation effort and if there are sufficient rewards for all parties to commit resources to the innovation effort (Dulaimi et al., 2003). The provision of contractual incentives is one way for suppliers and clients to share benefits (OGC, 2004). However, it has been suggested there must be a cultural change to promote a win–win attitude in construction contracts (Dulaimi et al., 2002). The government has stressed that financial benefit is not the only means to drive innovation. Acknowledgement, kudos and good press are all suggested as alternative motivators for suppliers (OGC, 2004).

Outcome and performance specifications: Fixed and detailed specifications are not flexible to innovation. On the other hand, it is argued that when clients express their needs in functional and performance terms industry has freedom to innovate and can exercise creativity to respond to needs how they see best (Ive et al., 2000; OGC, 2004). The use of outcome specifications challenges suppliers to generate innovative solutions (OGC, 2004).

Client technical competency: A government authority that understands its requirements and has a high level technical expertise can motivate suppliers to innovate because they are able to deal with uncertainty associated with innovation (Rothwell, 1984; Edquist and Hommen, 2000). Technical competence on the part of the procuring organisation can also mean timely approval of innovative ideas (Nam and Tatum, 1997) whereas a lack of technical capability on the client-side could mean the rejection of innovation or lengthy tests and consultation.

Client – constructor working relationships: In order for innovation to be successful strong co-operation from the relevant parties is required (Ling, 2003; Dulaimi et al., 2003). A high level of client involvement in construction projects has also been found to be crucial to achieving good results in construction innovation (Nam and Tatum, 1997). The working relationship between client and constructor can be improved when there are formal procedures for client-supplier dialogue and continuous improvement suggestions (OGC, 2004).

Coordination of project teams: The integration of project teams is important because the interdependency of components and subsystems in construction requires technical know-how and resource exchange between a range of disciplines and parties (Gann and Salter, 2000; Dulaimi et al., 2003). Clients can improve the integration of project teams by including specialist contractors early in projects (Dulaimi et al., 2002). Functional fragmentation, self-protective pressures and adversarial attitudes traditionally work against the multi-disciplinary teamwork needed to generate innovative solutions (Kumaraswamy and Dulaimi 2001).

Coordination of innovative effort: Innovation leadership and coordination of innovation effort have been found to be important determinants of innovation in construction

(Slaughter and Shimizu, 2000). Public sector clients can coordinate innovation and demonstrate innovation leadership by incorporating new products and systems in building programmes and guaranteeing public markets for innovative firms (Seaden and Manseau, 2001; Morizzo and Dewick, 2002).

2.4 Summary of Literature Review

A lack of research specifically investigating innovation in public sector construction forced the above review of potential motivators of innovation to be based on associated bodies of literature. However, the relevance of this literature to public sector construction can be questioned. The vast majority of the generic public procurement research is based on industries other than construction and this research, like generic innovation research, has not been sufficiently envisioned, embedded and evaluated in a construction context (Barrett et al., 2001). Conversely, the construction-specific innovation literature has in the main considered only clients generally and not explicitly focused on public sector clients. Specific attention on public sector clients is necessary because, unlike private sector clients, public sector clients are constrained by strict governance and public accountability regulations (Palaneeswaran et al., 2003). Given these issues the appropriateness of the above drivers and motivators of innovation to public sector construction is unknown. The next section of the paper describes the methodology used in this research to explore the motivation of innovation in public sector construction.

3. CASE STUDY BACKGROUND

3.1 Methodology

The empirical research presented here involves an exploratory case study of a public sector procurement programme. In order to explore the question of how public sector clients motivate suppliers towards innovation three different qualitative research methods were employed. The study used participant observation as the principal research method, supplemented by document analysis and semi-structured interviews. Document analysis was used to examine key procurement material including the Pre-Qualification Questionnaire, Invitation to Negotiate publication and the formal responses from potential constructors. Semi-structured interviews with key individuals from both the public and private sectors were also undertaken to enrich the case study data.

Participant observation could be used in this study because the public sector client employed the first author during the procurement programme in the capacity of research assistant. The job role was a low status position and did not give the researcher any mandate to participate in decision-making regarding procurement, but it did grant first-hand access to observe the procurement process as it unfolded. As a research assistant the author was assigned a project by the procurement director and worked closely with the procurement team to deliver the work. The work enabled the researcher to participate in a range of activities including internal team meetings, formal meetings with local councillors and negotiation meetings with private sector constructors. Observations about the procurement process were recorded during working hours and more detailed fieldwork notes were produced at the end of each day.

Although participant observation is considered a time-consuming method and is sometimes criticised for being unable to produce quantifiable data, it has been justified elsewhere in public sector construction research as being very advantageous (Ball et al., 2000). Participant observation was deemed appropriate for use in this research because:

- The procurement process is an observable social process;
- Participant observation allows first-hand contact of attempts to motivate suppliers towards innovation;
- Participant status provides the observer with rich understanding of the case study context and awareness of the main project developments and idiosyncrasies;
- Participant status gives the observer access to the key individuals who influence the development of innovations, but would normally either be unable (time wise) or unwilling to communicate directly with researchers;
- Participant observation allows the investigation of the innovation as the procurement process unfolds and this can reveal how influences on the innovation change over time;
- The longitudinal nature of participant observation means that new influences on innovation might be identified that other 'snap-shot' research techniques have overlooked.

3.2 The Case Study Background

The case study investigates a major housing market renewal programme in the North of England. In the case study the public sector client (referred to in this research as ClientX) is a partnership between a local authority and a central government funded pathfinder organisation in the sub-region. The partnership was formed to intervene in the housing market in three inner neighbourhoods of the local authority. The purpose of the intervention was the transformation of depressed and stagnant housing markets into a situation where property values aligned with regional averages and housing tenure aligned with national averages.

The procurement process observed during the case study involved the appointment of two private sector lead developer partners (LDPs) who would be responsible for building new housing in the three most depressed neighbourhoods of the local authority. Although the prime task of the LDPs was physical development in the intervention areas, ClientX also wanted the LDPs to contribute towards wider regeneration goals as part of the partnership. In particular, ClientX wanted the appointed LDPs to innovate by addressing broader economic and social issues through the use of local labour. The objective of ClientX was for the local labour market to benefit from the construction expenditure in the area through LDPs offering:

- Employment opportunities to socially excluded groups including unemployed people, BME, disabled and women;
- Training and qualification opportunities for existing employees;
- Apprenticeships and work experience placements.

Using labour from the local area during development would be an innovation for both the client and LDPs, and this was the innovation followed by this research.

4. RESULTS

The research investigation revealed ClientX attempted to motivate its LDPs towards implementing the local labour innovation in a number of ways. These motivators have been grouped into four categories:

- Structure of the housing investment programme;
- Articulating the need for the innovation;
- Incentivised performance measurement;
- Innovation to support the LDPs.

Structure of the programme: The housing investment programme was designed to approach housing market renewal over the long term, with funding from central government available for at least 15 years. This meant that ClientX was able to use the length of the intervention to try and persuade LDPs that training and employing local labour would 'pay-off'. The long-term nature of the partnership, between the client and developers, was frequently stressed by ClientX as offering the continuity of work required to allow LDPs to commit resources towards local labour. The structure of the programme was also acknowledged as a potential motivator in other ways. The client was aware that by dividing the programme into small projects of around 20 housing units a culture of competition between different developers could be created. A procurement manager in ClientX explained: "By using small projects we're able to continuously measure the performance of the LDPs against each other on KPIs [Key Performance Indicators] like local labour and quality". When faced with comparison against other developers on local labour statistics the same procurement manager predicted developers would take the issue of local labour seriously and maybe even generate creative solutions as they strived to be the best performer on the issue.

Articulating the need for the innovation: Throughout the entire procurement process ClientX wanted developers to recognise the importance of local labour involvement in the programme. ClientX did this in the expectation that developers would be motivated to implement the local labour innovation if they recognised its importance to the overall regeneration masterplan. At the beginning of the procurement process ClientX used developer briefing and open days to verbally introduce the importance of the issue of local labour. As procurement progressed the formal Pre-Qualification Questionnaire (PQQ) and Invitation to Negotiate (ITN) documents were both used to articulate the importance of local labour to potential developers. These procurement stages were also used to try and stimulate developers to generate ideas on how they could contribute to wider economic and social goals during the programme.

The PQQ document included the following statement:

> *"ClientX is committed to ensuring that local people are given the chance to access the on-site vocational training and employment opportunities that the Housing Market Renewal Programme brings"* (PQQ).

The ITN document included the following statements:

> *"ClientX is working to maximise job opportunities and develop the skills of residents in the area ... we are asking lead developers to play their role in providing job and training opportunities and so to support the local supply chain ... we look forward to reviewing your proposals"* (ITN).

Potential LDPs were asked to describe in their ITN responses their approach to local employment and economic development, and answer questions like the following:

> *"Explain how you will support this initiative* [local labour] *through creating mainstream and innovative local training opportunities, at both trade and professional levels, within your organisation and your supply chain"* (ITN).

The above extracts are a demonstration of ClientX's demand for innovation on the issue of local labour during the housing market renewal programme. Specifying the need for local labour occurred consistently throughout the procurement process, from the very beginning of the process. There was a consensus amongst ClientX procurement staff that they had used the procurement procedures, to motivate developers towards the use of local labour, as best as possible.

Incentivised performance measurement: ClientX developed an incentivised performance measurement framework for the programme. The framework would become a management tool for the client to measure the performance of the LDPs against key performance indicators (KPIs). Two of the KPIs, out of twelve in total, measured local labour and training opportunities. In order to ensure that achieving the KPI targets was worthwhile for LDPs, ClientX incentivised the KPIs by linking them to the LDP profit margin on the project. Good LDP performance on a KPI would mean the LDP would get rewarded and earn a higher return, bad performance would mean the LDP would be penalised and lose some of their return. The incentivised framework of KPIs was regarded by the procurement staff as the most influential method available to them to motivate LDPs towards innovation. Linking KPIs to developer return was the idea of ClientX's procurement director who prior to this position had been a senior manager with several private sector developers. The procurement director argued that knowing the industry as he did ClientX had to use something *"with real teeth to get action on local labour"*. Another procurement manager argued that incentivised performance is *"really the only way we can get the developers do what we want ... to innovate"*.

Innovation to support the LDPs: The final method used to motivate LDPs towards the implementation of the local labour innovation was ClientX's decision to create a construction employment and training agency. Such was ClientsX's belief in the potential of the housing market renewal programme to bring wider economic and social benefits they were prepared to innovate themselves. The creation of the construction agency was an innovation for ClientX and they expected that it would encourage LDPs towards implementing the local labour innovation because the agency would be able to offer dedicated support. The construction agency was tasked with working alongside employment agencies, colleges and LDPs to create a long-term construction skills pool for the sub-region.

5. DISCUSSION AND CONCLUSIONS

Two of the ways that ClientX attempted to motivate its developers towards implementing the local labour innovation were identified in the review of existing literature earlier in the article. When ClientX highlighted the long-term structure of its housing investment programme it attempted to demonstrate its market power to potential developers. Long-term market presence reduces the risks of innovating for private sector firms (Dalpe, 1994). ClientX's articulation of its requirement for the local labour innovation also correlates with existing literature. Demand for innovation from clients is recognised in the existing constructive literature as one of the most influential drivers of innovation (Nam and Tatum, 1992; Gann and Salter, 2000) and the need for effective articulation of innovative demands has been stressed elsewhere (Rothwelll, 1984).

The use of an incentivised framework of KPIs to motivate suppliers towards innovation has not been discussed in existing literature. There has been reference to incentivised contracts, but there has been no specific research into the incentivisation of KPIs and the influence that this has on performance and innovation. This is surprising considering how much of a popular performance measurement tool KPIs have become within industry. Furthermore, the strong belief of ClientX's managers in the power of incentivised KPIs to motivate developers to innovate suggests that practitioners would welcome future research into this subject. ClientX's confidence in the potential of incentivised KPIs might also explain why the other potential methods of motivating constructors towards innovation, identified in the literature review, were not adopted.

The decision of a client to innovate themselves to support LDPs innovation efforts has also not been examined in the associated literature. When ClientX created the construction agency it showed very strong commitment in the local labour innovation, and such commitment has been identified as an important innovation determinant previously (Nam and Tatum, 1992). It might be argued that the client was taking on an innovation coordination role (Slaughter and Shimizu, 2000) when it created the construction agency. However, observation revealed that ClientX wanted the LDPs to take leadership and coordination responsibility for the local labour initiative within the new build program, with the new construction agency only providing support where required.

The findings presented here contribute to the knowledge on innovation in public sector construction and addresses the knowledge gap identified in the existing literature of how public sector clients can motivate for innovation. The research offers managers and researchers an insight into how one public sector client attempted to motivate its suppliers to implement an innovation in a contemporary construction procurement programme. The influence and impact that these client actions had on the motivation levels of developers to implement the local labour innovation is the next phase this research.

One issue that is already apparent from this research is that the different attempts to motivate developers received a mixed response from developers. In the example of incentivised KPIs, whereas one developer was able to say *"We would recommend using KPIs to measure the involvement of local labour in the programme"* another developer rejected incentivising local labour KPIs because they felt the quality of its product might be compromised if they were trying hard to achieve a good performance rating on local labour. Another of the potential developers completely rejected the use of any performance measurement that was linked to their return. The findings of this future research should provide further insight into the issue of public sector clients motivating private sector constructors and reveal the outcomes of implementing the local labour innovation.

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KNOWLEDGE TRANSFER OF SOLUTIONS TO SPECIFIC PROBLEMS IN THE FORM OF A DEFINED 'SOLUTE'.

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ABSTRACT in the action research project into 'Hospital Design Quality', and the identification and confirmation of recurrent real world problems, one of the questions posed was why do problems recur? If the participants in the design and construction of the buildings have no knowledge of the problem, then to them no problem exists, so no solution is sought.

This question led to a literature search into the nature of knowledge and of knowledge management. This investigation unearthed the fact of, and an explanation of, the extreme difficulty of the transfer of knowledge and learning, even where problems are known to exist.

The research has led to the proposal that the parameters of a problem can be defined and a solution identified as a 'Solute', which could be more readily accepted and understood, given that it both defines and resolves a succinct issue. The 'Solute' would be the encapsulation of the cause of the problem and sufficient knowledge to resolve the problem. This could be in the form of a design or prefabricated component, together with a list of the issues resolved. In the hospital context a whole room could be a component.

The acceptance and implementation of the defined 'Solute' bypasses the barriers to knowledge transfer. The outcome is twofold in that all the knowledge relating to a specific problem is transferred and the problem itself is resolved.

Keywords – Knowledge, barriers, transfer, problems, solution.

1. INTRODUCTION

PhD research into 'Hospital Design Quality' is currently being undertaken at Salford by the author. The question originally asked was why do problems recur on project after project? Firstly the question had to be validated. Were there actually problems and were they recurrent? The literature search painted a backdrop of an industry beset with recurrent problems. This in turn led to the posing of further questions. Were people aware of the problems, was there any Post Occupancy Evaluation and Feedback? If people were not aware of the problem they would not look for a solution. If they were aware of the problems, were they trying to resolve them or not? If they were trying and failing, why were they failing?

These queries led the literature search into the area of the nature of learning, knowledge and knowledge management. The issue that came out of the literature review was that knowledge and experience gathered from project to project are not systematically collected and implemented from project to project. Equally importantly some problems are manifesting themselves once buildings are in use and the people who were responsible for the design and construction of those buildings are unaware of the existence of the problems. If people are unaware of the problems they will obviously take no steps to remedy them.

Issues that arise during the design and construction phase of a project captured during a post project review. Some problems do not become apparent until the building has been in use for a period of time. This would be beyond the period of defects liability (usually one year), when the constructors of the building cease to visit the project. These problems would only be identified by some form of Post Occupancy Evaluation (POE). The research has shown that this does not happen with the rigour it deserves. Even when problems are identified, there are issues which make their resolution difficult. These are the capacity an organisation has for 'learning'. Also that the transfer of knowledge itself is difficult, with varying impediments and degrees of difficulty. The process of knowledge management is also complex in providing current knowledge and removing redundant knowledge to the right people at the right time. The above was all within a framework of identifying and eliminating, if possible, real world problems. The literature review covered construction industry context and the issues arise across many (if not all sectors). The specific hospital context of the examples has been identified from experience and case study research into some aspects of hospital design quality. To resolve a problem the notion of a 'solute' is proposed that encapsulates all the knowledge that relates to the problem, its effects and how to resolve the problem. The advantage would be a succinct package of knowledge that illustrates the problem, its effects and provides a credible solution without widespread changes to work practices or processes. It provides an acceptably compact solution to a real world problem. The concept with a specific example is described in the conclusion.

2. KNOWLEDGE

Knowledge is a vital resource in project based industries such as aerospace, construction, shipbuilding and software. If managed effectively, knowledge can be used to reduce project time, improve quality, customer satisfaction and reduce rework. This could ultimately increase competitiveness.

According to Hung and Newell (2003) competitiveness depends on the diversity value of specialised knowledge, as well as an organisations capacity to integrate the knowledge in effective manner. The level of efficiency depends on the extent to which common knowledge exists between participants, the level of co-ordination and organisation structure. Common knowledge is the common understanding of a subject area shared by organisational members who engage in communication. Undoubtedly, the lower the level of common knowledge that exists, the harder the integration between organisational members. Despite the importance of common knowledge, the level of co-ordination can only be improved through repetition.

It is often assumed that knowledge freely exists and can be captured and shared. Knowledge per se is a concept that does not lend itself easily to codification and it is embedded in specific social context which compounds the complexity. Knowledge is highly individualistic and conformant with various surrounding contexts within which it is shaped and enacted

Another element in gathering knowledge is obtaining information that relates to a building once it is being used. It is one thing to learn about the process up to completion of a building and another to find out about issues that only materialise after the defects liability period. This type of knowledge becomes apparent after Post occupancy Evaluation and this method of knowledge gathering does not appear to be practiced sufficiently (Amaratunga 1999, Enright 2002). Attempts to then transfer this type of knowledge also encounter the impediments to transfer described in the paper.

Knowledge and experience gathered in different projects are not being systematically integrated into the organisational knowledge base and that there is a great discrepancy between the need for project debriefing and its actual deployment. This knowledge includes that learned during construction, from and post project reviews and also any POE's undertaken. Project team members return to their line functions (or they are being moved into other functions) after having completed their tasks in the project and they usually take their new experiences with them. The end of a project is consequently the end of collective learning. If their specific knowledge of that project is not needed organisational amnesia begins.

"The risk of a knowledge loss at a projects end is a serious problem for organisations, especially in knowledge intensive industries. Companies could save considerable costs, which result in redundant work and repetition of mistakes " (Schindler and Eppler 2003). According to Egan in Rethinking Construction Report 1998 about 30% of the construction industry output is rework! Knowledge that is easy to document, such as numerical data often does not present answers to pressing project queries or problem. Numerical data mainly answers "what", "where" and "how many", questions but does not address critical "why", and "how" questions that are better addressed by "stories" course studies or project reports.

The fundamental problem of organisational learning in connection with project work can be found in the conflicting aims between a project and the surrounding organisation. While the existence of an organisation is designed for the long run, a project only exists for the duration of its completion.

Project amnesia, which becomes organisational amnesia, is a concept described by Schindler and Eppler (2003). Experience within different construction organisations over 30 years have borne witness to all these issues listed below. Project amnesia means that the organisation some-how forgets knowledge that it had during a project, when the individuals disperse to other projects. Although some of the individuals retain the knowledge for the reasons described in other sections this knowledge does not get transferred to where it is needed again. The causes of project amnesia are:-

- High time pressure toward the projects end (completion pressure, new tasks already waiting for the team).
- Insufficient willingness for learning from mistakes of the persons involved.
- Missing communications of experiences by the involved people.
- Lacking knowledge of defined methods. Underestimation of process complexity which a systematic definition of experience brings along
- Lacking enforcement of the procedures in the project manuals.
- Missing integration of experience recording into project procedure
- Team members do not see a (personal) use of coding experience
- Difficulties in co-ordinating. Persons cannot be engaged for a systematic project conclusion, since they are already involved in new projects.

In those areas where lessons learned gathering takes place, the gained knowledge is often not transferred for re-use, or not accepted as valuable knowledge by others. If debriefings are conducted, there is still a certain risk that the results (i.e. the insights computed by a project team): -

- Are not well documented or achieved
- Are described too generally or are not analysed where necessary, which prevents re-use due to a lack of context (e.g. it is too difficult to understand or not specific enough for the new purposes).
- Are achieved in a way so that others have difficulties in retrieving them.
- Are not accepted, although they are well documented and easy to locate (the so-called "not invented here" syndrome)

According to Hansen *et al.* (1999) the strategy of an organisation to manage knowledge leads to two approaches: a codification approach – capturing knowledge for many individuals for re-use by many others – suitable if your product or service is standardised; and a personalisation approach – relying on individuals sharing their intuition and know-how to create innovative or customised products and solutions.

Raja and Kagiouglou (2005) explain that to help understand the definition of knowledge management it is essential to differentiate between data, information and knowledge. Information uses data as its raw material and is easy and quick to transfer from one place to another. Knowledge is used to activate information by application of a range of skills and experiences and is often very slow and difficult to transfer knowledge from person to person

- Tacit knowledge comes from personal experiences and is not formally shared or documented
- Explicit knowledge can be shared through media like newspaper, website or books.

There is now a wealth of information emanating from many sources, which could be useful to designers. This well established scientific, technical and social knowledge about the built environment can remain unexplored and do not become manifest in design.
"No matter how good or appropriate, if designers do not choose to access information, cannot access it, cannot understand it or cannot apply it readily, then it is of no use to them". (Powell 1968, cited by Newland et al 1987)

Knowing that; is the kind of knowledge, which can be made explicit, which can be formulated into advice, into procedures or into organised rules of conventional wisdom 'Knowing how' cannot be made explicit. It is the tacit knowledge, which we know but cannot tell. The architects 'know-how' derives from the experience of planning and designing

3. ORGANISATIONAL LEARNING

"Effective use of knowledge to enhance organisational performance depends on organisational learning of others within". What is an organisation that it may learn? The question posed by Argyris and Schon in Organisational Learning II 1996

Learning is a product (something that is learned) and a process that yields such a product. There is also a requirement for organisations to 'unlearn' which, for example is subtracting obsolete strategies from the organisation's store of knowledge. I prefer the notion of knowledge substitution, rather than unlearning, which somehow suggests forgetting which is difficult to consciously do.

"Organisations are not merely collections of individuals, yet there is no organisation without such collections. When, then does it make sense to say that a collection of individuals constitutes an organisation that acts?"

It is individuals that decide and act, but they do these things on behalf of the collectivity, as its agents. In order for individuals to be able to decide and act in the name of the collectivity; there must be rules that determine the boundaries of the collectivity, when members create such rules, they have organised.

Organisational knowledge is embedded in routines and practices which may be inspected and decoded even when the individuals who carry them out are unable to put them into words.

Argyris et al suggest a definition for organisational learning,

"Organisational learning occurs when individuals within an organisation experience a problematic situation and inquire into it on the organisation's behalf. In order to become organisational, the learning that results from organisational inquiry must become embedded in the images of organisation held in its member's minds and/or in the procedures embedded in the organisational environment".

The limited number of studies on knowledge production in 'learning organisations' have yielded highly abstract frameworks. These frameworks are not suitable for addressing how employees produce new knowledge or for identifying ways of stimulating the production process. This is so because they are based on how individuals learn through their cognitive systems, and thus they cannot resolve the dilemma between the individual as entities *learning* on behalf of the organisation and the organisation *memorising* what the individuals have *learnt.*

Furthermore, the above perspective on organisational learning and knowledge production is based on systems thinking, which presupposes 'designing and installing systems' as the solution to the KM problem. This perspective is even more problematic in the construction industry, where 'even the management of existing knowledge is still uncharted territory' (Kululanga and McCaffer, 2001:346).

'Near Misses' are almost but not quite organisational learning. This is where individuals' inquiry leads to both new understandings and action but remains outside the stream of distinctively organisational activity and produces no change in theory-in-use.

There are also instances in which organisational inquiry produces a temporary change in organisational theory-in-use, but the new understandings associated with that change, held only in the minds of certain individuals "carriers", are lost to the organisation when they leave.

Near misses suggest that organisational learning does not have a clean 'edge' and that there are boundaries at which it is difficult to determine whether interactive inquiry is truly organisational or has truly changed organisational theory-in-use or whether its results have been truly embedded in the organisation's procedures.

The value attributed to a particular instance of learning also depends on how we judge its validity. Learning seems to suggest the acquisition of valid, workable knowledge or know-how.

4. THE CONCEPT OF 'STICKY KNOWLEDGE'

Szulanski, in his book 'Sticky Knowledge' 2003, explains that the difficulties to the transfer of best practices within firms are traditionally ascribed to the interdivisional jealousy, lack of incentives, lack of confidence, insufficient priority, lack of buy-in, a heavy inclination to re-invent the wheel or to plough twice the same fields, refusal of recipients to do exactly what they are told, resistance to change, lack of commitment, turf protection and many other manifestations of what seem to be the popular definition of the Not Invented Here (NIH) syndrome. (Well recognised in the construction industry)

Szulanski's literature review identified another set of barriers to knowledge transfer, which he called knowledge barriers. Examples of which are the recipient's level of knowledge prior to the transfer, how well the transferred practice is understood within the organisation, the recipients ability to unlearn, ie. Shed prior practices, and the pre-existing social ties between the source and the recipient of knowledge. These factors are quantitavely different from motivational barriers, such as the motivation of a recipient to absorb and institutionalise external knowledge.

Szulanski identified examples of internal transfers of best practice where the internal recipient potentially benefited from the sources superior knowledge because they perform tasks that are similar in some way to that performed by the source (Galbraith 1990). This paper speculates that in order to accept the knowledge based on another person's skill and experience people would require a similar level of skill and experience. If they have not had the experience of an issue they do not know or accept that it exists based upon the 'advice' of another who has that knowledge and who they may not even know or trust.

Even proven and well-defined knowledge can be difficult to transfer because favourable tendencies propelling its diffusion are "nullified and offset by competing organisational dynamics".

All transfers of knowledge in general, require some degree of effort, some require significantly more than others and are said to be stickier.

The transfer of practice within the firm could be seen as a particular kind of knowledge transfer since practice is a manifestation of a firms' knowledge. Recent research has demonstrated that when practice stops, organisational learning depreciates – sometimes rather fast (Argote 1999). Thus, organisations not only learn by doing but also remember by doing, and thus routines act as the memory for the organisations knowledge. Practice is seen as fragmented, distributed and embedded in organisational routines. Thus practice may be seen as a manifestation of organisational knowledge.

According to Szulanski, traditional approaches to the re-creation of knowledge within organisations have paid little attention to the impediments. Communication theory, for example, views the process as one where the source transmits a signal to the recipient – a process in which information transfer is almost instantaneous and costless. Subsequent analysis of knowledge has recognised some of the impediments to knowledge transfer that result from the cognitive and emotional characteristics of human beings and the social systems they create. These include the limited information processing capability of 'social channels', the emotions and experiences of sense-making individuals, the peculiarities of the relationships and of the social context in which the transfer is embedded (Hansen 1999), distortions in the communication process and characteristics of the knowledge transferred. These features and numerous complications, which could in many cases, transform the 'act' of transfer into an intricate process. Therefore some degree of difficulty could be expected in most situations.

5. TYPES OF STICKINESS

'Initiation stickiness' is the difficulty in recognising opportunities to transfer and acting upon them. 'Implementation stickiness' occurs following the decision to transfer knowledge, attention shifts to the exchange of information and resources between the source and the recipient.

The true motivations of the source and the recipient are likely to be revealed at this stage. The recipient may increase difficulty by ignoring the source's recommendations out of misunderstanding, resentment, or to preserve pride of ownership or status.

"Ramp-up stickiness": Once the recipient begins using acquired knowledge, eg Starts up a new production facility, rolls over a new process or cuts over to a new system, the main concern becomes identifying and resolving unexpected problems that keep the recipient from matching or exceeding the expectations of post transfer performance.

"Integration stickiness": Once satisfactory results are initially obtained, the use of the new knowledge gradually becomes routine. This progressive routinisation is incipient in every recurring social pattern. Unless difficulty is encountered in the process, the new practices will blend in the objective, taken-for-granted reality of the organisation. However, when difficulties are encountered, the new practices may be abandoned and when feasible, reversion to the former status quo may occur.

The eventfulness of the integration phases depends on the effort required to remove obstacles and to deal with challenges to the routinisation of the new practice.

Organisational sub-units may differ in the ability to maintain routine operation
It appears that although those in charge understand that knowledge is highly people-based, they focus on funding technology.

The main challenges remain much the same; changing people's behaviour; and finding ways to measure the value and performance of knowledge assets. They also faced other challenges. The most significant of these were:

- Time and cost constraints
- Organisational culture; and
- Failure to provide a tangible demonstration of the value of knowledge management during the early days/months

6. VARIABLE IMPEDIMENTS TO KNOWLEDGE TRANSFER

There are a number of elements within different environments that inhibit the transfer of knowledge. These are the make-up of the company's organisation and its attitude to and the environment created for learning. Within that context are the relationships between the participants' involved in knowledge transfer. This is one of the crucial and most important interfaces at which knowledge transfer and learning can take place (or not).

In general, the unfolding of the transfer depends to some extent on the disposition and ability of the source and recipient, on the strength of the tie between them and on the characteristics of the object that is being re-created. The features of the organisational context where re-creation occurs are important as well. Traditional analysis acknowledges these factors but stops short of specifying their impact, which Szulanski investigated.

Causal ambiguity: successful replication of results, in a novel setting, may be compromised by idiosyncratic features of the new setting in which the knowledge is used. The theory of uncertain, suggests that there may be irreducible uncertainty that prevents a complete understanding of the features of the new context affect the outcome of the re-creation effort.

If results cannot be precisely reproduced elsewhere because of differing environmental conditions, and if there are causal ambiguities about the inner workings of productive knowledge then problems that arise in the new environment have to be solved in-situ through costly trial and error.

The motivation of a source of knowledge to supply conceptions of practice or to facilitate access to the recipient may influence the degree of difficulty experienced during a re-creation effort.

The credibility of the source affects how the conception of the practice supplied by the source will influence the behaviour of the recipient. When the source is credible ie perceived as knowledgeable and trustworthy the recipient will be less suspicious of the offered conception and therefore more receptive to its detail

A recipients' motivation to accept knowledge from an external source and to engage in the necessary activities to re-create and apply knowledge may prove critical to ensure a non-eventful replication. The reluctance of some individuals to accept knowledge from the outside (the Not Invented Here syndrome) is well documented.

Absorptive capacity: the ability to exploit outside sources of knowledge is largely a function of the prior level of related knowledge (Cohen and Leventhal, 1990). In other words for a recipient to be able to receive new knowledge they have to have a certain level of appreciation and understanding of the benefit of the new knowledge. At the most elemental level, this knowledge includes basic skills, a shared language, prior experience that is relevant and up to date information on related knowledge domains (Cohen and Leventhal 1990, Gilbraith 1990). Critical prior knowledge also includes an awareness of the laws of useful complementary expertise within and outside the organisation. Examples of this awareness are knowledge of who knows what, who can help with what problem or who can exploit new information (Cohen and Leventhal 1990). The stock of prior related knowledge determines the absorptive capacity (Cohen and Leventhal 1990:128) of a recipient of knowledge [important if no concept of problem no desire to absorb the knowledge]

A recipient that lacks absorptive capacity will be less likely to recognise the value of new knowledge, less likely to re-create that knowledge and less likely to apply it successfully. This may increase the cost, slow the completion even compromise the success of a re-creation effort.

Retentive capacity: a transfer of knowledge is successful if there is long-term retention of the transferred knowledge, ie to the extent that the recipient persists in using the knowledge when practicable. This is compounded if there are many required recipients.

Formal structure and systems of organisational context, sources of co-ordination and expertise and behaviour and behaviour- framing attributes can influence the number of attempts to re-create knowledge as well as the outcome of those attempts. A barren organisational context does not permit knowledge transfer.

Another important contextual aspect for the source and the recipient of knowledge is the nature of their pre-existing relationship. A transfer of knowledge is rarely a singular event, but more often it is an iterative exchange process. A potential recipient may require explanations of the nature of the knowledge being transferred to decide whether this knowledge would meet its needs. Likewise once engaged in a transfer the source may have to work to gain a closer appreciation of the needs of the recipient, in order to select appropriate components to transfer.

The closer, continuous and more sympathetic the relationship, the easier the transfer of knowledge.

7. PROBLEMS WITH KNOWLEDGE MANAGEMENT

Research, by Egbu et al 2004, suggest that people within the organisations studied have frequently shown a reluctance to change their ways of working, not embracing KM and the culture change required to facilitate its full effect. Employees are still reluctant to use these products to share what they know with each other, with their colleagues or even to obtain new knowledge themselves that they can profitably apply to their work (despite financial incentives).

Socialisation of knowledge takes place through shared experience (Taylor & Levitt 2004). Combination of knowledge is a process by which explicit knowledge held by individuals is shared. In the process of sorting, adding, re-categorising and re-contextualising, explicit knowledge can lead to new knowledge. In interacting around a new product or process, a project team would combine knowledge about how best to integrate the product or process during formal or informal meetings. The combined knowledge would lead to new knowledge of better ways to implement the product or process.

In the case of an incremental innovation, inter-organisational knowledge can amplify knowledge and facilitate the diffusion of the new product or process across the industry. In the case of a more complicated systemic innovation involving several different organisations knowledge flows do not accumulate effectively.

Problems with management of knowledge occur due to:-

Sometimes new management approaches are not clearly defined or have no internal coherence – they are rather more a bundle of loosely related practices
There is often a natural tendency for companies to want to select out and apply preferred parts of a total package and to reject the rest. Partly this may reflect a sensitivity to context
Concerns about the nature and purpose of change are also complicated by the tendency for change to be driven by different and sometimes conflicting, agendas.

Perhaps one of the main problem areas affecting the diffusion of new management ideas among practitioners are the difficulties of producing clear evidence of performance effects. This is particularly a problem in project environments such as construction.
Many of the above points imply that context – both external and internal – is important in determining the relevance of particular management techniques. With regard to external context, different economic and market conditions, institutional influences and legislative constraints are all going to have an effect upon the pressure for change and upon the nature and direction that change takes.

With regard to the internal context, it is important to acknowledge that organisations are complex entities with high levels of internal differentiation. This creates conditions for the development of different ways of viewing and solving problems and potentially leads to the emergence of subcultures and countercultures.

It has long been recognised that construction activity cuts across organisational boundaries and links together closely interdependent organisations in a complex web of contractual and managerial relationships.

The process of knowledge diffusion is complicated immensely when one considers that the knowledge diffusion process is itself not neutral, but instead influenced by a range of social, cultural, political and psychological factors. The net effect is that there are a multitude of ways in which the diffusion of new management ideas from other sectors into construction might be subject to process of modification, re-interpretation, re-enactment and distortion.

8. POST OCCUPANCY EVALUATION

The most powerful learning comes from direct experience. Indeed we learn through taking action and seeing the consequences of that action; then taking a new and different action. But what happens if we can no longer observe the consequences of our actions? What happens if the primary consequences are in the future or in a distant part of a larger system within which we operate? We have a "learning horizon" a breadth of vision in time and space within which we assess our effectiveness. When our actions have consequences beyond our learning horizon, it becomes impossible to learn from direct experience.

An architect does not simply come to a conclusion on one scheme and then the following day start work on another. The reality is that work on one project overlaps work on another depending on size, an architect may well be working on several different schemes at once. Finding time to carry out a feedback and appraisal exercise is not usually a priority.

If all parties can be gathered around the table for an appraisal session at the end, so much the better. There is no doubt that such a session would be very useful, but the chances of achieving it are remote… It is important that the discussion is carefully structured or it will achieve nothing. (If there is no mechanism for implementing the findings then what is the point anyway?).

In their paper "Organisational Learning as a vehicle for improved building procurement" 1998, Waller and May-Waller state that in a series of recent Australian studies into construction time performance revealed that neither the building construction companies nor the client undertake any meaningful organisational learning activities from their experience of managing building and civil engineering projects…Waller quotes Tsang:-

"It is one thing to undertake an informal review of lessons learned but quite another to build a system where learning is readily available and easily communicated to those faced with problems and issues where past learning would be of help. A structural and codified way of capturing learning is needed as no learning can take place in an organisation unless it possesses a proper memory system"

It is clear from the general management as well as construction management literature that the value of learning from past experience plays a crucial role in building process improvement. Post-project evaluation is an important tool for facilitating organisational learning

There is a stark difference between shallow, unstructured and ill-conceived process for harvesting lessons learned from any project and a well-structured and rigorous examination of the 'history' of a project.

So if there is no mechanism for storing, transferring and retrieving POE, then there is little point in doing it in the first place, and therefore people don't.

9. CONCLUSION

The research has identified that there are difficulties firstly in getting enough information to identify that a problem exists. A recommendation would be for more rigorous Post Occupancy Evaluation to be undertaken. Secondly and this would apply to any new knowledge coming from POE's, that knowledge itself is quite difficult to transfer

Agyris and Schon identify that organisations must learn and unlearn, ie discard old information or substitute new knowledge for old. Organisations are collections of individuals who act on its behalf. In the section on the variable impediments to knowledge transfer, one of the most important interfaces identified for knowledge transfer is between individuals. Those who have the knowledge and those they wish to transfer it to. Transfer is further complicated if the recipient does not recognise the value of the new knowledge or simply does not wish to receive it. Szulanski's concept of the 'stickiness' of knowledge identifies some of the issues that have to be overcome for any transfer to occur.

It can be seen from the literature that there are impediments to knowledge transfer. Egbu et al (2004) did identify promoting characteristics to knowledge. Given that recurrent problems are being investigated, it is evident that the impediments have outweighed the promoters, in the case of these problems any transfer to occur.

What this paper has attempted to outline is the difficulty of being aware of the problems in the first place. Then, when there is knowledge of a problem, how to transfer the knowledge of a solution.

The notion of a 'solute' is to provide sufficient information to give an understanding of the problem and the reasons why it occurs as well as all the effects that the problem has on the project, the building and its users, together with the recommended remedies to the problem. The 'solute' is a package of knowledge that contains all these elements. The fact that there is an understanding of cause and effects should overcome the variable impediments to knowledge transfer and achieve credibility. The 'solute' is well defined and succinct and does not require wholesale changes of work processes, which have been identified as a barrier to knowledge transfer.

The implementation of the 'solute' will resolve a problem and so benefit the recipient as well as his ultimate client ie hospital patients and staff.

The particular recurrent problems that were identified by the author in MA research in 2000 were in the design and construction of hospital en-suites. The main problems were water leakage from the shower area due to inadequate falls and water escape between the junction of different materials. This can be caused by both design and workmanship issues. In May 2005 The Yorkshire Post reported the findings of a working party, commissioned by the Department of Health, which were problems in hospital bathrooms (Monro & Mulley 2004). The findings were almost identical to the findings of a similar group also commissioned by the DoH. in 1966. These were similar issues to those identified in the author's previous research.

The proposal is to overcome the barriers to knowledge transfer, and both transfer the knowledge of the problem, the solution and the actual resolution of the problem. This would be by providing a list of the issues, providing a set of design parameters, incorporated into an exemplar design that could be made to fit most situations. To overcome the on-site workmanship issues, this design solution could me modularised as a component. This limited and defined scope for resolution of specific problems would be a 'Solute'.

9.1 The Solute (an abridged example) for a Hospital En-Suite

This was selected as an example of a problem identified by a POE exercise at some new hospitals in 2000

9.2 The Problem

The two main problems are water leakage through joints in construction, or water escaping from the shower area due to inadequate falls or both. This can be either design and/or workmanship issues.

9.3 Current Situation, (identified from research)

Of 400 en-suites reviewed:
8% (32No.) had been built right first time!
13% (50 out of 220) had been replaced satisfactorily!
79% (320 of 400) were currently unsatisfactory!
Of the 79% currently unsatisfactory 170 (of the 220 that had been replaced) had been replaced with another unsatisfactory solution, some of them more than once!

9.4 The Effects

Almost all shower designs leak between construction materials within 1-3 years of being constructed. Damp in the building fabric causes infection control issues and the en-suites are closed.

Water escapes from 25% of en-suites because the falls are inadequate. This causes slip hazards and infection control issues. Often soggy towel dams are used to retain the water by staff.

9.5 The Recommendation

Welded vinyl, laid to falls on the floor and on the walls of the shower area. Ideally the high point is at the door threshold. If concrete slab construction does not permit sufficient recess for falls from this point, falls from beyond the shower area can be constructed. This requires a threshold at the door to retain any water going beyond the high point of the fall. The workmanship issues are crucial for effectiveness as are the compliance with healthcare requirements (eg avoidance of trip hazards and steps etc.

Future development of the 'solute' is underway to investigate the possibility of modularising the en-suite and so building-in design and workmanship criteria. Case study research is being undertaken at several £300 million plus PFI hospital projects so the effectiveness and acceptability of the 'solute' principle will be tested in a live situation

Further study is also underway on the extent of POE and any barriers to it.

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HIGHER CAPABILITY MATURITY DYNAMICS OF UK CONSTRUCTION ORGANISATIONS

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ABSTRACT: This paper attempts to identify the dynamics of the CMM (Capability Maturity Model) higher capability maturity level characteristics within the UK construction context from a theoretical perspective. Firstly, this paper follows a literature survey and a synthesis to identify the nature of CMM higher capability maturity level dynamics and its specific attachments to the software industry. Based on this synthesis, this paper presents a model to mimic the likely higher capability maturity dynamics of the UK construction industry.

Keywords: Construction Process Improvement, Software CMM, SPICE, Higher Capability Maturity Level KPAs.

1. BACKGROUND

Unpredictability and the under achievements of the UK construction industry have been a strong concern within various studies and institutional reports (Koskela et al, 2003, Santos and Powell, 2001; Egan, 1998; Love and Li, 1998; Latham, 1994). Fragmentation and confrontational relationships have been identified as the main causes of this unacceptable level of performance of the UK construction industry (Love and Li, 1998; Egan, 1998; Latham, 1994). Further, the traditional functional view of construction projects could be highlighted as the main reason for the fragmentation and confrontational relationships identified within the UK construction industry (Fairclough, 2002; Holt et al, 2000).

In the light of the above argument, it is suggested that the UK construction industry should focus on its processes, in order to overcome its performance related problems. The importance of this focus shift has been stressed specifically within the Egan's report. Egan (1998) has highlighted the importance of taking process improvement initiatives within the UK construction industry as a measure to overcome its problems. At the same time, the importance of learning lessons from other industries has also been stressed within the same report. However, the expected synergic advantage of learning process improvement lessons from other industries to construction has raised some concerns of the researchers. It has often been argued that even though the performance improvements have been achieved through process improvement initiatives within the manufacturing and services sectors, the direct applicability of this strategy within construction has to be given careful thoughts (see: Santos and Powell, 2001; Love and Li, 1998; Egan, 1998). It has further been argued that the principles of process improvement of the industries such as manufacturing and services are not readily applicable within the construction context, due to the "unique" nature of the construction product. Further, the complex supply chain arrangements and project based product delivery systems have also been identified as inhibits for process improvement initiatives.

On the other hand, some researchers have argued against the above view by raising concerns about the fundamental assumption of process improvement being successful only within the services and manufacturing disciplines where same process is repeated for mass production activities. Being a project based industry the software industry provides examples in favour of this argument through the success stories of its highly successful process improvement initiatives (Sarshar, at el, 2000a). On the other hand the concepts such as lean construction place the construction within the manufacturing framework suggesting similarities between the manufacturing and construction. These arguments suggest that the process improvement initiatives within construction cannot be treated as impossible. However, as Lilrank (1995), the practices of one industry cannot be used directly within another industry rather the practices will have to be recreated within the second environment after considering its own characteristics and existing practices. Accordingly, the process improvement in construction is not a simple repetition of what is being done within other industries; rather the construction should have its own process improvement methodology.

2. CONSTRUCTION PROCESS IMPROVEMENT INITIATIVES

Until recently, the construction industry has had few recognised methodologies or frameworks on which to base a process improvement initiative (Sarshar et al 2000a). This is particularly apparent when considering the availability of such frameworks or methodologies to look at the organisational maturity and capability aspects. Unlike in a linear production situation, the project based nature of construction demands complex relationships between various parties. These complexities are influential factors when determining the organisational capabilities which are visible in varying degrees. Moreover, this hinders the capabilities of organisations to assess their standards and prioritise their process improvements appropriately. Further, absence of clear guidance at the macro level, hinders the repeatability and benchmarking capabilities of individual performance improvements (if any) at industry level (Sarshar et al 2000a). Thus it is important to establish a structured, common approach to construction process assessment and improvement based on the current capabilities of the organisation.

Lessons from the software industry

As a process improvement initiative the Software Capability Maturity Model (CMM) has demonstrated its success within the software industry. CMM was developed for the US department of Defence (DoD) who is a major software purchaser (Sarshar et al 1998). The use of CMM includes the evaluation of software manufacturing organisations prior to award them contracts. CMM is based on a five levelled structure. Within this, organisations are ranged from level 1 to level 5 based on their maturity. Within this framework, a maturity level has been defined as “a well defined evolutionary plateau towards achieving mature processes. Each maturity level provides a layer in the foundation for continuous process improvement” (Paulk et al 1993). Level 1 organisations are the least matured organisations where as level 5 organisations are the most matured organisations. In order to achieve a specified maturity level, organisations must satisfy all the “key processes” defined within the immediate below maturity level. The organisations are tested against “key enablers” to determine weather they have satisfied each key process within a maturity level. Through this framework, organisations are guided to adopt stepwise process improvements and ensure that the organisation in question is ready for the next level of process improvement. This, intern initialise a process improvement culture within the organisation and guides the procedures and the people towards improvements, using the available and potential tools.

The SPICE model

Sarshar et al (1998) have attempted to apply the principles of the software CMM model within the construction industry. This attempt was named as the Structured Process Improvement in Construction Enterprises (SPICE). The similarities between a software development projects and construction projects have laid the foundation for the SPICE to consider CMM as its base. Adopting the five level architecture of the CMM, the SPICE framework has also organised the process improvements of a construction organisation into five evolutionary steps. Each step is known as a maturity level. Within this paper maturity levels up to the third maturity level are identified as lower maturity level and 4th and 5th maturity levels are considered as higher maturity levels.

Each maturity level has several “Key Process Areas”. In order to achieve a level of maturity, the organisation should successfully perform all key processes related to that maturity level. This ability of performing key processes of that particular organisation is evaluated against five key process enablers. Those are,

- Commitment
- Ability
- Evaluation
- Verification
- Activities

It is also said within the SPICE framework that one organisation cannot skip maturity levels while progressing. As an example, to achieve third level maturity, organisations have to go through the second maturity level and cannot advance directly from first maturity level to third maturity level.

The SPICE Level 1 organisations have been identified as organisations which use ad-hoc processes during their day to day activities. And generally these organisations are surviving or performing due to the ability of some individual characters within the organisation.

Within the SPICE framework the level 2 has been identified as planned and tracked. At this level there is a degree of project predictability. A level 2 organisation has established policies and procedures for managing the major project-based processes (Sarshar et al, 2000b). SPICE Level 3 is identified as “Well Defined”. Within this level practices are well defined and institutionalised. Knowledge capturing and sharing mechanisms are established within these organisations to institutionalise the good practices and processes. After this institutionalisation, a high level of predictability can be expected towards future projects of an organisation.

The current SPICE model does concentrate on higher capability maturity levels of construction process improvements. As the Sarshar et al (2000b) have explicitly mentioned, so far the SPICE research has had little focus on level 4 and 5 issues. While lower maturity levels of CMM establish the required capability and the background of the organisation, the higher maturity levels are responsible for dramatic and sustainable process improvements. Within the SPICE, the dynamics of higher maturity levels were not explored thoroughly, leaving its full potential unexplored. This part of this paper is attempted to address this research gap from a comparative basis. The CMM level 4 and level 5 Key Process Areas will be analysed thoroughly, comparing the distinctive characteristics of both the software and construction industries. Furthermore, this analysis will be extended to discuss the applicability of these CMM higher maturity level dynamics within the construction environment.

3. LEVEL 4 CHARACTERISTICS OF CMM

CMM level 4 is classified as the "The Managed Level". Many characteristics of levels 4 and 5 are based on the concept of statistical process control (Paulk et al, 1993). From a project management and organisational perspective, the focus of level 4 is on establishing quantitative process management processes, while from engineering processes perspective, it is on establishing Software Quality Management processes (Paulk et al, 1995; Paulk et al, 1993).

There are two Key Process Areas (KPAs) at CMM level 4, which are based on above mentioned focuses. One has to do with process quality, that is, process performance (Quantitative Process Management – QPM) and the other, Software Quality Management, with product quality (Dymond, 1995).

Quantitative Process Management (QPM)

The purpose of QPM is to control the process performance of the software project quantitatively. Software process performance represents the actual results achieved from following a software process (Paulk et al, 1995). QPM involves establishing goals for the performance of project's defined software process, taking and analysing measurement of the process performance and making adjustments to maintain process performance within acceptable limits (Paulk et al, 1995).

Once the process performance is within the acceptable limits, the settings are established as a baseline and used to control process performance quantitatively. Further, within this KPA, special causes of variations in process performance will be identified and removed (Dymond, 1995). Collection of process performance data across all the projects of the organisation will be used to characterise the process capability of the organisation's standard software process. This process capability data in turn will be used by the software projects to establish and revise their process performance goals (Paulk et al, 1995).

Software Quality Management (SQM)

The second KPA of the CMM level 4 is SQM. The purpose of SQM is to develop a quantitative understanding of the quality of the project's software products and achieve specific quality goals (Paulk et al, 1995). This KPA involves defining quality goals for software products, establishing plans to achieve these goals, monitoring and adjusting the software plans and products to satisfy the needs and desires of the affected stakeholders.

The determination of quality goals is based on the plan developed for the project software quality. This plan takes its quality requirement input from customers, organisational and project quality plans and organisational capabilities. The quality requirements become numeric quality goals when data values describing those quality features are produced from the measurement plan (Dymond, 1995). After establishing the quantitative quality goals, the actual quality is measured against the goal at the start of each life cycle stage and corrective measures will be taken as and when necessary.

4. 4TH LEVEL DYNAMICS WITHIN CONSTRUCTION

Within the construction context, the principles of the above KPAs can be interpreted from a different view point. Taking QPM into consideration as a KPA in within the construction context, it is important to establish the definition of "construction process performance" in relation to the "software process performance". Since "performance" is a relative measure, firstly it is important to establish an objective basis within which the "construction process performance" can be defined. Since the major objectives of a construction project are based on the time, cost and quality aspects, scaling it down to the process level, the objectives of a construction process can also be identified within a time, cost and quality framework. In effect this means that the performance of the construction processes can be measured monitored in terms of time, cost and quality. The major emphasis is on the ability to take quantitative measurements of these parameters to establish "goals" for the processes based on which the performance of the processes can be evaluated for improvements. However, it is not the intention of this study to investigate and propose suitable methodologies for measuring and monitoring the performance of the processes in place, rather it is intended to identify whether the organisation;

- has the commitment to quantitatively measure the performance of processes as described above
- has the ability to perform quantitative measurements of its processes
- have activities in place to perform the quantitative measurements
- evaluate the activities in place to measure the performance of processes (internal evaluation)
- verifies the activities to measure the performance of the processes are in compliance with standard practices (external verification).

The above five items are the key process enablers against which each of the KPAs has to be tested.

When mapping the "Software Quality Management" KPA to construction, the main emphasis has to be given to the quality of the final product. This effectively reflects on the performance of the "core processes" or "technical level processes" as well as other related parameters such as programmer's skill within the software industry and workmanship and material quality within the construction industry. While the software industry uses quantitative measures such as number of bugs per thousand lines of code to quantify the quality of its final product, construction industry practices various material testing techniques and industry standards for material quality determination to ensure the quality of its final product. Due to the reason that the software quality does not heavily depend upon external factors such as material quality or the soil bearing pressure, it is sensible to assume a strong relationship between the software quality and the software processes in place. This is further justifiable since the measures such as number of bugs for thousand lines of code have a higher chance to get a high figure if the programmers work under stress within ad-hoc fire fighting situations in contrast to the existence of a working environment where proper processes in place to ensure minimal stress to the programmer.

Within this context, construction has a strong requirement to monitor the quality of its final products as it will be determined by a combination of various factors. These factors include quality of workmanship, construction processes in place, external factors such as ground and weather conditions, supply chain arrangements, etc. In order to enable continuous improvements within an organisation, it is important to monitor the impact of these parameters to the quality of the final product. This establishes justification for the need a different KPA within construction to quantitatively monitor and manage the quality of the construction product. Further, it is required to emphasis here that it is not the intention of this study to identify "how" the quality of the construction product is measured within construction organisations, but to identify the level of the construction quality measurement within the five key process enablers described above.

After establishing the "Quantitative Control", the next aspect of the organisation is to move towards an "Optimisation" where the monitored processes are continuously improved. This is the main objective of the CMM level 5.

5. CMM LEVEL 5 CHARACTERISTICS

CMM level 5 is classified as "Optimising". The focus of this level is on the continuous process improvement. The software process is changed to improve quality, and the zone of quality control moves to establish a new baseline for performance with reduced chronic waste (Paulk et al, 1993). Lessons learnt during these improvements will be applied in future projects. At this point, common causes of variations are addressed which in tern will result in reduced chronic waste and new baselines for improved performances. This feedback loop completes the cycle of continuous process improvement. CMM Level 5 consists of three KPAs which lead the organisation towards the ultimate goal of continuous process improvement. Those KPAs are;

- Defect Prevention
- Technology Change Management
- Process Change Management

a) Defect Prevention

Even though the defect prevention (DP) is identified as a KPA within the level 5, it doesn't prevent organisations at lower levels from practicing DP. But DP is one of the key considerations of a level 5 organisation (Dymond, 1995). The purpose of the DP is to identify the common causes of defects and prevent them from recurring (Paulk et al, 1995). DP involves analysing defects that were encountered in the past and taking preventive actions to systematically eliminate those from the future projects.

b) Technology Change Management (TCM)

The second KPA of the CMM level 5 is the technology management. The purpose of TCM is to identify new technologies (i.e. tools, methods and processes) and transition them to organisation in an orderly manner (Paulk et al, 1995). It involves identifying, selecting and evaluating new technologies and incorporating effective technologies into the organisation. The objective is to improve software quality, increase productivity and decrease the cycle time for product development.

c) Process change management (PCM)

PCM KPA is aiming to continuously improve the software processes used in the organisation with the intention of improving software quality, increasing 1 and decreasing the cycle time for product development (Paulk et al 1995). It involves defining process improvement goals and systematically identifying, evaluating and implementing improvements to the organisation's standard software process and project's defined software process on a continuous basis. These improvements are piloted before integrating to the normal software practice. Once the improvements are approved for normal practice, the organisation's standard software process and project's defined software process are revised as appropriate.

6. 5TH LEVEL DYNAMICS WITHIN CONSTRUCTION

When viewing the above KPAs from the construction perspective, it is important to take the construction specific characteristics into consideration. The place of Defect Prevention KPA in software CMM is justifiable as a 5th level capability maturity level dynamic as lesser number of defects (bugs) found in a software product directly contribute to the software quality positively, as this is the major measurement of software quality. Further the quantitative measurement and control of the software quality has considered as a key process area within the 4th maturity level enabling the organisation to concentrate on preventing measures once the organisation reaches the 5th maturity level.

In contrast, the construction "defects" does not covers the full aspects of construction product quality as explained under the 4th maturity level dynamics. Rather "defects" in construction projects are treated separately and treated under the arrangements such as "defect liability period" and "maintenance period". However, if a construction organisation to practice defect prevention measures at the 5th maturity level, it has to establish quantitative defect measurements and control preferably within the 4th maturity level. This initiates the necessity to consider the establishment of a new KPA within the 4th maturity level, "quantitative defect control". Once this is established, the defect prevention measures can be considered as an explicit KPA within the 5th maturity level.

While technology change management has considered as a key process area within the 5th maturity level of the software CMM, construction industry may not be able to limit this within these boundaries. Technology Change in software is relatively straight forward due to the fact that software uses relatively less number of different technologies within different sections of the product. As an example, in software a technology change would mean migrating from one programming language to another. In this case the change effect is organisation wide. But the construction utilises different technologies within different sections of the product. As an example, a new technological innovation in fabrication of steel structures might influence the processes involve for the erecting of the steel structure but might not have significant effects on processes to erect other elements like services or finishes. And due to these diversifications it is difficult to adopt an organisation wide technology change management as a single key process area within the 5th level of the construction capability maturity. This in effect suggests that operational level technologies within construction have to evolve with the processes in concern. An institutionalising effort may not be practical for these core technologies within a construction process improvement initiative. On the other hand, supportive technologies to these core technologies can have an organisational wide improvement strategy. Information Technology can be considered as an example, where it provides a technological infrastructure to all the core technologies to initiate their own innovations. Based on the improvement requirements of these technological processes and the capabilities of the IT, different elements of the construction product can initiate continuous improvement of its own underlying technologies. However, the level of use of IT as a supportive (enabling) technology within the construction process is also depend upon the maturity level of the organisation in question. Due to these reasons it is impractical for a construction organisation to consider Technology Change Management as a single KPA within the 5th Capability Maturity Level as seen in the software CMM. However, this research further queries how the IT usage within construction organisations can mature with the maturity of its capabilities. The objective of this query is to establish a process-IT co maturation model to be used by the construction organisations.

The final KPA considered within the software CMM is the process change management, which is the core to achieve continuous process improvements. The principle of this KPA is generic and the same principles can be used within the construction industry. Since the 4th level capabilities ensure the availability of the quantitative data within the organisation to reflect the opportunities for improvement, this KPA can be used to establish new stretch goals for the processes in place which can stimulate innovative processes. Thus this can be used as the starting point for the "revolutionary process improvements" within the organisation with out straining the organisational resources.

7. CONCLUSION

By considering the similarities between the two industries, some construction process improvement initiatives have adopted the principles of software industry's Capability Maturity Model. However to date, the higher maturity level characteristics of the software CMM has not been analysed thoroughly to evaluate its applicability within the UK construction environment. Thus, this paper looked analysed these characteristics within the comparative setting between the software industry characteristics and the construction industry characteristics to build a initial model how the CMM higher capability maturity level characteristics fit within a construction environment.

After considering the CMM model, software industry practices and construction practices, three KPAs can be identified within construction which has to be tested against the five key enablers described above as 4th capability maturity level dynamics. Those are;

- Quantitative Process Management in Construction
- Construction Product Quality Management
- Quantitative Defect Management in Construction

Within the 5th capability maturity level two KPAs have been identified as applicable within construction. Those are;

- Construction Defect Prevention
- Construction Process Change Management

However, the Technology Change Management KPA identified within the software CMM level 5 has its limitations if to be implemented within the construction due to the diversification of technologies used within a construction project. However, it is intended within this research to investigate the role of IT as a supporting (enabling) technology to be used within the construction industry.

8. WAY FORWARD

As this is a part of an ongoing PhD, it is intended to validate this initial understanding about the higher capability maturity dynamics through a case study approach. Further, this model is intended to go through several refinement cycles to ensure that it captures the actual industry characteristics and requirements. Moreover, special emphasis will be given within this research to understand the role of the information technology within this process to achieve higher capability maturity dynamics within the UK construction organisations.

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CONSTRUCTION INNOVATION: A LITERATURE REVIEW ON CURRENT RESEARCH

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ABSTRACT: Innovation in construction is a subject being discussed during a considerable period of time. However current research and statistical data shows that construction is lagging behind other sectors in the aspects of productivity and efficiency for which lack of innovation is blamed. This paper is an effort to illustrate present status of construction innovation research and perceptions of researchers and practitioners based on a review of current literature. Emphasis was placed on identifying the prevailing nature of construction innovation with reference to enabling and disabling factors and ways to improve the performance of construction to address the stakeholder needs.

Keywords- Construction Industry, Construction Innovation

1 INTRODUCTION

The construction industry is being increasingly challenged to successfully innovate in order to satisfy the aspirations and needs of society and clients, and to improve the competitiveness (Latham, 1994). Number of definitions is given for innovation within the literature. Dulaimi (2005) identifies innovation as the generation, development and implementation of ideas that are new to an organisation and that has practical or commercial benefits. It is generally accepted that innovation is the implementation of significantly new processes, products or management approaches in order to increase efficiency of an organisation (Seaden, 2003). The work of Sexton and Barrett (2003) emphasis that for an innovation to be successful, *new ideas* should be followed by *effective implementation* and must *improve overall organisational performance.* Further it was agreed among researchers (Dulaimi, 2005, Seaden, 2003, Sexton and Barrett, 2003) that ideas should not necessarily be new to the world, but to the organisational context under concern to generate innovation.

The main aim of this literature review is to identify the prevailing knowledge regarding construction innovation in order to identify areas which require further investigation. The literature was organised under four main sections. In the first section nature of construction innovation is discussed, highlighting the specific characteristics. This is followed by facilities to enhance construction innovation and barriers to construction innovation in section two and three respectively. The emphasis of section four is on implementation and management of innovation towards the envisaged goals of the construction industry. Finally the paper is concluded with a conclusion from literature reviewed.

2 NATURE OF CONSTRUCTION INNOVATION

What is the status of construction innovation? Is the industry innovative compared to other main industrial sectors? There are literature to state that construction lags behind the innovativeness of the manufacturing and services sectors. Productivity growth in construction is far below the national average (Nam and Tatum, 1997). In contrast there is literature stating that engineering and construction projects are inherently innovative (Pries and Janszen, 1995; Tatum, 1986; Tatum 1984). The project base nature of construction industry makes every project unique (Veshoskey, 1998), thus there is significant opportunity and tendency for new approaches. Building practitioners and their clients have often interpreted these new approaches as innovative behaviour (Seaden and Manseau, 2001). On the other hand uniqueness was criticised as a hindrance for construction innovation. Due to the unique conditions contractor has little to gain from being innovative, other than optimisation of their own process. The economies of scale rarely exist and knowledge gains are rarely being transferred (Pries and Janszen, 1995). There are observations to suggest the effect of uniqueness on innovation depends on the nature of the projects. In the study of use of virtual reality in construction industry, Whyte (2003) identifies that small projects with design reuse and large unique projects motivate use of virtual reality innovatively. When the company is small and work is repetitive it is possible to harvest higher return with comparatively smaller investment on technology. On the other hand large complex projects make room for innovation to overcome the associated practical problems.

Regardless whether the construction industry is innovative or not; there are concerns over the lack of systematic diffusion of innovation through the industry. The Business Roundtable (1982, cited in Nan and Tatum, 1997) attributes lack of innovation not to the lack of capability, but to the absence of a coordinated effort to link market needs and inventive capacity in spite of adequate demand pull as well as supply of promising technologies, such as computers, robotics and advance materials that are standing ready till being utilised through coordinated system. Further, innovations developed to solve problems at project levels are not effectively documented or communicated to others for future reference (Veshosky, 1998) and are rarely commercialised by manufactures (Slaughter, 1991).

Empirical study conducted by Reichstein et al, (2005) using the data form 'UK innovation survey' found out that number of firms engaged in product and/or process innovation in construction sector is lesser than other sectors. Further it was found out that construction firms are less open to the external environment and they tend to have poorly developed research and development (R&D), with low capacity to absorb ideas from external. However, some researchers are skeptical about so called conclusive evidence of the poor performance of the construction industry *compared with* other industrial sectors. Winch (2003) attributes that this observation to the deficiency of Standard Industrial Classification (SIC) on which most researchers categories statistics regarding construction and other sectors. Construction sector in SIC excludes Architectural and Engineering Consultancy firms where large amount of innovative designs are carried out. Further large proportion of value added in construction sector is repair and maintenance work where room is limited for innovation and productivity is low due to the nature of work. Nevertheless, this is not the case in most of the other industries or not significant as such. Thus it can be argued that construction sector under SIC is not comparable with other industries. However, Winch (2003) admits that there is insufficient evidence to state that the construction industry is any worse or better compared to other industries.

The question 'is the industry truly innovative, i.e. good at adopting new processes and products?' still remain without a clear answer. Unfortunately, official statistics are limited in measuring innovation and existing measures are related to the R&D statistics. R&D expenditures, number of R&D personnel, number of patents, number of publications and their citations, etc are considered as indicators of measures of R&D performance, thus for the innovation (Seaden and Manseau, 2001). Is R&D an indicator of innovation? OECD (1996, 1997) has reported that innovation can emerge from various sources of activities, and not only from R&D, although it constitutes an important part of innovation activities. The study of Slaughter (1991), also attest to this statement where majority of innovation was originated at sites by the builders (see section 3). Kline (1985, cited in Seaden and Manseau, 2001) states that research is not the direct source of innovations, and much innovation proceeds with little or no input from current research. Nevertheless, the level of R&D activity has been positively correlated with the relative innovativeness of various industrial sectors, particularly high tech manufacturing sectors, therefore considered as a valid indicator of innovation (Seaden and Manseau, 2001)

In recent era construction companies are keen on innovation. Due to the escalating labour charges construction companies identify innovation as a means of being competitive in the international markets (Nam and Tatum, 1997). This fact is reflected by the use of "innovative"/ "innovation" words in the company brochures and other marketing documents (Nam and Tatum, 1997).

The above section discussed different opinions regarding the innovativeness of the construction industry and how the characteristics of the industry has influence the innovation. Following section will look into the facilities to enhance innovation within construction industry.

3 FACILITIES TO ENHANCE CONSTRUCTION INNOVATION

One of the principal themes in the management of innovation is that, 'innovativeness' of the organisation and the extent to which the design of the organisation facilitates or inhibits innovation (Winch, 2000). According to Winch (2000), organisations that are relatively programmed and planned have more difficulties in innovation. This was confirmed in the comparative study on the innovativeness of French and British construction organisation involved in Channel Tunnel project. Based on case studies it was found out that the French were more ready to make process improving innovations than their British counterparts, particularly through the use of automated systems. Winch (2000) attributes this difference to the organisation structure, culture and behaviors of team members. One important difference is the allocation of roles. French had unitary hierarchy with multi skilled managers. In contrast British had multiple hierarchy composed of different, more narrowly defined skills. Further British method of working is more procedural compared to French.

Tatum (1989) found out that to foster innovation, there must be implicit vertical integration. This fact is confirmed by Dulaimi *et al*. (2002), who states that procuring more contracts based on design–build method would enable companies to increase their innovation, compared to design–bid–build, which is known to be one of the causes of fragmentation (Ling, 2003).

To increase the probability of successful innovation, implementation should be preceded by searching for alternatives, evaluating them and justifying the cost (Ling, 2003). Nevertheless, it should be noted that innovation does not originate only from R&D or from manufacturing facilities; but from users as well (Slaughter, 1991). Users innovate when the technology is easy to modify, specifically when the cost for the user to innovate are decreased (Slaughter, 1991). This fact was proven in the detailed field study of a single major innovation in the construction of residential housing; the stressed-skin panel, and innovations relating to its installation. Major finding was that users of stress-skinned panel (in this case the builders) are the main source of innovation who innovate 80% of innovations studied. This research intends to suggest that "learning-by-doing" and user innovation during implementation can be viewed as an iterative process that can push forward the development of a technology (Slaughter, 1991).

Kangari and Miyatake, (1997), identify four main factors that contribute to innovation in Japanese construction industry as: strategic alliances; effective information gathering capabilities; reputation through innovation and technology fusion. The link between innovation and business strategy in a large construction firm in Japan was found to be the long-range technology forecasting that integrates action of today with the vision of tomorrow (Kangari and Miyatake, 1997).

Information plays a key role in innovation as in many other situations. Lack of information regarding innovation is identified as a barrier by Project Managers (Veshosky, 1998). However there were companies that provide information sources but there availability were not properly communicated to the Project Managers thus proper utilisation was not achieved. Further, lack of focus of innovation in external sources was observed, which hinders the ability to learn from others experience and develop the industry as a whole (Veshosky, 1998). Therefore, it can be said that accessibility to information is essential to promote innovation. Veshosky (1998) have come across positive actions which certain companies have taken to improve the information flow to key personnel. They are:

- Assigning responsibility for managing innovation information to a specific individual or group;
- Maintaining a file or database of innovation information;
- Conducting internal technical seminars;
- Producing internal technical reports;
- Providing library capabilities including electronic information services;
- Encouraging project managers and engineers to interact with windows to external; and
- Encouraging project managers and engineers to participate in professional activities;

Early research has identified the importance of client to promote innovation. The Business Roundtable (1981, 1982, cited in Nam and Tatum, 1997) claimed that technological progress in construction requires the clients' involvement and leadership. In most cases, the willingness of client for risk sharing, commitment to innovation and leadership in project planning and execution seemed to be critical for the success of the innovation process (Nam and Tatum, 1997). The research suggest that there might be a close relationship between the clients' technical competence and their active participation in the project or at least a better understanding of technical matters for timely approval of innovative ideas. In addition, the clients' important role as the leader of the project appeared to influence the project environment by encouraging more integration among project participants. On the other hand, lack of above mentioned capabilities by the client may negatively effect the innovation. Ivory (2005) studied three projects where the influence of client had adversely effect the innovations. In this particular three case studies desire of clients to avoid risk associated with the innovations were highlighted. In each case, it is clear that the clients actively sought to control innovation and to ensure that it did not threaten the project or the resulting buildings (Ivory, 2005). However the case studies also provided some insight to the reasons behind the suppression of innovation. The dangers to clients of innovation stem both from short-term consequences, such as late or over-budget projects and from longer-term issues, hidden amongst the 'unknowns', such as higher than expected running costs or maintenance bills. In two case studies it was noted that the benefits of innovations were targeted at the users, but the paying client did not benefit from them. On the other hand client was facing the danger of criticism if the innovation failed. Further, in some instances clients simply failed to see the benefits of the innovation. Despite the arguments the projects studied were highly client focused, but the criticism is from the aspect of the encouragement to innovation. Ivory (2005) argues that the clients' intention of using established innovations rather than taking risks in new innovations hinder the advancement of technological frontier which can cause adverse effect to the industry in long term.

Above section identified the factors that positively influence the construction innovation. Further, it was revealed, how important the commitment of client for construction innovation and how lack of clients commitment to innovation can become a barrier. The following section further discusses barriers to construction innovation.

4 BARRIERS TO CONSTRUCTION INNOVATION

The fragmented nature of the construction process is identified as the main barrier to innovation (Pries and Janzen, 1995). Contractors and consultants are isolated from one another and contractors are often of small size and fragmented (Gann 2000). Moreover, construction projects also have a significant coordination and integration problems due to extreme specialisation of functions and/or involvement of various professions (Nam and Tatum, 1992).On the other hand the fragmentation of the professional bodies in construction has weaken their ability to act as honest brokers of innovation as they typically threaten the interests of one or other amongst them (Winch, 1998).

The particularly long life span of the construction products are also viewed as a barrier to innovation as it compels the client to stick to known methods rather than being radically innovative (Blayse and Manley, 2004). Since risk of failure is higher in construction, trial-and-error approach is not much acceptable (Nam and Tatum, 1997).

Due to technical regulations the room to be innovative is restricted (Blayse and Manley, 2004; Veshosky, 1998). Pries (1995, p: 45) exaggerates the scenario to the extent of stating that the “enterprises do not produce for the client; they produce to meet government regulations”. The research of Bowle (1960, cited in Ling, 2003) provides evidence to that restrictions imposed by regulations have been a hindrance to the construction innovation for a long time.

The construction industry is also known for conservatism; professionals cling to an accepted industry practice and norms in fulfilling client’s need; changes are taken as a threat, and slack resources are rarely permitted (Nam and Tatum, 1997). These statements were confirmed in the interviews conducted by Dulaimi (2005). In the interviews some Project Managers had expressed concerns that innovators who may go beyond established organisational policies and practices might trigger an increased risk on the project objectives. In this context, securing the support of project parties may become increasingly challenging. Many Project Managers have also referred to the very tight schedules, undue emphasis on cost-cutting measures, economic recession and lowest bidding practice that impeded their actual ability to innovate. Veshosky (1998) also received similar comments from the Project Managers. Further he observed very diverse opinions about innovation. Some Project Managers state that they don’t do innovation because it is against organisational and industrial culture. Whereas some Project Managers considered innovation as “sustainable competitive advantage”

The commitment from top management and the level of technical expertise have been evident as preconditions for successful innovation in construction (Nam and Tatum, 1997). Top executives in innovative organisations appear to assume responsibility actively for technological decision making and have sufficient technical expertise to do so. Nevertheless many managers, in particular high level managers, in construction industry appear to have a limited view concerning their roles in the innovation process. They no longer see themselves as engineers who actively make technical decisions; they claim that their roles as managers prevent them from being personally involved in engineering. The belief in the supremacy of management (including marketing, customer contact and management of R&D) over engineering appears common in design and construction (Nam and Tatum, 1997). However, the suggestion of Nam and Tatum (1997) that the construction should be managed by technically competent people is not always supported. Pries and Janszen (1995) identifies ‘engineer’s paradigm’ or strict technical focus as a barrier to innovation. Pries and Janszen (1995)’s study revealed that only 4% of the managers have a degree in economics or management subjects, while 51% are engineers, 2% have law degrees and the rest didn’t have any academic qualification at all. All of them were gradually promoted to the top management position which is perceived to be superior as Nam and Tatum (1997) implies. In the authors’ opinion this pattern of promotion had resulted in placing engineers and technicians in a dilemma between practicing there technical skills where they are good at, and performing managerial tasks where they lacks competence. Thus innovative ideas may not be managed prudently to gain expected results. In the following section it is further discussed how the innovation should be managed towards achieving the goals of the construction industry.

5 INNOVATION IMPLEMENTATION

The literature identifies two broad variables that govern the decision of innovation i.e. business environment and business strategy. Further, size of firm and its specialisation is also to be considered. The study conducted by (Seaden, 2001) on Canadian construction industry revealed that smaller firms being more risk averse, with lower intensity of use of innovative practices, whereas a greater percentage of larger firms reported adopting technological or business changes with significant impact on their business.. However Blayse and Manley (2004) contradict the lower intensity of innovation of smaller firms as the research conducted suggest approximately 75% of innovations emerged from smaller firms. Nevertheless, they further state that majority of innovations from the smaller firms are process innovations. Regardless to the intensity of innovation, smaller and particularly medium size firms indicated that such changes provided them with bigger competitive advantage when compared to large firms

One school of thought suggests that the innovation can only create competitive advantage when managed properly (Pries and Janszen, 1995). Another school of thought takes the view that innovation is unmanaged self organise processes originating due to collective motivation of individuals (McElroy, 2002). However the project based nature of construction industry and the participation of number of organisations with varying competencies make implications on both schools of thought. Fragmentation make initiation and implementation of innovation difficult and challenging (Kangari and Miyatake, 1997), therefore the management of innovation as well. The fragmentation gives rise to separate managerial roles from each participant who tries to integrate effort of the project toward innovation. Under this fragmentation, success in innovation relies on two major aspects: high intra-organisation motivation and good inter-organisational interaction (Dulaimi et al 2003) Construction typically has two separate systems integrators: one at the design stage and the other at the construction stage (Winch, 1998) which generally hinders the ability to innovate. Therefore need for the compatible management systems among stakeholders is emphasised to reinforce integration across construction value chain (Dulaimi, 2002). For an innovation to be successful, it would be necessary for firms to work together, erode boundaries between professions and for project-based firms to embrace new roles and develop new capabilities (Gann, 2000).

However, there is literature to show how these different integrators can facilitate innovation. Many researchers have stressed the importance of key individuals in the innovation process (Nam and Tatum, 1997). The Project Manager is often identified as a person who can focus the fragmented effort towards common goal. Dulaimi (2005) agues that the innovation at site is positively related to the championing behavior of the Project

Manager. Thus, Project Managers need to exhibit commitment in the innovation process by expending their energy, taking responsibility and reasonable amount of risk. Further positive relationships are established between Project Manager's level of education, size of project and innovativeness of Project Manager's problem solving style to the level of innovation at site (Dulaimi, 2005). Studies of Ling (2003) conducted on construction industry of Singapore shows that interest level of the main consultant when the innovation is being implemented plays a major role in convincing team members of the benefits of innovation.

Identification of key factors is important to manage innovation towards expected goals. Ling (2003) states that to improve the possibility of innovation, expected goals of the innovations should be clearly laid out to the team members, further maximisation of capabilities and commitment exerted at the management and project levels and minimisation of constraints and challenges are also important. Dulaimi et al (2003) agrees with Ling (2003) stating that an innovation may be successfully implemented in the project if effort is put into carrying the innovation through, and there are high expected goals, favourable results and high commitment.

Dulaimi et al (2003) emphasis the need of proper plan to implement innovation with regard to other participants. Organisations that are in pursuit of innovation can derived there plans based on existing models of innovation such as Incremental innovation, Modular innovation, Architectural innovation, System innovation and radical innovation (Slaughter, 1998). Eaton (2001) supports the view that innovation should be selected to suit the context of innovation. He proposes a model which consists of an ordered set of four epochs (factor condition epoch, investment condition epoch, innovation condition epoch, and wealth condition epoch) in which different types of innovation strategies are required. Eaten (2001) further identifies pattern that organisations moves through these epochs, and propose five typologies. A construction organisation in pursuit of innovation can decide on the best suited typology to choose based on epoch it is in.

6 CONCLUSION

Is construction innovative or not? There is literature, as summarised above, to suggest yes as well as no. In the support of innovativeness some argues that the unique nature of each project provides significant opportunity to innovate. Nevertheless, uniqueness is criticised as hindrance as it discourages expenditure on innovation or R&D. Similarly there are diverse views about use of innovation. Some professionals state that they don't do innovation because it is against organisational and industrial culture, whereas some considered innovation as "sustainable competitive advantage". In the authors opinion all these observations are governed by its own context, without reference to the context it is impossible to state which is right or wrong.

Regardless whether the construction industry is innovative or not; there are concerns over the lack of systematic diffusion of innovation through the industry. Previous research attributes lack of innovation not to the lack of capability, but to the absence of a coordinated effort to link market needs and innovative capacity. Productivity growth in construction is far below the national average. Number of firms engaged in product and/or process innovation in construction sector is lesser than other sectors. Further it was found out that construction firms are less open to the external environment and they tend to have poorly developed R&D, with low capacity to absorb ideas from external due to lack of focus of innovation in external sources. However, R&D cannot be considered as a direct measure of innovation despite positive correlation. There are number of occasions where innovation stemmed away from

R&D facilities. Unfortunately, due to limited official statistics regarding innovation, measures related to R&D is used to access innovativeness.

Structure of industry and constituent organisations affects the level of innovation. It was generally accepted principle that organisations that are relatively programmed and planned have more difficulties in innovating. The fragmented nature of industry, very tight schedules, undue emphasis on cost-cutting measures, economic recession and lowest bidding practice are criticised as a barrier to innovation,

There were concerns regarding the diffusion of benefits of innovation as well. Some research implies that the reluctance of clients to facilitate innovation may be due to the inappropriate diffusion of benefits. If the paying client is to take all the risk of the innovation while the benefit is targeted at the users (in a case of public building or apartment for rental etc) the client may suppress innovation. There is a possibility for this phenomenon to affect other team members as well.

Most researchers suggest the need to eliminate fragmentation to the point that is practical. There is a need for the compatible management systems among stakeholders and to improve the possibility of innovation, expected goals of the innovations should be clearly laid out to them

Finally authors conclude this paper by identifying diffusion of innovation, diffusion of knowledge regarding innovation, diffusion of innovation benefits within construction industry, organisational structures and cultures that promote innovation, management and coordination problems in innovation and measures to assess innovation as areas that requires further study to identify knowledge gaps to be researched in future.

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MEASURING PERFORMANCE AND THE IMPACT OF RESEARCH AND DEVELOPMENT IN CONSTRUCTION: RESEARCH METHODOLOGICAL PERSPECTIVES

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ABSTRACT: Research and innovation in construction industry have a significant role to play in performance improvement while providing benefits to the industry as well as to its stakeholders. However, it has been identified that the nature of Research and Development (R&D) work has become complex. Due to the rising cost, time and other resource constraints, much attention is paid on the successfulness of R&D and the managers are under pressure to monitor and improve the performance. In this context, the use of performance measurement (PM) systems benefits R&D organisations by evaluating the successfulness of related activities. Accordingly, this paper highlights the aspects which will be covered when designing a feasible research methodology for the study under consideration. The paper illustrates how the philosophical issues directed the use of case studies as the suitable research approach. The importance of case study design in gaining the maximum outcome from the research is also discussed.

Keywords- Case study, Research and development, Research methodology

1 INTRODUCTION

The main intention of any research is to add value to the accumulated knowledge through the means of identifying, investigating and producing solutions to an unsolved problem (Remenyi, 1998). The process of finding solutions to the research problem is "not a clear cut sequence of procedures followed by a neat pattern, but a messy interaction between the conceptual and empirical world" (Bechhofer, 1974, cited in Gill and Johnson, 2002, p: 3). Booth et al (2003, p: 5) also agree with this view state that "research follows crooked path, taking unexpected turns even looping back itself". Even though the research process is uncertain and risky, the appropriate research design would minimise the possibilities of any failures by identifying and forecasting any problems and pitfalls that the researcher may come across. Further more, such research design follows a procedure of work which determines the approaches, methods and strategies to be adopted during the study (Gittins, 1997). In addition to that, research design looks into the philosophical aspects of the research which intern helps to identify the overall research strategy (collecting, analysis, interpretation of data and drawing conclusions); evaluate various research methods and identify their limitations; increase the compatibility of research approaches and research techniques (Easterby-Smith et al, 2002).

This paper aims to outline the research design for a study based on identifying the impacts and influences of performance measurement (PM) towards research and development (R&D) activities within the construction process. Gill and Johnson (2002) state that there is no one best approach to research, but the approach is governed by number of variables. Further they argue that the "research methodology is a compromise between options in the light of tacit philosophical assumptions" (Gill and Johnson, 2002, p: 1). Accordingly, this paper discusses how the variables such as philosophical issues, nature of the research problem, resource constraints have led the way to select the appropriate research approach and techniques. The first section of the paper presents the background to the study followed by addressing the need of PM to construction R&D activities. Next, the research methodological aspects of this study is discussed with particular reference to establishing the philosophical stand for the study, selection and design of the case study research approach, and data collection and analysing techniques. Finally the conclusion of the paper is presented.

2 BACKGROUND

The contribution from R&D for the development of the construction industry is immense as it leads the path to enhance the effectiveness of construction organisations and to raise the international competitiveness through technological advances and managerial developments (Hampson and Brandon, 2004; Gustavsson et al, 1999; Ernst, 1998). To remain competitive in the market, organisations should make sure their customer needs are properly met, and future demands of the customers are properly addressed. In this respect R&D acts as a valuable "input" for the development of the organisations (Business Link, 2005).

"R&D have become more complex, as they involve many parties and have a wide range of, often interrelated, technological, market and organisational options to choose from under constrained conditions" (Kerssens-van Drongelen et al , 2000, p:113). R&D activities require many resources ranging from human to technical which require proper utilisation. The accountability for these resources is being questioned by the management as well as by the shareholders (Wood, 1998; Nixon, 1998). As a result of that, a growing interest can be identified in managing, controlling and monitoring the R&D activities (Bone and Saxon, 2000). In this context, the use of PM mechanisms benefits the R&D activities by evaluating the successfulness of their activities.

3 NEED OF PERFORMANCE MEASUREMENT TO RESEARCH AND DEVELOPMENT IN CONSTRUCTION ORGANISATIONS

To get involved in high quality research, construction R&D requires resources such as necessary equipment, skilled individuals and funds (Seaden, 2002). Like in any other investment, the construction R&D investors expect reasonable returns from their investments (Seaden, 2002; Courtney, 1999). A low level of investment can be identified for UK construction R&D (DTI, 2005). One of the main reasons for the low investment is "improper reporting of R&D expenses" (Seaden and Manseau, 2001, p: 186). Therefore, Courtney (1999) argues that R&D returns should be "more calculable" by means of establishing certain and visible relationships between the investments and output of construction R&D activities. This can be done by implementing a PM system within the construction R&D. By doing so, proper utilisation of investments and clear links between investments and potential income for the investors can be identified.

Identifying new ways to access technical solutions and creating new and improved products in the construction industry requires not only sufficient investments, but also the commitment and time of the employees (Building Research Establishment, 2005). Thus, the time devoted for construction R&D should be justifiable. In addition, it is equally important to show that the results obtained through construction R&D activities are properly aligned with the expected objectives. This has demanded proper controlling and monitoring mechanisms, and a way to assess the R&D goals against the outcomes. This can be achieved by implementing a PM system within the construction R&D work as such a system continuously evaluate the successfulness of the activities and identifies the gaps between the goals and expected outcomes.

Cohen and Levinthal (1989, 1990) argue that R&D activities help to develop new information/ knowledge as well as improve the ability of the organisation's absorptive capacity. The absorptive capacity is highly dependent on the internal capabilities of the organisation such as availability of qualified staff, the nature of internal and external communication, coordination and feedback mechanisms (Cohendet and Steinmueller, 2000; Steinmueller, 2000). Therefore, the management of internal R&D capabilities is essential for effective and efficient R&D activities. Gann (2001) states that most of the construction R&D organisations do not have the required internal R&D capabilities. Further, Dulaimi et al (2002) recommend that the construction R&D activities should be coordinated to gain the maximum outcome. They emphasise the ability to develop superior products and services is significantly influenced by the level of cooperation between the parties involved within the process. The implementation of PM system increases the communication, coordination, and feedback mechanisms and directs the employees towards the common goals (Martinez, 2005; Neely et al, 2002). Thus, a PM system within construction R&D will improve the aforementioned internal capabilities and would generate successful results.

The need for training, participation in seminars, conferences has been identified to increase the skills and knowledge of people involved in construction R&D activities (Dulaimi et al, 2002). A properly designed PM system identifies such needs by looking into whether the R&D process is supported with the qualified people that are needed. Further, PM helps to control, monitor and allocate the organisational resources (Melnyk et al, 2004; Love and Holt, 2000). Accordingly, by implementing a PM system, construction R&D process can properly handle the resources which they are accountable for.

This section identified the important role PM plays within construction R&D. However, the concept of PM within the construction R&D is not adequately exploited. Therefore, this study is aimed at addressing the gap in R&D within the construction sector with particular reference to its PM application. Section below presents the research problem, aim and objectives pertaining to this study. Following research problem is formulated to address and reflect this need.

3.1 The research problem, aim and objectives

The following research problem is derived form the literature review which reflects the need of addressing PM within construction R&D.

Research and development has been identified as one of the main drivers for the development of the construction industry. For the success of R&D work, significant amount of resources such as money, time, and commitment of the people are being spent. But, whether these resources are utilised to their maximum capacity is in doubt. Further, it is a question whether the strategies, aims, and objectives of construction R&D process are properly met.

The aim of this study is to explore the applications of R&D within construction and to evaluate the influence of PM towards construction R&D. The following specific objectives have been formulated to address this aim:

- to identify the importance of R&D in the construction industry;
- to identify the current status of construction R&D;
- to determine the critical success factors for construction R&D process;
- to evaluate the importance of R&D performance measurement in construction R&D process;
- to develop a R&D performance measurement framework that enable the management to assess the successfulness of R&D process.

To address this research problem while fulfilling the aim and objectives, a mechanism has to be developed within which the research can be built upon. According to Nachmias and Nachmias (1996), a research methodology identifies the explicit rules and procedures which the research can be based upon. Accordingly, the section below discusses the development of suitable research methodology for this study.

4 RESEARCH METHODOLOGY

Research methodology is a procedural framework within which the research is constructed (Remenyi et al, 1998). Accordingly the "nested approach" presented by Kagioglou et al (1998) is used for this research. Kagioglou et al (1998) presents the research methodology as a hierarchical model where the research techniques are under the research approaches and the research approaches are under research philosophy (Figure 1). Within this "nested" model, research philosophy which is at the outer ring "guides and energises the inner research approaches and research techniques" while ensuring that the chosen research philosophy, approach, and techniques are compatible with each other (Kagioglou et al, 1998). The following sections further describe the research philosophy, research approach and research techniques pertaining to this study.

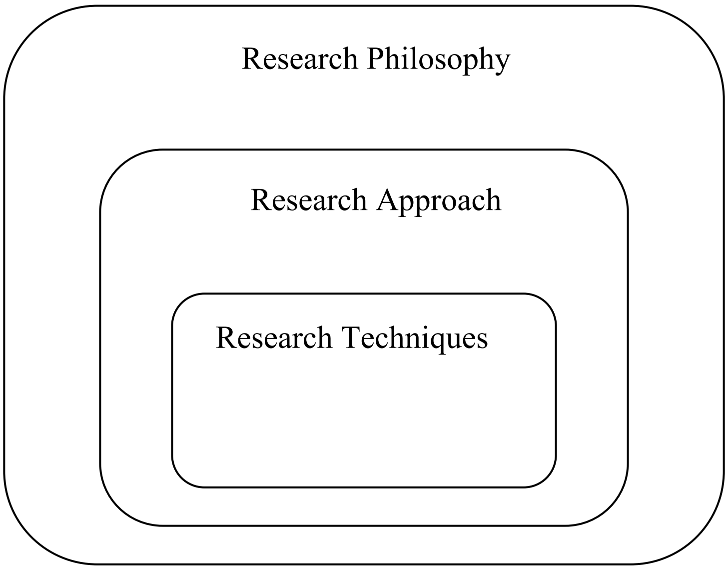

Figure 1: Nested approach

4.1 Research Philosophy

According to Guba and Lincoln (1994) and Healy and Perry (2000), a paradigm consists of fundamental assumptions in relation to the "world", the place of the individual in it, and the relationship between the world and the researcher. Researchers often operate in such a "paradigm" where the researcher's activities are guided by philosophies and methods (Kuhn, 1962). Easterby-Smith et al (2002) identifies research philosophies as the base for effective research design and argues that failure to adhere to philosophical issues can affect the quality of the research negatively. Easterby-Smith et al (2002) point out three reasons to highlight the importance of philosophical issues in research: firstly the research philosophies help to clarify the research design; secondly the researcher can recognise which designs will work and which will not work and thirdly, the knowledge about research philosophy will help to identify and create designs which are out side the researcher's past experience. In addition to that, research philosophies guide the researcher to consider about research constraints of different subject or knowledge structures (Easterby-Smith et al, 2002).

Epistemology, ontology, and axiology are the three assumptions that are within the research philosophy (Collins, 1998; Guba and Lincoln, 1994) which can be further seen in Table I.

Table I: Assumptions of research philosophy (Sexton, 2003)

Epistemology (The how?)	General set of assumptions about how we acquire and accept knowledge about the world
Ontology (The what?)	Assumptions that we make about the nature of reality
Axiology (The why?)	Assumptions about the nature of values and the foundation of value judgments

4.1.1 Epistemology

Under the epistemological undertakings, Easterby-Smith et al (2002) identify two traditions of philosophies, "positivism," and "social constructionism (interpretivism)". They recognise that these philosophies can be placed in two extreme ends of continuum where "in the red corner is constructionism and the blue corner is the positivism" (Easterby-Smith et al, 2002, p: 28). Positivists argue that "the world exists externally and that its properties should be measured through objective measures rather than being inferred subjectively through sensation, reflection or intuition" (Easterby-Smith et al, 2002, p: 28). Moreover, positivist searches for causal explanations and fundamental laws and use the deductive approach for the research (Easterby-Smith et al 2002; Gill and Johnson, 2002; Remenyi, 1998). Conversely according to social constructionism, reality is determined by people rather than by objective and exterior factors (Easterby-Smith et al, 2002) where the social scientist should welcome and appreciate the different views and meanings that people place upon their experiences. Comparisons of the two epistemological paradigms are presentment in Table II.

Table II: Contrasting implications of positivism and social constructionism (Easterby-Smith et al, 2002)

	Positivism	**Social Constructionism**
The observer	Must be independent	Is part of what is being observed
Human Interest	Should be irrelevant	Are the main drivers of the science
Explanations	Must demonstrate causality	Aim to increase general understanding of the situation
Research progress through	Hypotheses and deduction	Gathering rich data from which ideas are induced
Concepts	Need to be operationalised so that they can be measured	Should incorporate stakeholder perspectives
Units of analysis	Should be reduced to the simplest terms	May include the complexity of 'whole' situation
Generalisation through	Statistical probability	Theoretical abstraction
Sampling requires	Large numbers selected randomly	Small numbers of cases chosen for specific reasons

Accordingly, “social constructionism” can be identified as the most appropriate epistemological undertaking for this research due to many reasons. First and foremost, this study requires the researcher to be a part of the environment and interaction is needed within the environment to identify the different views of people and to interpret them (For instance, the views about the importance of R&D within the construction sector, factors which is needed for the successful attainment of R&D work, suitable PM metrics and methods for R&D activities). Further, it requires appropriate understanding of the context and the process of R&D work, and to acquire knowledge by the use of reasoning, intuition, or perception. Thus the researcher cannot be independent from the environment under consideration as a positivist. Further, the research requires in depth analysis to gather detailed facts about the research environment. This requires the selection of a small number of samples, which is facilitated by the social constructionism stance. According to the above reasons, it can be argued that social constructionism is preferred over positivism stance for this research.

4.1.2 Ontology

Ontological assumption or the assumptions that are made about the reality of the nature is the other important aspect within the research philosophy. The ontological assumption is based on the external world is having a predetermined nature and structure is known as “realism” (Johnson and Duberly, 2000) and the assumption based on the external world is not having a pre determined nature or structure is known as the “idealism” (Gummesson, 1991).

According to Burrel and Morgan (1979, cited in Gill and Johnson, 2002) Nomothetic (realist) methodologies base the research on systematic protocols and techniques which is focus on testing hypothesis. In contrast, Ideographic (idealism) methodologies emphasise analysis of the subjective matters by getting involved in the everyday activities (Burrel and Morgan, 1979, cited in Gill and Johnson, 2002).

Gill and Johnson (2002) presents a comparison between the Nomothetic (realist) and Ideographic (idealism) as in Table III.

Table III: A comparison of Nomothetic (realism) and Ideographic (idealism) methodologies

	Nomothetic	Ideographic
1	Deduction	Induction
2	Explanation via analysis of causal relationships	Explanation of subject meaning systems and explanation by understanding
3	Generation and use of quantitative data	Generation and use of qualitative data
4	Use of various controls, physical or statistical, so as to allow the testing of hypothesis	Commitment to research in everyday settings, to allow access to and minimise reactivity among subjects of research
5	Highly structured research methodologies to ensure replicability of above 1,2,3 and 4	Minimise structure to ensure above 2,3 and 4

This research takes the “idealism” stance in terms of the ontological undertakings. As discussed earlier, the researcher will be analysing the subject matters by being a part of the environment. Due to this reason it self, this research is more towards the idealism stance. In addition, since the research requires developing explanations and theories form observations, the idealism stance will be more suitable. Further, the research environment is not expected to control and simplify with assumptions as in deductive research methodologies and the free flow of ideas, perceptions will be encouraged and studied. Hence, it can be seen that this research favour idealism than the realism stance.

4.1.3 Axiology

Within the research philosophy, axiology is the third aspect that has to be visited. Axiology concerns assumptions about the value that the researcher attaches to the knowledge. Social constructionism suggests that the research is value-laden (Healy and Perry, 2000; Silverman, 1998) whereas the positivism suggests the researcher should retain a value free view (Susman and Evered, 1978). Accordingly, in the value free research, the choice of what to study and how to study is determined by objective criteria and in Value laden research the choice is determined by human beliefs and experiences (Easterby-Smith et al, 2002).

In terms of the axiological undertakings, the research in question takes the value laden stance. Due to the exploratory nature of this research, it requires people to come up with different views. Accordingly, this research would take the Social constructionism stance in terms of the epistemological undertakings. Further, in terms of the Ontological and Axiological undertakings, the research will take the Idealism and Value laden stances respectively (

Figure 2).

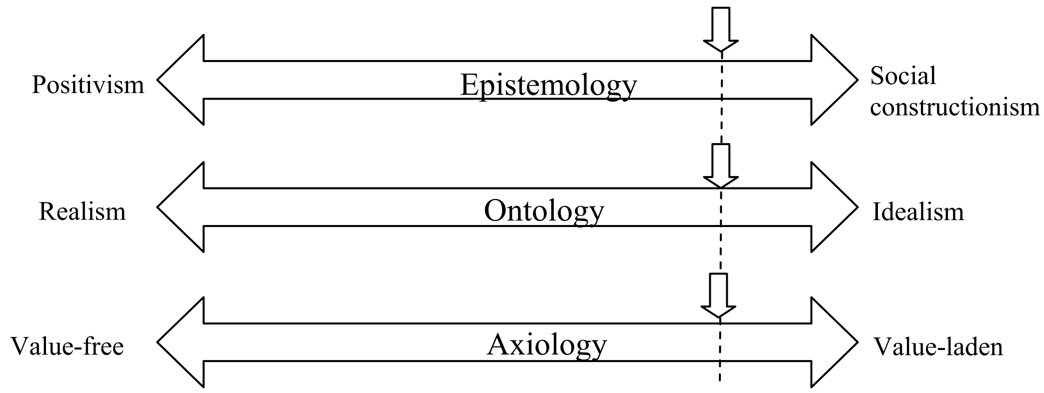

Figure 2: Research philosophy continuum (Collins, 1998)

4.2 Research Approach

There are number of different research approaches where ones research can be based upon (Yin, 2003; Gill and Johnson, 2002).

shows how the research approaches can be positioned within the epistemological and ontological continuums. It can be seen that how experiments and surveys are governed by positivist and realist stances where as case studies, action research and ethnographic approaches are towards social constructionism and idealism stances.

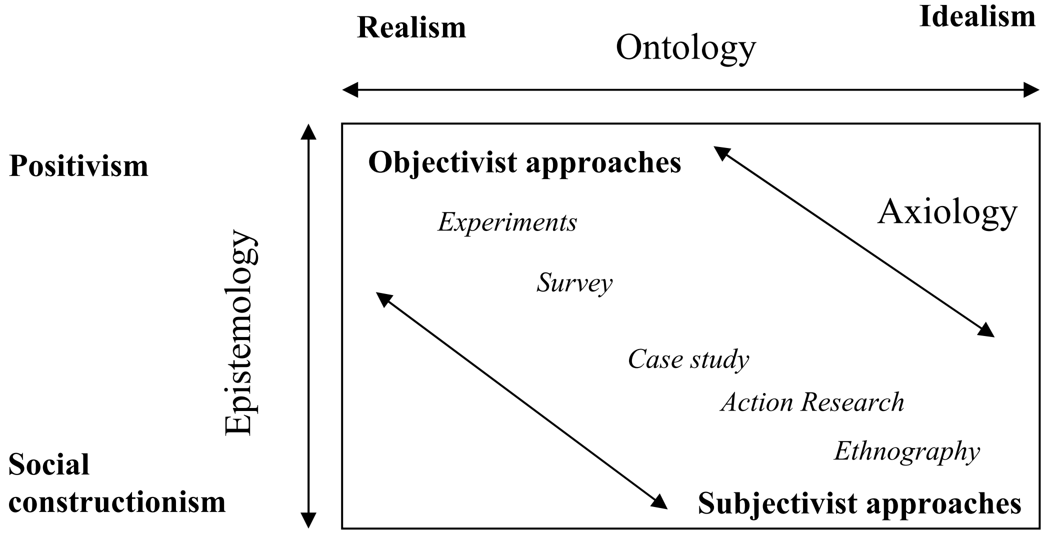

Figure 3: Research approaches (Sexton, 2003)

Yin (2003) identifies three conditions which have to be considered when selecting the appropriate research approach:

- the type of research question posed;
- the extent of control an investigator has over the actual behavioural events;
- the degree of focus on contemporary event.

According to

, experiments and surveys take the positivism and realism positions in terms of the epistemological and ontological undertakings respectively. Since this research takes the social constructionism and idealism with regard to the philosophical stances, use of experiments and surveys are unjustifiable. Experiments and surveys are conducted under controlled environments where in the former situation the phenomenon and the context is separated and in the latter situation investigating the context is difficult due to the limited number of variables set out (Yin, 2003).

Since this research falls under the social constructionism and idealism stances, the researcher has to make a choice between ethnography, action research, or case studies. According to Harvey and Myers (1995), the Ethnography approach provides the researchers insights into the beliefs and values of human, social, and organisational aspects of socio-cultural phenomenon. Further, Ethnography research takes a considerable time period (Burns, 2000; Van Maanen, 1982). In action research, the researcher will be a part of the environment under study, tries to solve practical problems (Waser and Johns, 2003; McNiff and Whitehead, 2002; Robson, 2002), and tries to influence and change the attitudes and behaviours of the participants (Waser and Johns, 2003).

Yin (1994, p: 13), describes a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident". Case studies are carried out in a way that it incorporates the views of the "actors" in the case under observation (Zonabend, 1992). Due to the open ended inquiry used in case studies, it is suitable to built theory and generate hypothesis (Amaratunga et al, 2002). Further, case studies provide the opportunity of dealing with full variety of evidence such as documents, interviews, and observations (Yin, 2003).

The research under consideration does not intend to influence or change the attitudes or procedures of the participants or the environment. Further, it does not intend to study behavioural patterns or physiology of the participants as in the case of ethnographical studies. Hence, the use of case studies is preferred over action research and ethnography. The case study approach is therefore suitable for this research to explore the R&D within the context of construction industry and its PM aspects within the case study organisations. The case study approach too provides the opportunity of carrying out an in depth study about the links between R&D and its performance measurement.

This research has the characteristics of both the exploratory and explanatory case studies. According to Yin (2003), the nature of the research questions posed has an effect on the research approach. Yin argues that "how" "why" questions favour the use of case studies and the use of "what" question is suitable for the exploratory type of researches. Research under consideration has a combination of "how" "why" questions coupled with "what" questions. Following reasons could be listed as the key points for the selection of case study methodology for this research:

- does not intend to control/ manipulate the environment under examination;
- does not intend to interfere the attitudes, perceptions or the procedures of the environment (as in the case of action research);
- analysing contemporary events;
- requires to do an in depth study on the selected environment. Thus it will be advantages to rely on multiple sources of evidence and the selection of a small sample to allow an in depth study;
- requires to explore and analyse the "real life" context of PM concept within construction R&D.

Above section described the selection of the most appropriate research approach. Case studies were identified as the suitable research approach. Accordingly, the following section describes the design of the case study.

4.2.1 Case study design

A *research design* has been identified as the "logic that links the data to be collected (and the conclusions to be drawn) to the initial questions of study" (Yin, 2003, p: 19). Nachmias and Nachmias (1996) argue that the research design guides the researcher to collect, analyse and interpret the observations he made. There are four conditions where the development of a case study needs to be satisfied. The way the research under consideration satisfies these conditions are presented in Table 5.

Table 5: Validity and reliability of case studies (adopted from Yin, 2003)

Test	Description	The method of achieving	Stage
Construct validity	Establishing correct operational measures for the concepts being studied	Use of multiple sources of evidence Key informants review the draft case study	Data collection Composition
Internal validity	Establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguish from spurious relationships	Do pattern matching	Data analysis
External validity	Establishing a domain to which the study's finding can be generalised	Use replication logic	Research design
Reliability	Demonstrating that the operations of the study (such as the data collection procedure) can be repeated, with the same results	Use case study protocol Consistent interview guidelines Develop case study data base	Data collection Data collection Data collection

Four major types of case study designs exist according to the 2 x 2 matrix suggested by Yin (2003). They are single holistic, multiple holistic, single embedded, and multiple embedded. The use of single case studies is preferred when the study represents a critical case, extreme or a unique case, representative or typical case, revelatory case or a longitudinal case (Yin, 2003). The research in question does not fall under these categories, thus multiple case studies are preferred over a single case study. Herriott and Firestone (1983) argue that the evidence gathered form multiple cases studies are often considered as more compelling which resulted in a healthier and a strong study. Sampling logic will not be used to select the case studies i.e. to select a sample from the pool of respondents/whole population (like in the situation of surveys). Thus, analytical generalisation is preferred over the statistical generalisation where the findings will not reflect the whole population. However, it is intended to claim literal replication by comparing the findings from the multiple case studies.

The approach to case studies in this research involves theory building and verification. That is to build up research questions, hypothesis, propositions via the literature review and verification of them through multiple data collection methods, analysing the data within and across case studies and finally reaching at the conclusions. The section above discussed how the case studies will be designed to facilitate the theory verification process and explained the methods that will be used to ensure the reliability and validity of the research. The following section will highlight the research techniques.

4.3 Research Techniques

As discussed in section 4.1 this research takes the *social constructionism, idealism* and *value laden* stances in terms of the research philosophy. These philosophical stances together with the characteristics of the research under consideration directed the use of *case studies* research approach which was discussed in section 4.2. Having identifying the research philosophy and research approach, the next step is to determine the appropriate research techniques for the study. Accordingly, below section will look into this.

4.3.1 Data collection

Yin (2003) identifies three principles of data collection;

- use of multiple evidence
- creating a case study data base
- maintaining a chain of evidence

Yin (2003) further identifies six main sources of evidence which can be used for case study data collection procedure. They are documents, archival records, interviews, direct observations, participant observations, and physical artifacts. Accordingly, for this research, review of documents, semi structured interviews, and direct observation will be used to understand the context of R&D and the applicability of PM concept within the R&D process under observation. When the same results are obtained through different mechanisms, the confidence of the results is high (Stoecker, 1991) as the weaknesses of one method will be compensated by the strengths of another method. Thus results obtained from this research will be more convincing and accurate, increasing the "construct validity" of the research.

In addition to the use of multiple sources, a case study data base will be created which consists of case study notes (resulted from the interviews, observations and documents reviews), documents related to the case study, tabular material obtained from the case study or created from the researcher, narratives produced by the researcher. The data base will be used to store and retrieve the aforementioned sources of evidence in a presentable manner. Further, during the data collection stage, it is expected to use case study protocol which consist of interview procedures, general rules that will be followed during the case studies. In addition to that, consistent interview guidelines are expected to use. The use of case study data base, case study protocol and consistent interview guidelines will increase the "reliability" of the research.

Having discussed the data collection methods, section below will discuss the data analysing methods of this research.

4.3.2 Data analysis

It is important to have a data analysing strategy as it will guide the researcher to select the appropriate data analysing tools, to make sure that the evidence is treated well, to generate sound and convincing analytical conclusions while discarding the alternative interpretations (Yin, 2003). The objectives, research questions, and hypothesis of this study are developed through the identification of theoretical propositions. Accordingly, this study is intended to rely on the theoretical propositions. This will focus the study more by guiding to identify the relevant data while avoiding the other.

Within case and cross case data analysis is expected to carry out during the data analysing stage by using Pattern matching; a technique which compares the theories and observed data (Yin, 1994; Eisenhardt, 1989). Accordingly, this research will match the data gathered from semi structured interviews and through observations with the theoretically predicted data. Content analysis will be used to code the textual data gathered from the semi structured interviews. Content analysis is a method that compresses many words into fewer content categories (Krippendorff, 1980). To display and identify the relationships of concepts derived from the interviews and observations, cognitive mapping technique will be used. This is a method that enables recording qualitative data in a structured manner to enhance the understanding and analysis of data (Ackermann et al, 1992). To facilitate the data analysis process, computer software packages are expected to use namely NVivo and Decision Explorer for content analysis and cognitive mapping respectively.

Arriving at conclusions for the study involves interpretation and drawing meanings from the displayed data (Miles and Huberman, 1994). The data from this research will be summarised and conclusions will be drawn which will justify or falsify the research hypothesis of the research.

5 CONCLUSION

This paper identified the need of developing a research methodology in fulfilling the aims and objectives of a study and thereby addressing the research problem. The investigation of PM concept within construction R&D process demanded the social constructionism, idealism and value laden stances in terms of the research philosophy. The aforementioned philosophical understandings and need of carrying out an in-depth analysis without interfering to the research environment led the way to select case study as the most appropriate research approach. It can be concluded that the proper understanding of the philosophical issues followed by a clear definition and design of research strategy are essential elements in developing successful research. The philosophical understanding of the research ensures the compatibility and consistency between research philosophy, approach and techniques while the clear definition and design of research strategy would generate unbiased and more convincing research outcomes.

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