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W096 - ARCHITECTURAL MANAGEMENT

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W104 - OPEN BUILDING IMPLEMENTATION

PAPERS AND POSTGRADUATE PAPERS FROM THE SPECIAL TRACK
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W096 - ARCHITECTURAL MANAGEMENT

PAPERS AND POSTGRADUATE PAPERS FROM THE SPECIAL TRACK

Task Group TG63 aims to stimulate ideas for future research by exploring the range of perspectives from which the construction industry is able to contribute towards improved resilience to disasters and by facilitating the dissemination of the existing knowledgebase. To this effect, the Task Group addresses the following objectives: Define a more expansive view of the construction lifecycle of infrastructure projects that encompasses the need to anticipate, assess, prevent, prepare, respond and recover from disasters, Create a portal for sharing and disseminating knowledge about resilience and disasters for land, property and construction professionals, Enhance knowledge and raise awareness among practitioners and researchers, of the linkage between good planning, design, construction and operation, and disaster prevention and resilience, Identify future research and work requirements relating to construction and resilience, Arrange symposia and workshops to facilitate wider discussions of relevant research pertaining to the subject area, and encourage collaboration and joint projects among members and other interested parties.

W104 - OPEN BUILDING IMPLEMENTATION

POSTGRADUATE PAPER FROM THE SPECIAL TRACK

The objectives of the Working Commission are: to foster, encourage and promote research and development in the application of Open Building principles in the design and construction of neighborhoods and buildings and in the education of architects and allied professionals; to encourage the use of Open Building tools and methods, through the documentation of exemplary case studies of open building implementation around the world, with a particular focus on housing and health care facilities; and to organise international conferences and workshops in such activities and to promote the communication of these activities and their results. W104 is aiming at improving the built environment by recognising two principal realities: designing is distributed and thus tools of cooperation are needed to streamline and support sound task partitioning; and the built environment operates on levels of intervention, recognising and formulating of which makes possible a more effective process of adaptation and change while assuring long-term value and environmental coherence.
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Abstract

Requirements are the basis for every project, defining what the stakeholders need from it and also what the end product must meet in order to satisfy that need. Requirements, therefore, form the basis for project planning, risk management, acceptance testing, trade off and change control. They are the essential elements of the briefing, design and construction stages of any development projects. However, past research studies overlook the lack of identification, management and traceability of the requirements during the life cycle of construction projects in the AEC industry. In addition, research on Requirements Management (RsM) in the AEC industry is very limited in comparison with studies on Requirements Engineering (RsE) in the system and software world. The aim of this paper is to investigate the need for and focus of research on Requirements Management (RsM) in the AEC industry. A comprehensive literature review on RsE/RsM in the system and software engineering as well as in the AEC industry has been conducted. The findings, imperatives and challenges for Requirements Management are discussed in this paper. We propose a framework for future research directions on Requirements Management in the domain of construction project management. This research is of significant value to professionals and academics in the AEC industry for improvement of RsM processes to achieve successful delivery of construction projects.

Keywords: construction, project management, requirements engineering, requirements management, AEC industry
1. Introduction

Facing increased competition and greater project complexity, architectural, engineering and construction (AEC) firms are seeking ways to gain client satisfaction and improve project performance. Requirements are the basis for every project, defining what the stakeholders need from it and also what the end product must meet in order to satisfy that need. Requirements, therefore, form the basis for project planning, risk management, acceptance testing, trade off and change control (Hull et al., 2005). They are the essential elements of the briefing process as well as the whole development process. The briefing process in construction is the process through which a client informs others of its needs, aspirations and desires for a project (CIB, 1997). Previous research reveals that there is a lack of identification, management and traceability of the requirements during the project development process in construction projects (Kelly et al., 1992; Barrett and Stanley, 1999; Kamara and Anumba, 2001; Yu et al., 2005, Arayici et al, 2006, Chan & Liu, 2007). The management of requirements in the whole development process in the AEC industry require professionalism and good communications among stakeholders; innovative use of IT as a facilitating platform; and a collaborative mindset and objective supporting system for decision making, but many of these are inadequate (Kamara and Anumba, 2001, Chan et al., 2005, Chan & Yu, 2005, Hull et al., 2005, Arayici et al., 2006, Chan et al., 2007).

Research on Requirements Management (RsM) in the construction industry is very limited in comparison with its counterpart on Requirements Engineering (RsE) in the system and software world. There is already plenty of developed theory and practice in RsE from which construction researchers could learn. The aim of paper is to investigate the need for research on Requirements Management (RsM) in the AEC industry. This aim is achieved through, first, a comprehensive literature review on RsE/RsM in the domain of systems and software engineering as well as the AEC. Then follows analysis and discussion of the findings, imperatives and challenges for Requirements Management in the AEC industry. The paper concludes with a synthesis of a vision for future research on Requirements Management. This research is of significant value to professionals and academics in the construction industry for improvement of RsM processes to achieve successful delivery of construction projects.

2. What are requirements?

A requirement is a statement identifying capability, physical characteristics, or quality factor that bounds a product or process need for which solution will be pursued. ‘Requirements’ in the computer engineering world are defined during the early stages of a system development as a specification of what should be implemented (Sommerville and Sawyer, 1997). They are descriptions of how the system should behave, concerning application domain information, constraints on the system’s operation, or specifications of a system property or attribute (Kotonya and Sommerville, 1998). They may be a constraint on the development process of the system. For example:, (1) the system must ensure that personal information is never made available without authorisation or (2) the word processor must include a spell check and correction command. Good requirements are complete, unambiguous, consistent, feasible, solution neutral, traceable, and necessary. Requirements should not
be used for the wrong purpose, be concise, correct, and verifiable (Kamara and Anumba, 2000; Young, 2004; Zielczynski, 2008). The importance of good requirements and the underlying dynamic nature of the process mean that it is necessary to identify the different types of the requirements in a project.

In the architecture, engineering and construction (AEC) industry, there are different types of project requirements. They are (Kamara, et al., 2002):

1. **Client requirements** – Requirements of the client which describe the facility that satisfies its business need. These incorporate user requirements, those of other interest groups (stakeholders) and the lifecycle requirements for operating, maintaining and disposing of the facility.

2. **Site requirements** – These describe the characteristics of the site on which the facility is to be built (e.g. ground conditions, existing services, history, etc.)

3. **Environmental requirements** – These describe the immediate environmental (e.g. climatic factors, neighbourhood, environmental conservation, etc.) surrounding the proposed site for the facility.

4. **Regulatory requirements** – Building, planning, health and safety regulations, and other legal requirements that influence the acquisition, existence, operation and demolition of the facility.

5. **Design requirements** – Requirements for design, which are a translation of the client needs, site and environmental requirements.

6. **Construction requirements** – Requirements for actual construction, which derive from the design activity.

The interrelationship between these project requirements is illustrated in Figure 1. Client requirements combine with site, environmental and regulatory requirements to produce design requirements, which, in turn, generate construction requirements. Other project requirements are generated from the business need of the client that is to be satisfied by the proposed facility. The end product of the building construction, the building, should fulfil the needs and requirements of all stakeholders in a comprehensive manner. This is the ultimate target of Requirement Engineering in AEC industry.
A requirement is a necessary attribute in a product or system, a statement that identifies a capability, characteristic, or quality factor of a product or system in order for it to have value and utility to a client or user (Young, 2004). Requirements are important because they provide the basis for all of the development work that follows. In the AEC industry, once the requirements are set, developers initiate the other technical work: design, tendering, construction, commissioning and operation. The practice of Requirements Management is critical to the successful delivery of a construction project.

3. **What is requirements Engineering/Management?**

The requirements problems have been existed for a long time. In their 1976 empirical study, Bell and Thayer observed that inadequate, incomplete, inconsistent or ambiguous requirements are numerous and have a critical impact on the quality of the resulting software. Noting this for different kinds of projects, they concluded that ‘the requirements for a system do not arise naturally; instead they need to be engineered and have continuing review and revision’ (Lamsweerde, 2009). Some 20 year later, different surveys over a wide variety of organizations and projects in the United States and in Europe have confirmed the requirements problems on a much larger scale. Poor requirements have been consistently recognized to be the major cause of software problems such as cost overruns, delivery delays, and failure to meet expectations of degradations in the environment controlled by the software.

Numerous initiatives and actions have been taken to address the requirement problem. Process improvement models, standard and quality norms have put better requirements engineering practices in the foreground. An active research community has emerged with dedicated conferences, workshops, working groups, networks and journals. Requirements engineering courses have become integral parts of software engineering curricula. Today Requirements Engineering has become inescapable for System and Software Engineering. It has been invented to cover all of the activities involved in discovering, documenting, and maintaining a set of requirements for a computer-based system.
The use of the term ‘engineering’ implies that systematic and repeatable techniques should be used to ensure that system requirements are complete, consistent, relevant, etc. Requirements Engineering is also about management and hence issues in relation to requirements and management blend to show how requirements can be used to manage systems development. The main purpose of Requirements Engineering is to create better requirements and to manage these requirements.

Requirement management is the process of managing changes to the system requirements. Requirements for a system always change to reflect the changing needs of system stakeholders, changes in the environment in which the system is to be installed, changes in the business which plans to install the system, changes in laws and regulations, etc (Kotonya and Sommerville, 1998). These changes have to be managed to ensure that they make economic sense and contribute to the business needs of the client. The technical feasibility of change proposals must be assessed and it must be possible to make the changes within budget and schedule.

The requirements management process ensures that we know what the client wants and that the design solution and the end product efficiently meet these requirements. The end product should fulfill the needs of all stakeholders in a comprehensive and logical manner. In order to attain this, the client requirements need to be identified and captured. This is the first target of requirements engineering. Since it is impossible to satisfy all needs of all stakeholders for various reasons, the second target of requirements engineering is to put the different client requirements together. When requirements of the various stakeholders contradict, it is difficult to judge whose need is more important than others. Robertson and Robertson (2006) suggested that the ranking of stakeholders’ opinion is based on the power, interest and proximity of the stakeholder. This may be the third target of requirements engineering. In addition, the compliance of design with the requirements should be verified constantly during the project. Finally, it is necessary to ensure the final product complies with the requirements of the client.

4. **Imperatives for requirements management in the AEC**

The dominant storyline in the literature of the construction industry exhorts the adoption of RsM with reference to a number of longstanding problems that are common in the AEC industry (Fernie, et al., 2003): failure to deliver projects within budget; late delivery of projects; failure to consider project decisions from a whole life cycle perspective; and poor customer satisfaction. As concluded in the Latham Report (Great Britain, Latham 1994), “more effort is required to understand client needs”. The report by the Hong Kong Construction Industry Review Committee (2001) has also recommended clients to “set out the requirements of their project clearly, systematically and comprehensively.”

Client requirements are the foundation for most all development projects. They are like an architect’s plans for a building: If the plans are wrong, the builders will construct the wrong building. However, an architect’s plans can only be correct if he has gone to the trouble of finding out exactly what the building owner needs, and the building’s intended use (Robertson and Robertson, 2005).
The first job of client requirements is to show what results clients need, and these must be documented. Thereafter, they will almost certainly be changed during the development process of the project. Moreover, every stakeholder may have different views and interpretations of the project’s original scope and objectives. All the stakeholders in a project, whether users or not, have requirements. The requirements allow the stakeholders a chance to say what they need and want and to represent these different viewpoints.

Writing down each requirement lets the project participants check that the building, as built, does what it should: they can check each part of the design and each function separately. From the developers’ viewpoint, this translates to what the designed building has to do. In addition, from the development project manager’s point of view, a clear requirement means that progress can be measured and areas needing attention can be identified. Everyone can be confident that the project is on track when it comes to meeting the client because they can see how much of the job is done already, and how well it has gone so far.

From the engineer’s point of view, a requirement is both something to be tested, and a source of acceptance criteria. Meeting these criteria provides evidence that a product does what it should. Good, sharp acceptance criteria come naturally from precise and well-organized requirement statements.

The proper application of Requirements Management to the AEC industry will help to integrate the project requirements into the design process and ensure the final product meets these requirements. It will not only elicit the true needs of the client and create a good brief in the briefing process but also allow the requirements to be recorded and traced back systematically during the project cycle for change management and performance assessment of the final building. Traceability of requirements can contribute to the following benefits (Hull et al., 2005):

- greater confidence in meeting objectives
- ability to access the impact of change
- improved accountability of subordinate organisations
- ability to track progress
- ability to balance cost against benefit

5. Challenges of requirements management in AEC

The challenge in writing requirements is mainly to communicate reliably and adequately between groups of project stakeholders who may never meet, and who have quite different viewpoints. For example, it may be difficult for the sub-contractors to meet end-users: their direct boss is the main
contractor of the construction projects. The problems of RsM may be as follows (Alexander and Stevens, 2002):

1. Gaps between people - There are various groups of stakeholders who need to communicate well to make a new project a success. In the construction industry, there are bound to be gaps between developers and marketing managers, users and developers, project participants and clients, designers and contractors, contractors and sub-contractors.

2. Time to work out a good structure – Getting the requirements structured correctly and precisely takes time because the structure depends on what kinds of user there are, on what each kind of user needs the project to fulfill, and on the nature of the constraints. Time must be allowed for gathering, organizing and checking out the requirements both formally and informally. This is not something that can be rushed.

3. Expected effort and time taken – To put some numbers to all this, Alexander and Stevens (2002) suggested to spend about 5 percent of project effort on the requirements and also allow a generous chunk of the schedule – up to 25 percent of calendar time – for requirements on shorter projects, but not more than three months on larger ones.

4. Requirements effort throughout the life cycle – Some effort on requirements is needed throughout the project because compromise and change are inevitable. An essential element in any acceptable compromise knows how important each requirement is to its owner. The issues concerning change of requirements are discussed in the next section.

5. Allow for change and feedback – The lack of well-documented updates make it difficult to trace the changes in Employer’s Requirements (Oberg, et al., 1998). Changes from outside are also inevitable. Every project with a lifetime of more than a few months will experience pressures from competitors, market or operational changes, from new technologies, and from stakeholders to change the requirements and the design. The change of requirements should be able to be tracked back, updated and recorded properly for future use and feedback for subsequent projects.

6. Allow for users’ participation and feeling – The lack of adequate end-user’s involvement causes failure to manage end-user’s expectations (Kujala et al, 2005; Arayici et al., 2006). The users are the real stakeholders that occupy and perform activities in the building. Their voice toward the requirements must be heard and should be paid attention to as early as possible during the project development process. Some users may be defensive about giving their opinions, especially if, for instance, they think their jobs may be affected by the project being developed. In that situation, it is essential to gain their trust before trying to start developing the project. It is necessary to consider who will really benefit from the use of the building and a win-win situation should be achieved if possible.
6. A vision for future research

After analysing and discussing the principles, imperatives and challenges of RsM, the next step is to carry out a comprehensive review and reflection of them and develop a practical framework for RsM in AEC industry. This is presented here and the authors of this paper propose this as a preliminary framework of RsM for construction projects (Figure 2). A more refined version will be developed on the basis of the results of further investigation. The proposed refined framework is likely to comprise some guidelines and critical success factors for managing project requirements in a holistic RsM process.

A further step will be to develop a practical “how-to” guide which explains the application of RsM principles in construction projects based on a literature review, followed by further data collection through interviews and questionnaire survey. The guide will provide practical solutions to critical issues frequently encountered by clients, consultants and contractors in the RsM process. The is intended to provide the necessary tools, techniques and examples of tasks such as: how to elicit project requirements, define the requirements, identify the needs and wants, prioritise requirements, verify requirements, record and trace the changes of requirements in construction projects.

Figure 2 Preliminary framework of RsM in construction projects
7. Conclusions

Requirements Management is crucial to the successful delivery of construction projects. Good Requirements are complete, unambiguous, consistent, feasible, solution neutral, traceable, necessary, concise, correct, and verifiable. The proper application of Requirements Management to the AEC industry will help to integrate the project requirements into the design process and ensure the final product meet these requirements. It will not only elicit the true needs of the client and create a good brief in the briefing process but also allow the requirements to be recorded and traced back systematically during the project cycle for change management and performance assessment of the final building.

Research on Requirements Management in the construction industry is limited in comparison with Requirements Engineering in the system and software world. There is already a significant body of knowledge about developed theory and practice in Requirements Engineering which AEC professionals could learn from. There is a need to evaluate the existing practices of Requirements Management in the construction industry and to investigate best practices to improve the Requirements Management process for construction projects.

This paper has put forward a preliminary framework as a basis for further investigation.

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Office Building Design Conception Guidelines

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Abstract

The complexity in office buildings design development is related to difficulties in incorporating the interests of all players involved (owners, designers, contractors and end-users) and to the increasing diversity of specialist designers. The clarity about key points definitions and who should make them, during the design conceptual phase, is imperative for technical, constructive and commercial feasibilities of the project itself, and design management must have complete control of these aspects. The aim is to investigate what critical information from several design subjects should be defined during this conceptual phase and its correct insertion sequence in the design process. In order to pursue this investigation, the research is based on the case study method, the studied object of which has distinctive conditions: the design team contractor is a real estate company that fully understands office building market needs, holds an experienced technical team to evaluate and select constructive solutions and, also, is a facility manager. Due to this, their design decisions actually focus on the project entire life cycle, which is not common in the Brazilian market. In conclusion, the development of an information flow is proposed, during the design conceptual phase, which indicates when each piece of information should be located in the design process, which is helpful to elucidate the correct function of each related player and to establish a useful tool for design management.

Keywords: office building, design management, data flow
1. Introduction

Office building design management is a complex task, as well as any design process, due to the diversity of the players who influence it or are influenced by it (owners, architects, consultants, contractors, facilities managers, end-users) and to their interests (in many cases, at opposite sides). Thus, it counts on an increasing number of specialist designers, owing to the development of new construction technologies and building automation systems.

Office buildings have specific needs, which distinguish them from others typologies, such as residential buildings. Open plan floors, which allow occupation flexibility, demand heavier floor loadings and specific free span between structural columns. MEP (Mechanical, Electrical and Plumbing) Systems are more sophisticated, since they deal with large populations and air conditioning central systems, which imply special care for energy infrastructure and efficiency.

The complexity in developing the office building design is reflected in the need of including the most important issues of these design specialties at the initial stages of design conception, in order to preserve their main demanded spaces and to allow feasibility studies based on realistic costs. In effect, a good design results from a correct integration of considered design specialties and from a consistent interface management of the involved team members.

2. Purpose

The aim is to investigate the demand of office buildings design guidelines. These guidelines consider several design aspects: the significant number of design specialties, the design management and the building, operation and maintenance aspects.

3. Research method

The object is the office buildings design process, focused on the initial steps, and its organization relationships. It is developed by the case study method, which comprises, according to Yin (2003), the studied object definition, the subject bibliographic review and the empirical data survey. In order to define the case study, and due to the great number of possible involved players, the one who dominates the design management as an entire process was selected, the real estate developer. This option allowed the study of a single case so as to grasp the day-by-day usual situations. Furthermore, the chosen real estate company presents an unusual aspect if compared to the market standard, because it works on all the phases of the project life cycle: business plan set up, design and construction management, and building operation and maintenance during its entire life span. The Brazilian market standard acting ends after the construction phase, leaving the operation and maintenance problems to the future end-users. This difference of the chosen real estate developer has a significant influence on the design technical decisions and the design process.
4. Design management theoretical aspects

Design, as well as project, can be understood as a product or as a service. Design management can be understood as the management of a process that begins with an idea and ends with a complete documentation, which allows a building construction. According to Melhado et al. (2005), design management is the group of activities related with design planning, organization, direction and control, as well as strategic and tactical activities – such as selecting and hiring design team members – in order to guarantee the supplied product and service quality.

4.1 Players and design coordinator importance

The real estate business type, conduction and even its location vary due to the way the involved players act in the design process. The main players are: a) real estate developers and owners, who make projects feasible; b) architects, design specialists and consultants, who translate the developers’ needs into documents; c) constructors, who quantify technical solutions to costs and build what was designed; d) end-users, who use the building and supply post-occupancy information; e) facilities managers, who operate and perform the building maintenance; f) government authorities, who regulate, by laws and norms, the activities of design, construction, permits and, in some cases, financing.

The design coordinator is an important figure that gravitates around the first three players. The planning in the design process, without him, does not exist, or is performed in a precarious way. The way he establishes the relationship with the other parties, and also, the way the players establish the relationship among them depends significantly on the hiring process. The commercial relationships carried out by the developer shall allow sufficient autonomy to the design coordinator, so that he can effectively conduct the design planning and management.

Design coordination, according to Melhado et al. (2005), is a support activity to the design process development, focused on requirements integration and design decisions. The coordination shall be conducted during the entire design process in order to promote design team interactivity and to improve the design quality. In this sense, not only does the design coordinator have to dominate the technical knowledge about the issues he will coordinate, but also needs to have managing and leadership skills – since he deals with several design team members with different interests. This type of profile, very similar to that of a project coordinator, in addition to the gradual loss of the architect authority (as deduced from RIBA, 1993; Gray and Hughes, 2001), somehow explains the ascendancy of construction and design managers in the design process.

4.2 Design process flow

Several regulations references, as well as researches, which study design development, are unanimous about the division of its process into phases, including the Brazilian norm NBR-13531 (ABNT, 1995), the phases of which are: Survey, Briefing, Feasibility Study, Preliminary Study, Schematic Design,
Legal Design, Basic Design and Construction Design. Several authors (RIBA, 1995; CTE, 1997; AsBEA, 2000) use similar approaches related to the design hierarchical and linear phases, and to the players’ responsibilities throughout the process.

The investigation of alternatives to the stiffness of this linear arrangement provides models, which suggest the design development integration with the construction development process. This approach is related to the concurrent engineering, investigated by Fabricio (2002), in which the main players’ representatives participate in design teams to bring their expectations and needs into the process. According to this approach, the work of Brazilian specialties design and design hiring corporate entities, which generated the issue of eleven guides of design services and design coordination scope (www.manuaisdeescoop.com.br), defined six design phases (Figure 1): Product Conception, Product Development, Solutions for Design Technical Interfaces, Detailed Design, Post-Design Delivery and Post-Construction Delivery. The work is focused on the activities developed at each phase, instead of the resulting products.

Figure 1: Main design phases

5. Case study

5.1 Introduction

The case study object was the design development process of a real estate enterprise of office buildings, located at Setor de Autarquias Norte, Brasilia – DF (Brazil). This project was developed by a private company, headquartered in USA, which has been operating in Brazil since 1996. The survey was conducted by interviews with the technical department representatives, architects, design coordinators and involved design specialists, in addition to coordination meetings attendance and design documentation reference.

5.2 Project description

The project to be built in Brasilia consists of two office facility towers, linked by a common basement, in which are located the parking lot, the entry lobby and a store area. Each tower is 21-story high, with a total of 42,500 sq. m. of rental area and 1,080 car parking spaces. The typical office floor has a rectangular shape and is based on the "core and shell" conception. The slab area of each floor is approximately 2,000 sq. m. and the free span is 12 m at the smaller side and 16.9 m at the larger side. The building enclosure is designed to mix masonry cladding, natural stone finishing and glazing with aluminium frames.
The structure floor framing system consists of reinforced concrete waffle slabs with incorporated post-tensioned beams. It allows flexibility to the MEP Systems distribution without significantly increasing the structural height, and presents appropriate cost-benefit to support the proposed spans. The MEP Systems accommodate saving water devices, treatment systems for rainwater and sewage, and a central HVAC (heating, ventilating and air conditioning) system, with chillers located at the basement, air-handling units at each typical floor, carbon dioxide sensors, heat exchanger wheel and variable air volume controls.

The passenger elevators, 10 units for each tower, are arranged into groups for low-rise and high-rise zones, in order to serve the occupants with comfort, based on traffic analysis criteria. Two of them are parking shuttle elevators, as a security measure. The life safety systems (emergency exits, escape routes, systems and fire resistant materials) are based on the local life safety codes and on the American NFPA (National Fire Protection Association) codes.

5.3 Process description

In order to support the whole chain of property development, the real estate company has a managing organization headed by the Investment Committee (IC), followed by the CEO\(^1\), served by several departments. The ones that are relevant to this paper are: Commercial Development (CD), Design & Construction (D&C) and Facilities Management (FM).

Its production process can be summarized into four main phases: Product Conception, Design Development, Construction and Maintenance (Figure 2). The Brasilia project, a process in progress, covers the two first phases, as follows.

![Real Estate company production phases](image)

Figure 2: Real Estate company production phases

**Product Conception**

In this phase (Figure 3), the CD department prospected an opportunity in Brasilia and proposed an enterprise, the estimated cost of which was taken by the D&C department to the Investment Committee. The next step of the studies was approved, and an Architect elaborated a “Basic Mass

\(^1\) Chief Executive Officer
Plan” based on a briefing, which included commercial type basics, such as: legal restrictions, floor areas, rental areas, floor shape and core, number of lower levels and number of stories. The submission of this plan to a cost estimate performed by the D&C department resulted in a first cost and expenditure schedule reference, which oriented the business feasibility study.

![Diagram showing the process flow from Prospecting to Business Feasibility]

Figure 3: Product Conception phase process flow

**Design Development**

The second phase, Design Development (Figure 4), was initiated as the study concluded the enterprise was feasible, and was conducted by the D&C department. In this phase, the Architect developed the Preliminary Design, with the initial briefing ideas development, geometry definition, macro calculation of areas, and a first outline specification. Also, a local consultant was responsible for the legal parameters survey. The Preliminary Design was submitted to a cost evaluation, so as to verify the agreed initial objective with the IC.

After this verification, the Schematic Design step was initiated, with the selection of design specialties consultants, the scope or work definition and the initial planning. The design coordinator was also selected, and in this case, this responsibility was brought to the Architectural office team. At the end of this step, drawings were developed based on the available information so far, with two purposes: first, to carry out physical interferences studies among design specialties, and second, to prepare the legal design base. The Schematic Design evaluation cost was conducted with the support of the future contractor.

In order to develop the Basic Design, the coordination meetings occurred with the presence of the contractor representatives and, once, with a subcontractor of building foundations. The approved concepts design detailing brought up several new interferences among design specialties, such as: difficulties in coordinating security with life safety concepts (the first intends to control the accesses, the second intends to liberate them); locations replacement at lower levels to improve the parking flow; how to achieve sustainable performance with architectural and MEP systems design, and how to manage the use of rainwater and reuse of sewage. The technical solution validation of the design specialties and its incorporation to the architectural design constituted this step developed products, which originated the Initial Budget. This budget was the basis for the first phase of the future construction.
The design natural detailing continues with the development of the Construction Documents, with which the Construction Budget would be extracted, used as basis to meet the construction and the business performance. Also, the business commercial launching would only occur with the legal permits approval, which has not happened yet. In this study, the design process stands in transition between the Basic Design and the Construction Documents step.

5.4 Project team interface management

The team groups were built according to the real estate developer established commercial and contractual relations (Figure 5).

The architecture design office, responsible for the design coordination, hired one specific office for the coordination work and another for the design detailing. Facing the client, which was the real estate company, these three players were, in fact, just one, but at least three people should attend meetings to represent this one player. The other design specialties offices had their work scope defined by the client.

A design process facilitation was expected due to the fact that the design coordination was the architecture design office responsibility, since the architecture incorporates the other design specialties main concepts. Nevertheless, the real estate developer had to work in the coordination process as the design contract manager, “splitting” the design specialties offices attention about
design management issues. The real estate developer evident prevailing of the design specialties concepts emphasized this aspect.

Another important point refers to the number of the parties involved during the coordination meetings. In the real estate company team, there were at least three members from the D&C department, one from the CD department and one from the FM department. From the other parties, there was at least one member of the contractor and one or two of each design specialty office. Since the conclusion meetings stand the technical solutions validation for all design subjects, it was possible to observe that the number of 20 or more people was easily achieved during those meetings.

6. Critical analysis

6.1 Process analysis

The observed process flow phases in the case study allow making a parallel (Figure 6) with the phases mentioned in the literature review (Figure 1). Both consider a Product Conception as an initial phase, in which the briefing is defined; and the following phases are very similar. In this sense, the case study Preliminary Design phase can be considered as the model Product Development; the Schematic Design phase, as the Solutions for Technical Interfaces; the Basic Design and Construction Documents phases, as the Detailed Design; and the Construction Budget as the Post-Design Delivery.

Despite the fact that the design phases are essentially in sequence (Figures 3 and 4), it was possible to observe that the real estate developer has intuitively practiced some concepts based on the concurrent design approach, when its process previews all the players attendance to the coordination meetings (contractor, subcontractor, maintenance and operation representatives), even though the number of participants seemed excessive at a first.
6.2 Interface analysis

The number of participants attending the coordination meetings has shown to be necessary, so that every player could contribute in the design process. It is possible to say that the way the interface of this process was structured (Figure 5) has limited the coordination autonomy and has contributed to some undesirable effects, such as: a) the real estate developer has had to deal with three different spokespersons to solve coordination and architecture issues, resulting in process efficiency loss; b) there has been a significant design schedule delay as compared to the first established deadlines (three-month delay), in part, due to the coordination office unawareness of the real estate company managing process; c) the coordination office has not effectively performed its expected function, reducing its scope to operational issues (convening meetings, taking meeting notes, drawing schedules).

In order to achieve an effective design management and coordination in the case study, the design coordinator should be closer to the player who happens to dominate the entire process and the specialties design technical information, in this case, the real estate developer. If, in another hypothetic case, the architecture office dominated the design multi-specialties technical issues, the design coordinator could keep being there.

7. Conclusion

In the case study, it has been observed that one part of the technical guidelines appears indirectly in the Product Conception briefing and the rest is defined during the following phases. This design process has been typified by the frequent comparison, at the end of each phase and step, of the Product Conception estimated value. This allows two reflections: a) these periodic verifications are important control tools to the process; b) the Product Conception is the phase, before the Architect draws the first sketches, in which the main design technical guidelines have to be already defined, since the economic feasibility established in this phase guides the whole following process.

In effect, those considerations suggest that an office building design guidelines can be split into two main categories: mass plan guidelines and guidelines for the design following process. The first category defines the building contours, its life span and use flexibility. The second category defines how the building will operate and what kind of contingencies it will have to be prepared for (i.e. lack of water or energy, flood, emergency situation). In order to identify the first category guidelines, the following interaction detailing between the Briefing and the Mass Plan steps (Figure 7) is proposed:

1- The site area, zoning regulations and the commercial product (office building standard, renting or selling purposes, using flexibility level) define the building contours and its maximum size;
2- The BOMA² area is estimated, which is a reference to the building performance and the base to define the building main areas;

3- The following concepts are defined: core configuration, leasing depth, structural system, HVAC system, raised floor preview or not. These concepts determine the floor-to-floor height, which, in addition to the maximum building area, define its number of stories;

4- Part of the building operation is conceived, in order to estimate the number of elevators and their distribution (low-rise and high-rise, parking shuttle elevators);

5- The typical floor is conceived, with main vertical circulation spaces preview, such as: escape routes, stairs, elevators and HVAC shafts;

6- The need of the previous steps verification is checked (i.e. if the BOMA area keeps profitable, if the mechanical areas are excessive, if there are too many elevators, if the core is disproportional to the typical floor);

7- The building envelope is conceived (which is directly related to the HVAC system definition) and the materials finishing standards;

8- The mass plan is concluded.

Figure 7: Interaction detailing between Briefing and Mass Plan steps

From this flow, it is possible to infer that it is necessary to dominate the technical concepts of several design specialties beyond architecture (such as: structure, HVAC system, life safety, vertical transportation and facilities management) in the early stages of the office building design phase, which is essentially commercial. In the case of a hypothetical real estate developer, which is looking for process improvements, the implementation of these guidelines can be suggested in the Product Concept phase of Figure 1 proposed model.

² Method of floor area calculation used by owners to determine the rentable area in an office building. The method is described in the American norm ANSI/ BOMA Z65.1 (1996).
The implementation of a Product Concept flow similar to the case study is expected, in addition to the initial phase proposed detailing, to facilitate the design process of the office building design and to avoid significant divergences in the entire project process.

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Since the 1990s, when the Private Finance Initiative was developed as the primary method for delivering major public capital projects, there has been concern about the quality of many of the products. Initially, it was the architectural community that raised doubts, but it has subsequently been joined by user groups. As the contractual period is over 30 years, there are issues such as ongoing maintenance, facilities management and operational factors, that need to be balanced with design quality. This paper will report on a research project being carried out with a metropolitan local authority in England, which is replacing its entire sheltered housing stock in one Private Finance Initiative project. The principal aim of the local authority is that it should receive these buildings as assets, rather than liabilities at the end of the 30 year period. The research work to date has been based on two stages of a three stage selection of the preferred bidder from the original six consortia.

The aims of this paper are to review the Private Finance Initiative management processes in relation to architectural design quality at each of the selection stages, including the generation and application of the design assessment criteria, and the role of user groups; and evaluate the outcomes against the objectives of maximising design quality within workable financial models. The methodology is that the researcher is based in the local authority project team, and has therefore been able to use participant observation techniques in the management processes, which include competitive dialogue and user consultation. The design assessment criteria were developed from the academic literature and refined at each selection stage. A comparative analysis of the design assessment criteria with intermediate and final designs, will assist in identifying the status of design quality in the selection of the preferred bidder.

**Keywords:** Private Finance Initiative, local authority, design quality, process management, sheltered housing
1. Introduction

When the Conservative Government launched the Private Finance Initiative (PFI) in 1992, it had two principal objectives. The first was to reduce public sector expenditure and the second was to transfer risk to the private sector. PFI is like no other type of procurement, as private consortia bid to construct and operate a facility for up to 30 years. The Labour Opposition labelled it totally unacceptable, proclaiming it to be an extension of the privatisation of public services (Shaw 2007). Upon being elected to Government, Labour set up a review. The resulting report enabled the Government to declare that the Private Finance Initiative was now able to provide:

- investment in the public infrastructure that would not otherwise have been possible
- greater value for money
- higher quality projects (Robinson 1998)

The aims of this paper are to review the Private Finance Initiative management processes in relation to architectural design quality at each of the selection stages, including the generation and application of the design assessment criteria, and the role of user groups; and evaluate the outcomes against the objectives of maximising design quality within workable financial models.

2. Methodology

The methodology was driven by three specific literature reviews:

- Critique of PFI, and proposals for improving design quality
- Survey of existing design quality evaluation tools and analysis of the Design Quality Indicator
- Identification of elements in sheltered housing, including statements and criteria for quality assessment; and development of the tool

A university researcher is based in the local authority project team, and has therefore been able to use participant observation techniques in the management processes, which include competitive dialogue and user consultation. The design assessment criteria were developed from the academic literature and refined at each selection stage. A comparative analysis of the design assessment criteria with intermediate and final designs, will assist in identifying the status of design quality in the selection of the preferred bidder.

3. Critique of PFI, and Proposals for improving Design Quality

3.1 Critique
Quality can be an elusive term but the Royal Fine Art Commission did not shrink from expressing its reservations in relation to PFI. It stated that there are inherent dangers in concentrating responsibility for designing, building, financing and operating a building in one service provider. Of course, it continued, the architect will be an integral member of the provider’s team, but he will most probably be a low-ranking one. Therein lies a serious danger – if the brief is filtered through intermediaries whose interests lie elsewhere, then the prospects for high quality architecture must surely be reduced (Fawsley 1997). The Royal Fine Art Commission was succeeded as the Government’s Adviser on Architecture, by the Commission for Architecture and the Built Environment (CABE) in 1999. If the sponsoring Government Departments thought that the change would alleviate criticism, they were in for a shock. The new Commission was almost as unequivocal as its predecessor had been. It noted that the UK is witnessing the largest public sector construction programme for a generation, through three preferred procurement routes: Design and Build, Prime Contracting and the Public Finance Initiative. It then added that the vast majority of PFI buildings commissioned to date have not been designed to a high enough standard and public service delivery has suffered as a result. CABE affirmed that it believed further qualitative improvement was urgently needed (CABE 2005). The architectural community had been suspicious of these new forms of procurement from their inception. It could be argued that it was because the architects’ influence was being diminished by them. The most extensive experience in this procurement method has been in primary health care and secondary education. PFI in housing has taken much longer to become established and therefore does not have the same body of user feedback. However, pressure groups have little doubt that the products are becoming increasingly unpopular with tenants. It is recognised that pressure groups are not unbiased sources of data. Yet, they are keen to verify the facts, in fear of losing credibility with Government (http://www.defendcouncilhousing.org.uk).

### 3.2 Proposals

The Commission for Architecture and the Built Environment had already started its rearguard action. In the same publication that it had criticised PFI, it stated that improvements in design quality can be made by studying design exemplars; including design criteria in output specifications; appointing client design advisers - specifically a design champion, independent adviser and user group; and undertaking post-occupancy evaluation and feeding the data into future briefing documents and output specifications (CABE 2005). Within two years a Treasury Taskforce (2007) published its technical note on how to achieve design quality in PFI projects. The stated aim was to assist public sector procurers to ensure the highest design quality solutions. It highlighted three areas for attention. The first was the management of the relationships with bidders, with the introduction of the competitive dialogue procedure. Secondly, was the provision of clear information early in the competition about what is required and how bids will be evaluated; and thirdly, was the need to ensure that design requirements are consistent with the budget available for the project. The Government was seeking a much changed process; one which it hoped would answer the critics about the design quality of PFI projects. Arguably the biggest procedural change was in the management of relationships with bidders. The new procedure became known as competitive dialogue, and had been introduced following an EU Directive (2004/18/EC) to enable contracting authorities to discuss all aspects of proposed contracts with the candidates. Such dialogue had not been possible under the previous
restricted procedures. In principle, dialogue was to be allowed with consortia to identify and define solutions required by the authority; and may be conducted in successive stages with the aim of reducing the number of bidders. Under the new provisions, an authority can also discuss bidders’ proposals for solutions, provided all bidders are treated equally (Office of Government Commerce 2006). At last, authorities could discuss design quality with bidders during the process.

3.3 Application

The ageing population represents one of the most extraordinary social transformations that has characterised and will continue to characterise British society. The heightened hope of living longer and the increase in the number of elderly citizens represents a challenge for all local authorities. North Tyneside Council, a large metropolitan local authority in the north east of England, faces a radical social change with housing stocks that are unlikely to meet future needs. Therefore the Council included in its strategic plan (North Tyneside Council 2007) provision to replace its existing sheltered housing schemes with 13 new build developments and 12 refurbishments. The programme represents both an increase in the quantity and quality of provision. The only feasible method of funding this huge transformation is through the Private Finance Initiative. The project will cost in excess of £100m over 30 years, including operation and maintenance, by bringing together Government grants and private sector funding to improve public services. From the beginning, the Council was keen to produce high quality buildings. The first priority was to act on the key roles that had been recommended by both CABE (2005) and the Office of Government Commerce (2007).

The design champion does not need to have experience of construction projects but must have the presence within the project to keep design quality as a vital shared goal and will need to learn about design issues that are relevant to the project. The role is to articulate the vision and desire for high quality design; formulate the authority’s aims and ensure they are clearly stated in the briefing documents; define, check and evaluate quality throughout the process; and insist that quality is maintained throughout the project (Office of Government Commerce 2007). The Council responded by appointing the Deputy Elected Mayor to the role; stating that its Design Champion will be committed to design quality in its broadest sense. It continued that good design is not an optional extra; it has to combine **fitness for purpose** with the building’s whole-life costs, to deliver value for money.

For definition and review of design quality, an adviser from one or more of the design professions relevant to the project may be needed. Advisers with other skills may also be required but should not be assumed to be qualified to advise on design (Office of Government Commerce 2007). The Council approached the Architecture Group at Northumbria University. It soon became apparent that a full-time researcher would be needed to work in the local authority Project Team. This was achieved through a Knowledge Transfer Partnership, in which the researcher is supervised by two members of staff from the Architecture Group.

According to both CABE (2005) and the Office of Government Commerce (2007) users should be directly consulted. A panel to represent different user groups (such as residents, occupants, staff, visitors) should be set up to gather information about user requirements as well as communicating
North Tyneside Council established a Users’ Group comprising the Assistant Project Manager and Lead Communication Officer (from the authority), a Tenant Focus Group (8 members) from local authority sheltered homes in North Tyneside, representatives of the local community over 50 years of age (4 members), representative of North Tyneside Coalition for Disabled People, manager of the local Alzheimer Society, representative of the Coalition for Older People and a representative of the Primary Care Trust. At an intermediate stage in the process, a focus group of 7 younger future tenants (30-55 years old) was added for consultation on the designs by the remaining bidders.

The researcher undertook the study of design exemplars, including the design-award winning Plas Y Mor (fig. 1) and will undertake the post-occupancy evaluation. This information will then be fed into future briefing documents. In terms of including design criteria in the output specification, the Project Team organised three design workshops with the User Group. They were based around the themes of communal facilities, sustainability and internal details; and the objective was to elicit users’ aspirations. The workshops considered a number of detailed issues. For example in workshop 1, the aspirations for communal spaces were established, and are almost totally reflected in the output specification checklist (fig. 6) as CABE (2005) had proposed. Most could be classified under fitness for purpose but occasionally, in notions like focal points in lounges, there were signs of higher level attributes such as character.

Figure 1: Plas Y Mor, Burry Port, Swansea, West Glamorgan

The competitive dialogue was planned in three stages:

1. Invitation to submit outline solutions: evaluation reduces 6 bidders to 3 bidders

2. Interim invitation to submit detailed solutions: evaluation reduces 3 bidders to 2 bidders

3. Invitation to submit detailed solutions: evaluation reduces 2 bidders to 1 preferred bidder

Aspects of the designs were discussed with the bidders on a weekly basis but the most significant feedback would be generated through formal Design Evaluation of the proposals at each stage.
4. Survey of existing design quality evaluation tools and analysis of the design quality indicator

4.1 Survey

A survey of existing design quality evaluation tools revealed the following options:

- Design Quality Indicator
  - Achieving Excellence Design Evaluation Toolkit (AEDET)
  - Design Excellence Evolution Process (DEEP)
- Housing Quality Indicator
  - Design and Quality Standards
- Post-occupancy Review of Buildings and their Engineering (PROBE)
- Building Research Establishment Environmental Assessment Method (BREEAM)

The Housing Quality Indicator was devised to assess housing for the general population. It is not intended to cover the specialist requirements for sheltered housing with the exception of the designated supported housing for older people (Housing Corporation 2008). The design and quality standards associated with supported housing, state that the core will apply in part, together with additional provisions to housing for older people (Housing Corporation 2007a). Even setting aside these partial provisions and ambiguities, Franklin, (2001) points out that design quality assessment using this tool, is limited to standards and measurement. She adds that unless attempts are made to engage with more interpretative issues, appraisals of housing design will continue to be limited to mechanistic and deterministic formulations, which have led to so many failures in the past. A section on character has been added to the current Housing Quality Indicator, but it represents only 2.5% of the total assessment (Housing Corporation 2007b), and the responses of yes, no or not applicable, appear insufficiently distinctive. Two other assessment methods – PROBE and BREEAM are limited to environmental quantities such as temperature and illuminance; and as its name suggests, the former takes place after construction and not during the design process.

4.2 Analysis

The Design Quality Indicator (DQI) is the only comprehensive method for evaluating the design and construction of new buildings and the refurbishment of existing buildings. There is a general DQI for all building types and a specific one for school buildings (http://www.dqi.org.uk/); together with two subsets, AEDET which focuses on hospitals and DEEP, which is exclusively for military housing. During the last part of the 20th Century a new culture of performance measurement started to take hold
across the UK Construction Industry. This was epitomised by Rethinking Construction (Egan, 1998). Architects and other design professions affiliated to the Construction Industry Council became concerned that design quality might be relegated to a secondary issue because of the performance-improving agenda, focussed heavily on physical processes. The concern was that a new generation of buildings might be produced where emphasis on measuring and reducing time, cost and waste would lead to a plethora of boring and unattractive designs. The response was the Design Quality Indicator was created explicitly to measure the quality of the design product.

The DQI consists of three elements:

- Conceptual Framework
- Data-gathering Tool
- Weighting Mechanism

The Conceptual Framework is represented as follows:

![Conceptual Framework Diagram]

The justification for this arrangement is to reflect the overlapping qualities. Other models were rejected because they did not account for the interaction between the three aspects shown above. Gann et al. (2003) offer the example of lighting in a building; which can have a functional quality in terms of the lux (lumens per square metre) needed for specific tasks as well as providing pleasure. However, if a hierarchical approach is adopted (fig. 2), lighting does not become the object but a means of satisfying part of fitness for purpose and providing part of ambience. These aspects are quite different and the design criteria for one are not the same as the design criteria for the other. Moreover, amongst others Veitch and Newsham (2000) have shown that fitness for purpose has been well researched, has accepted standards and these standards are generally achieved. Whereas, a quality pilot study undertaken on an existing sheltered home in North Tyneside demonstrated that the choice of lighting was one of the contributory factors to the institutional atmosphere of the interior. Thus, it is not the overlapping nature that is significant but how to add amenity to function.
The Data-gathering Tool in the DQI is essentially a questionnaire that can be used by anybody involved in the design and use of the building. Perhaps not surprisingly, the questions are framed around function, impact and build quality. The respondents are asked to assign a weighting to the importance of each feature; on a scale of strongly disagree to strongly agree. The mechanism uses the priorities that the various stakeholders have set for the building and weights perceptions of design quality against these intentions. Responses to the questionnaire are weighted using a simple formula responding to individual respondents’ views on particular attributes in each section of design quality. As the Design Quality Indicator is effectively a questionnaire for individuals’ to complete – the weighting reflects individuals’ priorities. In the example offered by Gann et al.(2003) (fig. 3) the employers’ agent emphasises functionality, budget and let ability. Whereas the hierarchical model (fig. 2) shows that once there has been compliance with the mandatory requirements, functionality is the next priority and quite properly should receive a weighting when it is achieved. However, the greatest weighting should be reserved for designs that additionally provide a sense of place and real well-being for the users, which are achieved by the amenity attributes.

Thus the Design Quality Indicator is not suitable as the basis of the Design Quality Evaluation Tool for three reasons. First, although a mid-design assessment tool has now been introduced; it is not as much about evaluating and developing the designs as completing another generalised questionnaire. Secondly, the conceptual framework does not recognise the significance of a hierarchy of assessment, in which fitness for purpose can be added to the mandatory requirements; and amenity attributes added to fitness for purpose. Each level is more difficult to achieve than the previous one, and this should be reflected in the weighting. Thirdly, with the DQI, the weighting itself is derived from individual respondents’ views, some of which are barely related to design quality at all. Whereas, the objective of this research is to establish a shared framework, against which proposals can be assessed.
and progressed. Thus the Design Quality Evaluation Tool for North Tyneside Council’s sheltered accommodation was generated from literature relating to the hierarchical model.

![Diagram showing design quality evaluation tool](image)

Figure 3: Comparison of different perspectives on design quality (Gann et al, 2003)

### 4. Development of the design quality evaluation tool for sheltered housing

The tool was developed by the authors of this paper, contemporaneously with the three stages of the competitive dialogue. As none of the existing tools suited the purpose, it was clear that the tool had to be generated from first principles. It was therefore not possible to follow the recommendations that the exact method of bid evaluations should be communicated to the bidders early in the process; although the bidders were clear about the evaluation criteria before each stage.

From the beginning, the importance of the amenity attributes was emphasised. At the presentations by the independent advisers’ from Northumbria University in December 2008, the primary objective was to provide supplementary guidance for bidders. Councillors (including the Design Champion) and representatives of the User Group were also present. The presentations focussed entirely on amenity attributes, and were based around people and places. The concepts from these presentations formed the principles for the stage 1 design evaluation: invitation to submit outline solutions. The
elements of sheltered housing provided the section headings, and a weighting was allocated to each section, ie:

<table>
<thead>
<tr>
<th>Section</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Space</td>
<td>10%</td>
</tr>
<tr>
<td>Building Form</td>
<td>10%</td>
</tr>
<tr>
<td>Entrances</td>
<td>15%</td>
</tr>
<tr>
<td>Communal Spaces</td>
<td>15%</td>
</tr>
<tr>
<td>Service Spaces</td>
<td>10%</td>
</tr>
<tr>
<td>Circulation Spaces</td>
<td>10%</td>
</tr>
<tr>
<td>Apartments</td>
<td>15%</td>
</tr>
<tr>
<td>User Groups</td>
<td>10%</td>
</tr>
<tr>
<td>Innovation</td>
<td>5%</td>
</tr>
</tbody>
</table>

The evaluation for part of the communal spaces section of a sample scheme was set out as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Positives</th>
<th>Negatives</th>
<th>Clarification</th>
</tr>
</thead>
<tbody>
<tr>
<td>grouping of communal spaces</td>
<td>all lounges and main communal areas around central core – accessible from around the building; informal seating areas to split up corridor lengths</td>
<td>cannot really tell from that provided – seems to be single storey from plans</td>
<td></td>
</tr>
<tr>
<td>heights in relation to floor space</td>
<td></td>
<td></td>
<td>changes in levels on site not clear and no information on colours</td>
</tr>
<tr>
<td>subspaces</td>
<td>cosy feel on the whole - not dynamic as walls fixed, but easy access to gardens and around building</td>
<td>no landscaping indoors so gardens not brought in</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4: Sample from Stage 1 Evaluation Tool

At the same time, as one bidder withdrew, the five remaining bidders presented their outline proposals for one new build and one refurbishment scheme. The presentations were to Officers, Councillors, Advisers and the User Group; but only the nineteen tenants present, were permitted to cast their votes on the projects. An electronic voting system was used, and the response to each question was on a scale of 0-4. Early indications that it was a flawed process revealed themselves almost immediately. The first presentation received the lowest score, and the points increased with each successive presentation. The tenants’ voting only carried 2% weighting in the overall evaluation at stage 1, and such a low percentage was strongly criticised at the time. However, as it became increasingly evident that it was a flawed process, the low percentage appeared to be a wise decision. The reasons for inaccurate voting were that the tenants found it difficult to differentiate between the presentation and the content of the projects; and their unfamiliarity with design proposals involved a steep learning curve. The assessment was re-run at the subsequent tenants’ workshop, without presentations, using the stage 1 design evaluation tool. On this occasion the outcome mirrored the results from the Project Team’s design evaluation group.

By the time of stage 2 design evaluation: interim invitation to submit detailed solutions, the tool had been developed, as shown by the first part of the communal spaces section:

<table>
<thead>
<tr>
<th>Element</th>
<th>Positives</th>
<th>Negatives</th>
<th>Clarification</th>
<th>2nd Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communal Spaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Provision of communal spaces is very good, however the therapy room, and long travel distance does let it down a little.

Figure 5: Sample from Stage 2 Evaluation Tool

The stage 1 and stage 2 evaluations were scored by section on a five point scale. By stage 3, both the proposals and the tool are considerably more detailed. This enables each point to be scored on the same scale. In addition, each point will be weighted 0.5, 1.0, 1.5, 2.0, according to its position in the assessment hierarchy (fig. 2) with 1.5 and 2.0 being reserved for amenity attributes. The stage 3 evaluation tool is now ready for its part in the selection of the preferred bidder. Scores will be multiplied by weighting and the totals for each section allocated the same percentages as the earlier evaluations.
The Treasury Taskforce (2007) stated that designs should be consistent with the available budget. The North Tyneside financial model permits immediate comparison of proposals and costs (fig. 7). The detailed appraisal enables cost savings to be identified, which will impact least on design quality.

Although at stage 2, all three proposals were above the budget, it was considered that Bidder 2 only needed to reduce maintenance and operation costs, as did Bidder 1; who also needed to reduce capital cost without affecting quality. Whereas Bidder 3 exceeded all parts of the budget by too large a margin to proceed to the next stage.

An early criticism of PFI had been that design would be insignificant in the overall assessment; as finance, maintenance, facilities management, operation factors etc., would take precedence. In the North Tyneside evaluation, design actually has the greatest influence of the six criteria, with a weighting of 35%.

5. Novelty and conclusions

The novelty of this research is in three main areas. First, the competitive dialogue enables bidders to develop their proposals through feedback based on the evaluation tool. Secondly, the engagement of the design champion, independent design advisers and the user group ensures that design quality remains a high priority throughout the selection process; and enables different perspectives to be incorporated. Thirdly, the evaluation tool itself can be used by future project teams without the need for explanatory seminars or approved facilitators, such as those required by the Design Quality Indicator. In addition, it offers objective decision-making in staged selection of proposals, and bidders have observed the unprecedented rigour of the feedback; both in the selection of unsuccessful candidates and improvement in specific aspects of successful designs.

From its inception, the Private Finance Initiative has been criticised for lack of design quality in the buildings that it produced. However, the Government became sufficiently concerned about this
deficiency that it encouraged the Commission for Architecture and the Built Environment and the Office of Government Commerce to develop recommendations to improve design quality; although it was greatly assisted by the 2004 EU Directive that enabled authorities to discuss all aspects of the proposals with the bidders. North Tyneside Council was concerned that its new generation of sheltered housing might be criticised in this way, and therefore took the recommendations seriously. Having assessed the existing design quality evaluation tools, it was concluded that none of them suited the PFI selection process. A new tool based on the hierarchical model, was generated mainly from academic literature. It was specifically devised to become increasingly more detailed at each stage. In its stage 3 form, the tool is currently making a significant contribution to the final selection of the consortia, who will undertake this ground-breaking project for the Council. Completion of the buildings and their post-occupancy evaluation are still some way off. In the meantime, there are proposals for introducing variants of the design quality evaluation tool on other building types, and a version for schools is under discussion with another local authority.

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[http://www.defendcouncilhousing.org.uk/dch/dch_PFIdcfm](http://www.defendcouncilhousing.org.uk/dch/dch_PFIdcfm) [accessed on 01/10/2009]

Participating in Integrated Project Delivery: The Future Mainspring of Architectural design Firms?

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Abstract

The construction industry is changing more and more towards integrated project delivery. Most of the research about integrated project delivery focuses on contractors. Architects could however also improve their competitive position and project portfolio by taking on an active role in innovative integrated projects. Based on a survey among 110 Dutch architectural design firms the types of offices are described that show interest in integrated practices as part of their competition strategy. Remarkably the office profiles found contrast to the expectations from literature about the organisation of firms. This could be a result of their need for flexibility and adaptability in order to deliver creative designs. Very small and very large firms seemed particularly interested in competing in integrated project delivery. The results of this survey reveal critical factors that are drivers for change in current marketing and organisational strategies of architectural design firms. Especially more control over construction processes and product quality makes firms think about changing their strategies.

Keywords: architectural design firms, innovation, integrated project delivery, competitive strategy, organisational structure
1. Introduction

According to the Dutch Economic Institute of the Construction Industry (EIB) integrated practice is the fastest growing method of project delivery in the Netherlands (Jansen & Sijpersma, 2007). In this paper the term ‘Integrated practice’ is used to refer to a collection of organisational contract structures that include some degree of integration of the traditional design phases of design, construct, and maintain (Elvin, 2007). The most common structures in the Dutch building industry are Total Engineering and Design-Build (Vogels et al., 2007). Total Engineering is a contract and organisation form with a partial integration according. The main contractor is responsible for delivering the complete design and total coordination of the project. According to Quatman (2006) Design-Build is a supply method in which the design and realization are combined in one contract. Until now the traditional Design-bid-build method is still favoured among large clients (57%), but a decrease of 21% is expected for the future (Jansen & Sijpersma, 2007). Yet, already 22% of the large clients require integrated project delivery for their projects and an additional increase of 14% is expected in the future. According to Elvin (2007) the popularity of integrated practice is caused by the single point responsibility for the entire project. The increase of integrated practice in the Netherlands will change the possibilities of market parties and actors to participate in the building project. This has to reflect on the strategy of architectural firms in managing their office because the portfolio of architectural design firms strongly depends on the preferences of clients in developing building projects.

Companies will have to anticipate on the changing market situations to preserve and increase their financial results as much as possible (Martens et al., 2003). The leading role in integrated practice is mainly taken upon by large construction companies. However, we believe that architectural design firms would also be capable of taking on this role. Compared to contractor architectural design firms are relatively small. Results of an annually held survey among members of the Royal Institute of Dutch Architects (BNA) show an average yearly net turnover of € 512.417 in 2007 with a net profit of 9.2% and € 610.000 in 2008 with a net profit of 14.7% per firm (van den Hurk, 2008). About 60% of all firms made profit. Large firms (over 40 FTE, average net turnover € 7.4 million) and the very small firms (0-2 FTE, average net turnover € 59.000) were profitable for 94% and 62% respectively. In general the number of employees of an architectural firm increased from an average of 4.5 FTE in 2004, to 6.6 FTE in 2007, and 7.1 FTE in 2008.

For many years half the portfolio of architectural firms has consisted of complete commissions (from initialization to realization) and half of partial assignments but the amount of partial assignments seems to be increasing. The portfolio of architects still consists mainly of traditional design-bid-build contracts. In 2006, the larger design firms (7%), medium and smaller firms (2%) were sporadically operative within the integrated practice. In spite of the small participation, 70% of the design firms find cooperation within the integrated practice a chance for a competition strategy. The clients of Dutch architectural design firms mainly consist of private persons, project developers, business relations and housing corporations. Governmental authorities were responsible for only 8% of the turnover (van den Hurk, 2008). About half of the turnover in 2007 was earned in the housing segment.
Offices, health care and education create respectively 11%, 7%, and 4% of the turnover. This image was about the same for 2008, but for 2009 a major decrease of turnover is expected.

The increased interest for the integrated practice offers both challenges as well as threats for architectural firms. In case the forecast of the EIB is correct the current position of the design firms could be damaged if no action is undertaken. Martens et al. (1998) indicate that when competitive pressure increases, defending an existing competition advantage becomes more difficult and less effective. The enlarged competitive pressure results in a dynamic game in which existing advantages erodes more rapidly and eventually can be destroyed. According to Cornelis (2003) this could have a negative impact for the competences of design firms such as knowledge loss, less focus on quality and usability of the end product, and less continuity in activities. A successful competition strategy must therefore not aim at scrupulously defending a certain advantage, but at creating new competition advantages instead. Hence, only participating in the traditional design-bid-build method does not seem judicious.

If firms decide to adjust their portfolios to the upcoming importance of integrated practice the current working method within the firm will have to change. This might include adjustments of the organisation structure. A knowledge gap exists between the type of firms and their marketing strategies. Apart from Coxe et al (1997) only a few scholars investigated the strategies of architects and their firms. Next to that, literature does not yet provide a clear understanding of the factors that contractors or design firms find important in developing a competition strategy for integrated practice. The purpose of this paper is to create more insight about the mainspring of design firms for participating in integrated practice. The objectives are to: 1) Describe the type of design firms which are interested in integrated practice as competition strategy; 2) Reveal critical factors for developing a competition strategy in integrated practice. The paper is based on a survey among 110 Dutch architectural design firms.

2. Background

How can architects successfully develop a competition strategy for the integrated practice market? According to Martens et al. (1998) a successful competition strategy assumes value creation for customers. The competition strategy refers to the way in which the enterprise creates value for its customers by the allocation, the management, and the mobility of resources. The resources of a firm provide the basis for the competition strategy. These resources can be deployed to develop technologies, products, and/or services to supply to customers. Martens et al. (1998) indicate that a competition strategy can only be realized if the drivers (company culture, processes and systems) and unique knowledge and skills will extend and incorporate.

A company culture is formed by the behaviour of people and the structure of the organisation (Martens et al.). The culture, assumptions, habits, and values as expressed on a symbolic manner influence the events of the firm. A company culture stipulates the degree in which a firm can adapt to the surroundings. In design firms the creative factor takes on a specific position because of its significant importance to create a product. This leads to a discrepancy between the needs of a designer
(autonomy) and the characteristics of strategies of the organisation (commercial context) (Coxe 1987, Gutman 1988). In this research the most important organisational structures of design firms developed by Mintzberg (1993) are combined with the market model of Winch and Schneider as described in the work of Loonen (2004). According to Mintzberg (1993) an organic organisational structure is the first phase of the development of an organisation. The structure will eventually develop to a mechanical structure. Contrary to a mechanic structure an organic structure can easily adapt to the production of new products and services.

![Figure 1: Market model of architectural firms (Loonen, 2004)](image)

Figure 1 shows the six possible firm types that are based on this combination. Loonen (2004) expects to find the following three configurations in practice:

1) Service focus in combination with an organic organisational structure: these types of firms are less able to realize complex projects, but offer a high service level at routine tasks. The activities of these offices aim at repeating solutions that were previously developed with regard to technique, budget and time. The organisational structure can be characterized by low complexity, less formalization, more communication, and more participation with employees of a lower level.

2) Experience focus in combination with a mechanic organisational structure: these types of firms are highly experienced in managing complex projects and meeting the quality standards of clients by sharing the responsibility for the project results. The organisational structure is characterized by a high degree of complexity, low formalization, a restricted communication network, and little participation in decision-making with the lower ranked employees.

3) Signature focus in combination with a mechanic organisational structure: these types of firms with a signature that focuses on aesthetics are able to realize high aesthetic value and quality levels for complex assignments. The organisational structure is characterized by a high degree of complexity, a lot of formal procedures, limited communication, and little participation in decision-making with the lower ranked employees.

A competition strategy can be only developed if a design firm has a horizontal look on the firm. This means a broad look on the organisation and an emphasis on processes. Developments in the market often lead to restructuring the existing activities of a firm. A new development in IT, such as Building Information Modelling, can thus be a ‘driver’ to restructure current activities and structures. In this research the increase of the interest for integrated practice is considered as such driver for change.
This past decade, the role of the architect has decreased moreover into tasks that are restricted to delivering the design and relate to obtaining the construction licenses only. Activities, such as briefing activities and supervision on the construction site, have been mostly taken over by other parties (Lourens, 2006). Even in relation to innovation potential architects have no mandate anymore to realize innovations (Rooke et al., 2003; Renier & Volker 2008). Some authors, such as Cornelis (2003), speak of ‘erosion’ or depreciation of the role and position of the architect. This is worrying in relation to the future existence of the profession. In spite of this situation, design firms still do not make well-considered and deliberate choices in their marketing strategies and positioning in the market. Until now no real intensions are shown by architects to adopt their strategies to changes in society. Lourens (2006) indicates that the current position of the architect elaborates on successes gained and choices made in the past. The office composition and structure generally evolved in the same way without a proper strategy or personnel policy (Loonen, 2004). This could explain why the integrated practice is hardly a component of the current task portfolio. According to Lourens (2006) 40% of the offices find the scope of the order portfolio too small to continue their activities on the long run. Considering the current weak financial situation of the firms - on average 33% of the architectural firms had to take financial losses in 2006 and 56% of the small offices till 5 FTE knows a negative financial result - a lot of potential for change should exist among the Dutch architectural firms.

Based on the theoretical framework two assumptions are made that will be tested in the empirical study. First, architectural design firms that focus on signature will not extend their competition strategy to the integrated practice because the need for creativity and autonomy of this type of organisation will show a tension with the commercial context of the integrated practice. Secondly the current weak position of limited turnover and a lack of future perspective (especially within the traditional design-bid-build method) should motivate architectural firms to deploy a new strategy in relation to integrated practice.

3. Research approach

Based on a literature review we developed a framework about a strategy for architectural design firms to compete in integrated practice that included several drivers for change, external barriers for participation, and competences of a firm (see also section 2 for the main concepts of the framework). The survey included an inventory of the organisational culture, the current portfolio, the perception of the threats and challenges related to integrated practices, and their potential interest in future integrated projects. Based on the framework a survey among all members of the BNA was conducted in March 2009. At that moment the impact of the financial crisis was already felt among the population. We therefore assumed a certain need for change in order to ‘survive’. However, despite these critical circumstances there was not much interest in participating in research related activities. 1501 Dutch architectural design firms were approached, of which 110 completed the survey. This is a response rate of 7% and can be considered a significant response in this field of research. The survey was addressed to executive board members and founders of the office. About 50% of the questionnaires was been filled in by architects, 35% from the population belonged to the executive board, and 15% belonged to the category ‘other’. This paper presents parts of the results from of the
full survey that was conducted. To derive statements for the whole architect population in the Netherlands, deductive statistics were applied on the data of the survey. The techniques used for descriptive statistics were cross tables, item analysis, Mann Whitney U test, and K-means cluster analysis. For explanatory statistics the logistic regression analysis was used.

4. Results

4.1 The strategy of the architect population

First we looked at the current competition strategy of the firms and their potential interest in integrated practices. 50.9% of the population indicated that they only participate in traditional design-bid-build projects and will not focus on the field of integrated practice in the future. Half of this group will continue focusing on the current market and target group, the rest (19.1% of the total population) will specialize more in a specific market group or will apply another strategy (8.2% of the total population). However, 49.1% of the total architect population indicated that they are interested in integrated practice now or in the future. 14.5% of the architect population is already participating in integrated projects and want to remain this position (8.2% as Design-Build consultant, 3.6% as Design-Build main provider, and 2.7% apply another strategy) and 34.5% wants to focus on the field of integrated practice in the future. Of the population who wants to develop integrated practice, 14.5% wants develop total engineering, 15.5% wants to develop Design-Build (11.8% as Design-Build consultant, 3.7% as Design-Build main provider) and 4.5% wants apply another strategy. For further analysis of the data the population has been subdivided in two categories: 1) Population NIP (Non Integrated Practices) (50.9%): the population that absolutely will not apply any form of integrated practice; 2) Population IP (Integrated Practices) (49.1%): the population that will apply or already applies integrated practice.

The results of the survey show that currently the architectural design firms are most active in the housing sector, although they indicate they want to be less active in this sector in the future. The office, school and healthcare sector is only a small component of the portfolio but these sectors are perceived as interesting for the future. It is remarkable that there is a significant difference between the population IP and NIP with respect to the sector health care. Population IP wants to perform significantly more health care projects in the future. Most of the commissioning clients are the project developers and the private organisations. Commissions of the government and other construction companies take no important position in the portfolio of the Dutch architectural design firms. It is striking that mainly the smallest and largest design firms in terms of number employees and turnover are interested in developing integrated practice. 61% of the population IP has a small office up to 10 employees and 15.6% of the population has more than 41 employees (see Figure 2). 47.7% of the population IP has a turnover of approximately 250,000 Euros and 16% have a turnover of more than 5,000,000 Euros.

In spite of the large part of the population that want to develop integrated practice, still very little integrated projects are realized nowadays in the Dutch building industry. DBFMO and alliances are
still not part of portfolio (<7.5%) and most of the total architect population has never realized a project with Design-Build (>75%). Hence, it is not surprising that the traditional design-bid-build and construction team method is the most important and favoured form of cooperation. There is no significant difference in portfolio of integrated practice between the population IP and NIP.

Figure 2: Size of the offices involved in this survey per group

<table>
<thead>
<tr>
<th>variable</th>
<th>Overview table: 6 clusters</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
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<tr>
<td>Informal</td>
<td>++</td>
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<tr>
<td>Heterarchy</td>
<td>++</td>
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<tr>
<td>Bottom-up</td>
<td>++</td>
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<tr>
<td>Flexible structure</td>
<td>++</td>
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<tr>
<td>Specialized tasks</td>
<td>*</td>
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<tr>
<td>Multidisciplinary teams</td>
<td>*</td>
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<tr>
<td>All-round departments</td>
<td>++</td>
</tr>
<tr>
<td>Focus experience</td>
<td>-</td>
</tr>
<tr>
<td>Focus Service</td>
<td>-</td>
</tr>
<tr>
<td>Focus Signature</td>
<td>++</td>
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Figure 3: Results of the cluster analysis in relation to the organisation types in figure 1

Figure 4: Scatter plot office profiles per group
4.2 Company culture as driver for integrated practice

To stipulate which type of offices wants to include integrated practice in their competition strategy, the office profiles as described in the theoretical framework (see figure 1) are compared to the results of this survey (see figure 3). The cluster analysis showed to what extent the theoretical assumptions about the organisational structure are valid and whether a difference exists in organisational structure and market focus between the population IP and NIP. Six clusters were found. The score on the clusters 1, 2, 3, 5 and 6 (N=87) correspond mostly to the characteristics of an organic structure. The organisational structure is characterized by a small degree of complexity, small formalization, more communication and more participation of the lower lines. Cluster 4 (N=9) is a remarkable exception on all other clusters. Cluster 4 seems like a mechanical structure. The organisational structure is characterized by a high degree of complexity, high level of formalization, a limited communication network in the decision making and little participation with the lower ranked employees.

The Scatter plot (Figure 4) shows that offices that want to develop integrated practice especially score highly on the focus on signature and service. Offices that do not want to participate in integrated practice score highly on the focus on experience and service. This means that the following office profiles in architecture act as a driver to develop integrated practices: 1) Focus on service and signature in combination with a mechanical structure (N=9): This office profile has a relatively strong focus on realizing projects with a signature in combination with providing services in relation to technique, budget and time; 2) Focus on signature in combination with an organic structure (N=12): This office profile contains offices that mainly focus on a strong signature. These offices realize primarily progressive architecture with a high level of aesthetic quality; 3) Focus on service and experience in combination with an organic structure (N=21): An office profile with a relatively strong focus on complex projects in combination with a high service level where previously developed solutions are applied.

4.3 Processes and systems as driver for integrated practice

In the past decades the traditional design-bid-build project served as standard contract and organisation form for design firms. These projects mainly determined the current processes and systems of the architectural firm. The current position of the company can act as a driver for developing integrated practice as competition strategy. A cross table is used to measure the extent in which architectural firms currently have enough customers, serve enough sectors and generate sufficient turnover within the traditional design-bid-build projects and collaboration structures. Moreover, also the general perception on the current realisation process and possibilities of integrated projects is measured to retrieve which drivers are important for the architect population.

The majority of the population (> 75%) finds that they can currently serve a sufficient amount and kind of customers but no significant difference was found (NIP: average rank score 47.85; IP: average rank score 52.80). A large part of the population finds (> 75%) it important to serve a sufficient amount of customers but no significant difference exists between the population NIP (average rank score 31.01) and IP (average rank score 32.09). The majority of the population (> 70%) thinks that
they can serve a sufficient amount of sectors and also regarding this issue no significant difference was found between the populations (NIP: average rank score 48.08 and IP: average rank score 51.39). Within the population NIP, 55.9% finds it important to serve a sufficient amount of sectors, for the population IP this is 66.7%. Also in this case no significant difference was found between the population NIP (average rank score 32.04) and IP (average rank score 29.69). Within the population NIP, 58.9% finds that they can generate enough turnover, whereas 69% of the population IP finds that they can generate a sufficient amount of turnover. This is not a significant difference between the population NIP (average rank score 50.35) and IP (average rank score 48.37). The majority of the total architect population (> 75%) finds it important to generate a sufficient amount turnover and no significant difference exists between the population NIP (average rank score 32.32) and IP (average rank score 29.33). Based on these results it can be concluded that no significant differences can be found about the number of customers and sectors and amount of turnover between the firms that are interested in integrated practices and not interested in integrated practices.

To measure the extent to which architectural firms can master the different phases of the design-bid-build process we used cross tables. These tables were preceded by an item analysis. Although considered as greatly important by both groups, for mastering the initiative and design phase no significant differences were found between the NIP and IP population. 82.1% of the NIP population and 73.8% of the IP populations think that they can master the initiative phase (population NIP: average rank score 47.46 and IP: average rank score 52.21) and they also think that it is important to master the initiative phase (> 88%; NIP: average rank score 28.10 and IP: average rank score 28.93). Within the population NIP, 89.3% finds that they can master the design phase, 73.8% of the population IP finds this too. There is border-significant difference (U=919; p<0.056) between the population NIP (average rank score 44.91) and IP (average rank score 55.62). The greatest part (>92%) finds it important to master the design phase with no significant difference between the population NIP (average rank score 24.82) and IP (average rank score 31.30). The population does not seem to agree about the level of control in the implementing phase. Within the population NIP, 57.1% finds that they can master the execution process, whereas only 35.7% of the population IP thinks they can. There is a border-significant difference (U=908; p<0.054) between the population NIP (average rank score 27.40) and IP (average rank score 29.77). It appears that 58.6% of the population NIP finds it important to master the execution process, whereas 46.2% of the population IP thinks this is important. The difference between the population NIP (average rank score 27.40) and IP (average rank score 29.77) is not significant. The population does not seem to have a unanimous opinion about the process innovations either. 35.7% of the population NIP, and 21.4% of the population IP finds that they can realize sufficient process innovations. In this case a significant difference exists between the population NIP (average rank score 44.19) and IP (average rank score 56.58). It appears that the population IP (U =878.5; p=0.029) realizes significantly less product innovations. 52.9% of the population NIP finds realizing process innovations important while 59.3% of the IP population finds this important. There is no significant difference between the population NIP (average rank score 31.38) and IP (average rank score 30.52). This means that only in the current perception of mastering the realisation phase of a building (actual construction) and enables process innovations significant differences were found between the firms that are open to integrated practices and the firms that are not interested in these kinds of projects.
Also for measuring the extent to which architectural firms can master the overall quality in the implementing phase a cross table was used. Again these tables were preceded by an item analysis. The architect population of our survey did not agree about the quality (product quality, price quality and financial turnovers) that is currently realized in association with the contractor during actual construction of the buildings. Within the population NIP, 58.9% finds that they can reach the best quality with the contractor, whereas only 34.9% of the population IP thinks this is possible. A significant difference exists (U =779.5; p<0.002) between the population NIP (average rank score 42.42) and IP (average rank score 59.87). The main part of the population (83.3%) finds it important to reach the best possible level of quality with no significant difference between the population NIP (average rank score 31.13) and IP (average rank score 26.63). The population also does not agree about the product innovations that are currently realized. Within the population NIP, 44.6% finds that they can realize sufficient product innovations, whereas only 21.4% agrees with this within the IP population. This leads to a significant difference between the population NIP (average rank score 43.38) and IP (average rank score 57.67). It appears that the population IP significantly (U =833; p<0.011) realizes less product innovations. Within the population NIP 67.6% finds it important to realize product innovations compared to 51.9% of population IP. This difference is not significant (NIP: average rank score 28.39 and IP: average rank score 33.61).

<table>
<thead>
<tr>
<th>Control implementing phase</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig</th>
<th>Exp(B)</th>
<th>95% C.I for EXP(B)</th>
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<tr>
<td>Step 1^ control work preparation</td>
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<td>.278</td>
<td>4.628</td>
<td>1</td>
<td>.038</td>
<td>1.844</td>
<td>1.068, 3.183</td>
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<td>-.304</td>
<td>.284</td>
<td>1.069</td>
<td>1</td>
<td>.301</td>
<td>.738</td>
<td>.415, 1.313</td>
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<td>control esthetic accompaniment</td>
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<td>.403</td>
<td>.421</td>
<td>1</td>
<td>.117</td>
<td>.707</td>
<td>.350, 1.698</td>
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<th>Quality implementing phase</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig</th>
<th>Exp(B)</th>
<th>95% C.I for EXP(B)</th>
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<td>product quality construction company</td>
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<td>.408</td>
<td>6.943</td>
<td>1</td>
<td>.008</td>
<td>2.932</td>
<td>1.317, 6.527</td>
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<td>price quality construction company</td>
<td>.519</td>
<td>.465</td>
<td>1.246</td>
<td>1</td>
<td>.264</td>
<td>1.680</td>
<td>.676, 4.175</td>
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<td>cost turnover construction company</td>
<td>-.495</td>
<td>.498</td>
<td>.989</td>
<td>1</td>
<td>.320</td>
<td>.609</td>
<td>.230, 1.617</td>
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<td>.241</td>
<td>.306</td>
<td>1</td>
<td>.580</td>
<td>1.143</td>
<td>.713, 1.832</td>
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</table>

Figure 5: regression analysis

The reasons why some firms are interested in integrated practice and other are not still remain unclear. Yet it is important to know which factors act as driver for integrated practice. The most important statistically significant variables of the traditional design-bid-build projects (control over implementation phase and quality of the implementation phase) are examined by a regression analysis. This means that: Response (Z) = B1 control implementing phase (control work preparation + aesthetic accompaniment) B2 quality implementing phase (quality subcontractors + product quality construction company + price quality construction company + cost turnover construction company + realize product innovations) (see figure 5).

An ideal regression model corresponds with a high value for Cox & Snell 'R square' and Nagelkerke 'R square' and a low '- 2 Loglikelihood' value. Our analysis shows a Cox & Snell R Square with a value of 0.243 and Nagelkerke R call Square of 0.323 which indicates that the model is moderately positive. Another way to stipulate the fit of the model is the Hosmer and Lemeshow goodness of fit test. We examined if significant differences existed between frequencies in the data and if the
frequencies could be predicted in the model. The differences are not significant (0.97) so we can again conclude that the model is appropriate moderated at the data. On the basis of a classification table we can conclude that 70% of the Dutch firms are correctly classified, which is a good score.

The population that will develop integrated practice in the future is for 33% explained by the dissatisfaction concerning the variables of: mastering work preparation, mastering aesthetic implementation, the quality of subcontractors, realizing product innovations, the product quality, and quality and cost turnovers of the contractor. The coefficients of mastering product quality (p<value 0.008) and controlling work preparation (p<value 0.028) exert a positive (significant) influence on the response on integrated practices. These factors therefore positively influence the choice to unfold activities that relate to integrated practices when the demand increases significantly and there are clear possibilities to reinforce the competitive position.

5. Discussion and conclusion

This research shows that approximately half of the total population of the Dutch architects is interested in developing activities on the market for integrated practices such as total engineering and Design and Build projects. Especially the small and large architectural firms (in terms of scope and turnover) are interested in integrated projects. The substantial amount of small offices is remarkable because we expected these offices to have lesser production capacity, capital and knowledge ‘in house’ for developing a new competition strategy that also includes activities beyond the design phase. Although integrated practice has not been a main part of the current portfolio of Dutch architectural firms, it appears that a substantial part of the firms is seriously considering adjusting their organisational strategy for integrated projects.

This paper mainly focused on the office profiles (service, experience and signature) and the extent in which these characteristics act as a driver to develop integrated practice. The results of this research indicate different results than the work of Mintzberg (1993), Coxe (1987) and Loonen (2004). First of all we did not find a relation between the orientation of the firm (signature, experience and service) and the organisational structure (organic and mechanic). Five out of the six office profiles we found to be organic (90.6%). In relation to the theory of Mintzberg (1993) this would mean that most of the design firms are in an early stage of organisational development. We question if design firms will proceed developing into the ‘next’ stages of organisational development. An organic organisational structure can be well understood from the issue of adaptability; it can easily adapt to the production of new products and services, which is important for creativity in design. A remarkable result within the office profiles that were found is profile number 4 with a service signature in combination with a professional bureaucracy. This office profile has an unusual mechanical structure and is strongly formal, hierarchical, and top down with a fixed structure. There is no univocal explanation for this office profile, but the two-sided focus on services and signature projects could be a possible reason for this specific type. Coxe (1987), Mintzberg (1993) and Gutman (1988) noticed that there is a conflict between the company situation and the personal aspirations of an architect. Theoretically this conflict can be found mostly with signature oriented offices. It is therefore surprising that mainly the signature oriented offices want to develop integrated practice.
This research was taken from a perspective in relation to the concerns about the marginal role and position of the architect in the Dutch construction industry (Renier & Volker, 2008; Vogels et al, 2007). The results show that the position and role of the architect are not very liable to fluctuations in the market situation. It becomes clear that design firms are still very satisfied with the traditional design-bid-build collaboration structure. Both populations (interested in integrated projects or not) stated that they are generating enough customers, sectors and turnover. Nevertheless an intriguing difference was found between the population NIP and the population IP. In contrast to the population NIP the population IP state to currently poorly master the implementing phase, the implementation of design quality enough and the realisation of product innovations. This could be due to the fact that the IP population mainly focuses at signature and service-oriented projects. Because of this profile it is possible that they use a different standard concerning the process control and product quality in the implementing phase. This means that the firms that are willing to develop integrated projects are motivated by the factors that relate to dissatisfaction about the current situation. 33% of the variables are explained by dissatisfaction about the issues of mastering work preparation, realizing product innovations, mastering aesthetic implementation, poor quality of subcontractors, a lack of product quality, and limited financial turnovers. This means that a new perspective on improved processes, more product control, and a better competitive position are the drivers of architectural design firms for developing a competition strategy within integrated project delivery.

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Towards an Effective Management for the Architectural Design Competitions: the Impact of the Pre-Competition Stage on the Achieved Result, Case Studies

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Abstract

Architectural design competitions have become an increasingly important tool in developing the ideas underlying construction projects. In order to harness this tool to produce ideas that meet clients' expectations and positively add to our built environment, it is necessary to develop linkages between the theoretical base and professional practice in the art of competition management. Based on the lessons learned from organizing a number of international design competitions which have been held in Saudi Arabia in recent years, this paper analyses the impact of the pre-competition stage upon the achieved result, using actual architectural competitions as empirical support for the arguments made.

The pre-competition stage requires a number of tasks and activities, to which attention should be drawn. Given that competitors normally come from different cultures and social environments, the good establishment of this initial foundation is found to be essential if the competition is to succeed in meeting its overall objectives.

The paper concludes by highlighting the need for a better understanding of how competitions work. Recommendations are given regarding the appointment of an expert team and the implementation of a management methodology which aims to assist competitors in achieving the optimum results, in the hopes of increasing the probability of success in such architectural competitions.

Keywords: architectural design competitions, competition management, pre-competition
1. Introduction

Architectural design competitions have become an increasingly important tool in developing the ideas underlying construction projects. Many factors have combined to give prominence to architectural design competitions in recent practices, making them the preferred method for the selection of the best design. One of those factors is the freedom of the globalized economy, which enables businesses to move beyond traditional boundaries, giving the international architectural firms a unique opportunity to compete with others through a simple process regardless of where the project is physically located. Another factor is the escalating complexity of the contemporary urban developments, which require integrated thinking to respond to the challenging needs of clients. In addition, the growing awareness of clients has played a pivotal role in accepting and adopting this tool to develop their projects.

Benefits from using the competition tool in realizing projects can be seen for both; clients and architects. On the one hand it gives clients a splendid chance to discover a range of possible solutions to a design problem, especially when the project is functionally complex or large-scale in its urban setting. Moreover, a competition usually generates public interest, by which a project's image can spread far more effectively. In addition, a competition constitutes an optimum investment of a client's capital, despite the high cost of the organization itself, since a multiplicity of alternatives are discovered and examined in a competitive way. On the other hand, there are many advantages which motivate architects to participate in competitions. One of them is to give emerging architects an opportunity to prove themselves among the "heavyweights" in the profession. It also represents an experimental field in which designers are free to produce odd and creative concepts, unlike the directly-commissioned projects. Beside the aforementioned advantages, a competition is deemed as a pedagogical process that reflects the essence of the profession.

In contrast to the positive side, conducting a competition has some disadvantages for both clients and architects. For the client, this kind of procedure usually exhausts time and money, which may be crucial for some projects. Another point that seems to be a downside is the probability of having a winner without enough experience due to the reluctance of leading firms to participate occasionally in competitions. Moreover, many clients feel that they are excluded from the selection process by leaving the jury an ultimate power of decision-making, compared to the powerful control of a direct commission. For architects, the most common reason for not participating is the high cost of entering a competition without any guarantee that they will get the job.

Having mentioned the pros and cons of organizing a competition, it is necessary to refer to recent debate on the role of architectural design competitions in creating well-liked buildings. Some researchers argue that whereas significant resources are being dedicated to competitions, the outcomes are not always satisfactory. It has been observed that some buildings resulting from competitions do not work properly, or occupants and passersby feel unhappy with the winner design and prefer the losing one and that juries give a priority to the aesthetic criteria rather than popular meanings and functions related to the end user, among other things which increase the need to question this kind of practice. Jack Nasar\(^1\), from Ohio State University, has pointed out that "design competitions have become very popular without much attention given to whether they're successful for the public". He
also provided an explanation as to why competition winners are sometimes regarded as losers by the public, because competition juries "want a unique design that stands out from its context, and this does not always make the best building". This negative feeling is not only evoked by the public and critics; some architects have their own opinions about competitions. Charles Gwathemey, an American architect, decided not to participate in architectural competitions nowadays because "they cost much money and divert energy from other projects". Whereas Richard Meier, a well-known American architect, questioned the reason why architects do competition; "do lawyers do competitions? Do doctors do competitions? No other professional does a competition. The downside is, you never know whether it's a real project or they're just kind of fishing around". Another reluctant architect, John Pawson, from Britain, states clearly that "a design produced in the circumstances of a competition would never be quite as grounded as working for a real client".

2. Architectural design competitions: between theoretical base and actual practice

A careful review of the aforementioned debate indicates the need to assess and tackle the current practice of architectural design competitions to see whether they are successful in producing the results expected from them. In this regard, the purpose of this paper is to review the present practice of architectural design competitions, focusing on one of the most important phases in the whole process, the pre-competition stage. Based on the lessons learned from organizing a number of international design competitions which have been held in Saudi Arabia in recent years, this paper analyses the impact of the pre-competition stage upon the achieved result, using actual architectural competitions as empirical support for the arguments made.

Architectural design competitions are particularly important in Saudi Arabia, where most of the big architectural projects are now competitions in one form or another. In addition to government bodies, the private sector has become an important player in adopting the competition method in developing construction projects. Since there is little experience in conducting competitions in a proper way, with reliance only on common sense, many undesirable consequences have occurred.

In order to harness this tool to produce ideas that meet clients' expectations and positively add to our built environment, it is necessary to develop linkages between the theoretical base and professional practice in the art of competition management.

On the theoretical side, clients and promoters are required to adhere to the professional guidelines for conducting design competitions issued by professional bodies (national or international), according to projects' purposes and types. There are many guiding rules in this regard and they vary from international to regional and even national standards. Guidelines and recommendations issued by the International Union of Architects (UIA) and the Architect's Council of Europe for instance are examples of international and regional standards. Moreover, there exist a wide range of national codes which take much of their content from the international and regional rules, with some adaptation to suit their local situations.
In most sets of rules, strict articles have been formed to ensure professional treatment among all parties involved in the competition and to maintain fair adjudication between competitors. Statements on definitions, types of competitions, steps to ensure anonymity and the like comprise the core content. Despite the importance of such articles, professional guidelines still lack guidance for the running of a competition that is to show the management art of how to perform such a practice, from the outset to the final result. Merely concentrating on how to keep entries anonymous or maintaining the mandatory steps to ensure fair treatment between competitors may not by themselves guarantee a successful result. Hence, there is a growing need to develop a methodology that targets a successful result, starting from the decision to hold a design competition, and including how to assist the competing architects to reach the expected end goal.

This paper will identify the nature and specify the components of the pre-competition stage, and then examine this important phase through three empirical case studies, to see how crucial this stage is in reaching the desirable objective. The case studies constitute international design competitions that have been conducted in Saudi Arabia from 2003 to 2009, in which the author was acting in different positions ranging from general coordinator to chairman of the technical committee. Two of these competitions were held in Riyadh, the political capital of Saudi Arabia, whereas the third was held in Makkah, the religious capital of Saudi Arabia. A number of well-known international architectural firms have participated in these competitions from different orientations, such as Foster + Partners from UK, T.R Hamza & Yeang from Malaysia, Lab Architecture Studio from Australia and Langdon Wilson from the USA. Lessons learned from these cases can be generalized beyond Saudi Arabia in the fact that they constitute a global common practice, which lacks the art of managing a well-tailored competition by relying only on professional guidelines.

3. Pre-competition stage: importance and components

Conducting a competition usually happens in three phases: the pre-competition stage, the competition (design) stage and the post-competition stage. Whereas each stage seems to be well-defined by its separate tasks, there are some activities that apparently seem to be shared between two stages as shown in figure 1. Of the three, the pre-competition stage represents the initial and important foundation, on which the other stages will be built. There are many tasks which could be identified as part of the pre-competition stage. Attention should be drawn to these tasks to ensure a good understanding of a competition, and therefore, reach a desirable result. It must be noted that most, if not all, of the unexpected results of competitions depend on decisions that have been wrongly taken or ignored in the pre-competition stage. Good organization of a competition should take into account the following tasks when starting to think about conducting a competition.

3.1. The decision to hold a design competition

As an initial task, such a decision is deemed an important and crucial step, on which the whole process will be founded. To decide whether to hold a competition versus a direct commission for a project, and what kind of a competition to conduct are not easy decisions. Sometimes, direct commission represents an ideal alternative in order to minimize wasted time and money, especially where there are not enough resources to hold a competition or a lack of competent architects. The
importance, complexity and publicity of a project may reinforce the choice to hold a competition, as mentioned earlier, but there is a need, firstly, to select which form of a competition to choose. The Royal Institute of British Architects (RIBA) differentiates between two distinct forms of competition: to find the right architect or design team, and to find the most appropriate design solution for a project. The recommendation for the first form is to conduct a competitive interview to examine the capabilities and personnel of each architect or design team. This form of competition is suitable when the architect is required to help the client develop the project brief, and/or when the project requires specialized tasks and studies that are difficult to undertake within a design competition. For the second form, it may be better to conduct a design competition, since the client would have good idea and knowledge about their project and a detailed brief might already be prepared accordingly. The following action in this step is to select which type of competitions is to be chosen: open, closed or invited. In this regard, an open competition constitutes the best direction for an "ideas competition", when a client is broadly seeking the best solution to a project that may not be built. It can also be used for real projects if no certain requirements or expertise are required. Closed and invited competitions are characterized by restricting participation to those who comply with specific conditions, such as being located within a defined area in the case of "closed competition" or having a specialization in a certain type of projects which fulfills the client's interest in the case of "invited competition". Both closed and invited competitions are used for simple and complex projects where certain expertise is required.

Figure 1: Phases of the design competition with the associated tasks

**3.2. The formation of a qualified managing team**

Forming a qualified management team is paramount to having a well-run competition. Although most of the international professional guidelines advise clients and promoters to appoint a professional adviser to take the whole responsibility of the organization, it is apparent that such work requires a
dedicated team to keep monitoring all activities from the outset until the announcement of results. The technical committee, which the guidelines suggest perform the technical review, should be formed from the beginning of the process to participate in initial steps such as defining the goals and specifying the competition requirements. The great benefit of having such a team, instead of only one advisor, is the opportunity to share ideas and carefully review all documents and decisions in a way that would maintain a unified direction throughout the competition period. Having the same team that prepared the requirements technically assessing the entries, would probably contribute to avoid any misunderstanding or even altering the requirements at later stage.

3.3. Collection of the existing and required data
The provision of good data and information regarding a project is very essential to enable competitors to start their mission on solid ground. Data related to the project site and broader location such as site surveys, soil tests, infrastructure networks, applicable city regulations and the like should be collected and provided to the competitors. Other necessary information to be provided relates to the specific subject or theme of the project, such as, for example, the provision of informative statements on the educational philosophy and system of the country when calling for an educational project. In addition, clients and promoters should make sure that good knowledge of the socio-cultural aspects has been clearly conveyed to the competitors, especially when they come from different cultures and environments. The "golden message" is: the more relative data and information can be provided; the more well-thought designs can be produced.

3.4. Preparation of the Terms of Reference (TOR)
The competition TOR document constitutes the communicating tool by which a client is able to convey his/her vision, ambitions and requirements to the designers. It is also used as a basis of the legal bond when forming a contract to identify rights and liabilities between the parties. It is worth mentioning that a well-prepared TOR can be seen as being half-way towards the final result. Attention should be drawn carefully to identify components of the TOR document to include all definitions, information, requirements and conditions that guide competitors through their mission. There are many types of information that a good TOR document can provide, but the main components may include: identification of the owner and promoter, statements of vision and objectives, site data and analysis, functional and area programs, competition instructions and conditions, scope of work and deliverables, design guidelines and evaluation criteria, competition schedule and deadline, eligibility and prizes and last but not least the particulars of the post-competition stage. It is strongly recommended to include additional information which aims to help competitors fully understand a project challenge, like information on socio-cultural aspects, an informative background about the project subject/theme and a statement on how the client looks to the project in terms of trends and styles. In short, the TOR document should be comprehensive, explicit and precise.

3.5. Selection of the appropriate consultants/competitors
A competition output will be greatly affected if unsuitable competitors are selected. There should be a considerable awareness and attention put towards the selection of the appropriate consultants according to the project's type, size and complexity. A frequently debated point is whether to invite a creative young consultant that lacks experience or to invite a consultant that has an extensive experience but classic style! To decide, a careful analysis should be undertaken to see which is the
most important for the project: to have the best architect, so that the client is confident about the design process and delivery, or to find the best solution, by which the client's "blue sky" vision is realized. Specialization is also another debatable issue: some consultants are known to have a wide range of specialities that enable them undertake any project in any field or capacity, whereas some others are specialized in one field with a high level of quality performance. These two factors, expertise and specialization associated with the project particulars should form the basis for the selection criteria.

3.6. Nomination of the suitable Jury

Competition results are often controversial and the reason is very obvious; the decisions of the judging panels! The formation of a jury appears to be the most important factor influencing the competition result. Attention should be given to select suitable jury members considering many criteria such as specialities, orientation and prevailing trends. Jurors should be selected according to their specialities (relevant to the project theme), in addition to their ability to evaluate many projects effectively in a short time. Moreover, the jury formation should balance intellectual leanings across the jurors for the sake of the project. Additionally, the presence of the client in addition to an end-user representative would probably strengthen the jury, providing they have been well selected. It is recommended that the jury be selected at the outset, prior to launching the competition, as many of international rules suggest. Involving the jurors in the preparation of the TOR and other conditions will make them familiar with the project, and more closely understand the client's ambitions and requirements. To keep the number of the jury members as small as practical, and at the same time accommodate the specialities that a given project requires, an advisory committee of very specialized professionals may be formed to assist the jury of their opinions on the entries, though without giving them voting rights. Whereas it would be useful most of the time, having both a jury and advisory team may cause mission overlap if the process is not well controlled and the roles are not clearly specified.

4. Case study descriptions

4.1. Case 1: Design competition for Saudi houses: Affordability & sustainability

The client and organizer of this competition is a governmental body that is responsible for the planning and development of Riyadh, the capital city of Saudi Arabia. Based on its regulatory role, especially in the urban and building legislation, the client decided to conduct an open ideas competition in February 2003 to explore solutions for the design of the Saudi house. A lot with a size of 325m² which represents a half-size of the typical lot has been chosen in one of the undeveloped quarters. To obtain as many solutions as possible, the competition was announced internationally in two separate categories, for professionals and for students with total prizes of SR 525,000 (US $140,000). The deadline for the submission was stated at early December 2003, on a justification to give the universities all over the world a good opportunity to take the competition as a class-project for their students.

The competition TOR was prepared internally to include the necessary information that is required to guide the competitors. A clear space program was provided, in addition to informative statements on
Saudi Arabia, Riyadh and the climate. The TOR also presented the urban and architectural heritage of Riyadh and the impact of that on the housing sector.

Due to its interesting theme, free registration and the big amount of the prizes, the competition has attracted 1393 registrants (833 professionals and 560 students) from 61 countries around the world. In the end, 178 entries were only received (155 from professionals and 63 from students).

The competition management was done internally with support from an architectural consulting office at a later stage. Given that the team who initiated the competition and prepared the TOR was different than the team who took the management following the registration, some modifications were made to remedy a few faults such as generating ID codes, stipulating only 2 boards for the submission and establishing a web-based confirmation process. The technical committee was formed later within the managing team to undertake technical scrutiny for the entries. A technical report was prepared, in which all entries were assessed for compliance with the competition regulations and requirements.

The discussion about the jury formation started very late - after entries had been received and checked. As a result, the client was obliged to postpone the jury session one month from the date that was originally stated in the TOR. The entries were judged by a panel of seven members. Three of these represented the client whereas the rest were academic and institutional members from Arab and foreign countries. Following five rounds of deliberations and voting over three full days without the presence of the competitors, the jury selected the first three places in each category for the award of the allocated prizes, and in addition, 12 entries in both categories which were recognized for certificates of merits.

4.2. Case 2: Riyadh business center complex competition

In this project, the client was a well-known real estate developer in Saudi Arabia. Inspired by a new vision, the new management board of this developer took a decision in 2005 to develop one of its valuable sites in Riyadh which has an area of 39,000 m² with a new concept; a business park. As the intention was to develop a prestigious and fascinating project that stood at the forefront, ahead of competitors, the choice of holding an international competition was strongly endorsed.

The management board has commissioned an expert advisor to prepare the TOR for this competition in close consultation with the board. The TOR included reasonable information; starting with a background about the client, objective and challenges, then identifying the functional and space program in a general way. The main requested elements were multi-tower office buildings that varied in heights from 6-15 storeys with a total built-up area of 80,000 – 90,000 m². The site description included maps and photos, in addition to building regulations and design guidelines.

Since the client was very keen to see impressive proposals developed in a highly competitive manner, a decision was made to conduct a limited invited competition, with an amount of US $ 220,000 for the first three prizes, in addition to US $ 10,000 for each of the others. A pool of 26 international and local consultants, whose works were creative and garnered the client's interest, was prepared. In October 2005, a final short list of six consultants (four international firms from Australia, Denmark
and Malaysia as well as two local firms) was reached. The competition schedule fixed the submission deadline to be late January 2006, giving a period of approximately three months for the design work.

The organization of the competition was undertaken internally at the projects department under the supervision of a general coordinator. An expert advisor was engaged in reviewing and modifying the TOR, in addition to consultancy contribution in other tasks. Following the submission deadline, a technical assessment was undertaken by the managing team for the six entries to review functions, areas and check to the extent to which each competitor responded to the competition conditions and requirements.

Having discussed the jury formation at a later stage, a panel of six members judged the entries in February 2006. The jury included two representatives from the board, two professors from the faculty of architecture in a local university, a representative from the municipality and the aforementioned advisor. Deliberations took three half-day discussion sessions, without the presence of the competitors, and voted in three rounds, eliminating the least competitive schemes in each round until they reached the ranking of the three first places.

4.3. Case 3: Mount Khandama conceptual planning competition

The client of this project was a venerable individual of prestige and influence in Saudi Arabia. This client owns a large piece of land with an area of 910,000m² in an important city: Makkah. Characterized by its prestigious location, less than one kilometer distant from the Holy Mosque and subject to a high demand for accommodation in Makkah city, the Mount Khandama site constitutes a marvelous opportunity to create a unique destination for pilgrims and visitors to Makkah, despite the challenging rugged mountainous topography.

To arrive at the most appropriate solution, the client was convinced to conduct an international competition. A local architectural consulting office was appointed in September 2008 to organize the competition.

The competition TOR contained the available information about the site and the nature of the development, which was required to prepare a conceptual Structure Plan for the Mount Khandama site to have a total built-up area of 6 – 7 million m². General information about Makkah and the site was given in addition to the client's goals and planning guidelines. The requested functions were mainly focused on hospitality and accommodation without giving any details or approximate areas.

The organizer decided to make the competition an international paid competition to give competitors motivation to produce well thought-out concepts. Total remunerations of US $ 235,000 for complying submissions were agreed for each competitor. Letters to request expressions of interest were sent in October 2008 to nine international consultants, without a clear set of criteria. In December 2008, a short list of five consultants (from Germany, UAE and UK) was reached, in addition to two consultants (from USA and Malaysia) who were added by the client. In late January, the final participant list was shortened to six consultants due to the unwillingness of one of the consultants to participate unless special conditions were put in place.
The organizer decided to hold a workshop session with each consultant in February 2009, following the Q&A period. The aim of these workshops was to present more information that the organizer had been investigating, in addition to assessing the initial approach of each consultant to see whether it complied with the nature of the site and client's vision.

In addition to the managing team which was supervised by a general coordinator, an advisory team of three experts in architecture and urban economics was created from the outset to assist in discussing technical issues. Later on, the technical committee was formed consisting of the advisory team and the general coordinator to undertake a thorough technical review of the six submissions. A detailed technical report was prepared for the jury, showing numbers and facts about each concept.

The discussion to form the jury was initiated early in December 2008. A pool of international and local expert professionals in architecture, urban design and landscape was prepared. The final list of five jurors was selected including four professors from USA, UAE and Saudi Arabia, in addition to a well-known Arab architect and urban designer.

During the period of 25 – 28 May 2009, the jury started its mission by attending the presentations by the consultants. Having seen the presentations, the jury began a closed discussion internally, without the presence of the consultants. After thorough deliberations, the jury finally came to a consensus to award first place to one of the German consultants.

Figure 2: Saudi Houses, professional winner
5. Case Study Analysis

5.1. Starting from the right way: the good decision factor

As noted in the examples described above, the choice of holding a competition, as an initial step, was the right decision in all cases. In the Saudi Houses competition, the client was seeking creative solutions for the design of a single-family unit to examine special regulations. In addition to the lot size and setbacks aspects, the socio-cultural traditions seemed to be the main factor that aggravates the problem. Hence, calling for an international competition would break this closed-circle by allowing foreign and fresh designers to participate with less philosophical constrains. In the Business Center case, the client was eager to surpass the other competitors in the real estate market by developing an unprecedented project. To obtain as many creative and diversified solutions as possible, the competition tool would constitute the best direction in this regard. In the last example, the Mount Khandama competition, the sensitive identity of Makkah in addition to the aggressive topography of the site and the competing mega-developments which surround the site represent significant challenges which require a holistic treatment and integrated investigation.

Having assessed the initial decision, it is necessary to see the extent to which final decisions were successfully reached. Examination of the cases with regard to the competition form and type reveals disparate results. The Saudi Houses competition was shaped as an open international ideas competition and this was seen to match client's objectives and its role as a leading planning arm of the government. Allowing both architects and students from all over the world to share the mission to produce possible solutions was a successful decision indeed. In the case of the Business Center competition, it was necessary to limit the participation to specific consultants to ensure the competence and professional experience of all of the participants, since the competition was dealing with a real project which was intended to powerfully enhance the owner's reputation. In the Mount Khandama example, one can strongly argue that the client failed to make the right decision! From an analytical point of view, the planning level that the project was dealing with required an experienced consultant that was fully aware of the site and the associated challenges. The functional program that the client requested without any precision or specification, in addition to the considerable lack of information, probably meant that an assessment interview and not a design competition would have been most appropriate. The selection of a good consultant that had a deep understanding would have helped the client define functions precisely, collect the missing data or even undertake the needed studies, before starting to search for a good plan for the site.
5.2. Managing the information factor: preparing data and TOR

The scrutiny of this factor also shows diverse outcomes. Since the intention of the Saudi Houses competition was to obtain a design that could be built anywhere in Riyadh, the organizers provided a broad contextual location and an abstract layout of one of a typical sub-division. Other information related to the housing sector and its history has been given in a summative way. The socio-cultural aspects were not separately emphasized; only some statements were mentioned when talking about the housing types. As a conclusion in this case, the given information might have been acceptable considering the type and objectives of the competition, although more in-depth focusing on the social factors of the Saudi house would have improved the resolution process, especially for the foreign participants. In the Business Center, more details were given in this case regarding the site maps and building regulations, whereas the geological conditions and city infrastructure networks were totally absent. The client also failed to provide any information about the business sector in Saudi Arabia although the project theme is strongly interconnected with this sector. In an in-depth review of this case, it appears that the client has thought about the conducted competition as ideas-generating process and not as a real project, perhaps explaining why insufficient effort was made to gather necessary information. In the Khandama case, although the competition organizer has provided a detailed land and topography survey, the infrastructure networks data, which was crucial and very much required in such an urban planning project, was not available. The fact that the project is located in the heart of Makkah, very close to the Holy Mosque, and within the context of the holy sites of the Hajj, the provision of in-depth information about the Hajj, Umra and the socio-religious life of Muslims constitutes a fundamental task that needed to be undertaken especially considering that all competitors came from outside the region and were for the most part non-Muslims. Whereas the organizer tried to remedy this shortage by providing some missing information in the workshops held later, the competitors still started their mission in a weak position: lack of site information, unfamiliarity with the Makkah's identity and confusion about the required development.

As a collecting-channel for all data pertinent to the competition, the value of the TOR may be evaluated through the main topics that it should encompass: to give information about the project, to convey the client's vision and ambition, to articulate conditions related to the competition stage and to illustrate the further step/s following the competition. The information section deals with the data related to the site and its context in addition to supporting information relevant to the project’s theme, as has just been reviewed. The other important item of this section is the functional and area program. In this regard, the Saudi Houses example can be cited as reflecting this item very clearly. The other two cases didn't give a detailed program and only provided general functions. Whereas it could be part of the competition challenge to let the competitors investigate possible functions that may enrich the business park theme, the client of the Mount Khandama competition should have identified, at least, types and associate areas or percentages of each functional group, in order to have them well planned.

In the part of the vision and ambitions which represent the client's values, we can say that good statements covering these issues were only mentioned in the Saudi Houses case. In the two other cases, it is difficult to figure out what the clients were looking for, in terms of expectations or wishes!
However, all the TOR documents failed to convey the preferences of the clients and how they appreciate their projects in terms of the styles and trends.

In the remaining sections, the conditions and the follow-up steps were properly covered in all cases. As a conclusion, it can be deemed that the TOR document in each case was prepared and issued in a way that positively satisfied and helped the competitors. This is despite missing elements or the misunderstandings which occurred and had an impact in some cases. If this had been avoided, the result could have been more satisfactory and acceptable.

5.3. Managing the personnel factor: choosing the team, the competitors and the jury

In the review of the management teams, we may recognize that two of the cases were organized and managed in-house by the clients: the Saudi Houses and the Business Center. Whereas in these cases the clients lacked experience in conducting such events, having internally organized these competitions has helped to build a close-relation between competitors and clients in a successful way. In all the cited cases, the formation of the managing team didn't follow the professional advisor method. The team in each case comprised a general coordinator with only managerial and communication responsibilities supported by an administrative secretariat. The technical issues were left to a professional team in most of the cases. Though this separation weakened the role of the general coordinator, it did strengthen the decision-making process by having expert members discussing technical issues. The technical committee for each competition was assembled at a later stage when receiving the submissions from competitors, and their role was only to assess the entries in terms of fulfillment of conditions and requirements.

Selecting competitors for the cases followed different methods, varying in appropriateness from one to another. In the Saudi Houses example, the participation was open to architects and architectural students, without any restrictions or even registration fees. This led to wide participation from young architects with varying expertise and backgrounds which could be seen to be compatible with the competition objective. In the Business Center, the selected international consultants were chosen according to their reputation as creative designers, whereas the local ones were selected only as a personal preference of the client, with no specific criteria. In the case of Mount Khandama, it can be said that the selection did not adhere to the fields of specialization that the competition required. In this case, participation was restricted to international consultants to ensure high quality, but most of them didn't have enough experience in urban design or planning projects! The majority of the six competitors are known as creative designers of "master piece" buildings but not famous for master planning projects. Having realized that this project had nothing to do with the detailed level of architecture, we can conclude that the inappropriate method of selection has led to missed opportunity to obtain promising structure plans for Mount Khandama.

In the jury formation, clients were strongly represented in two cases: the Saudi Houses and the Business Center. In the Saudi Houses competition, while the combination of Saudi, Arab and international positively contributed to the evaluation process, the type and objective of the competition should have been such as to encourage the client to add other members to maximize the opportunity of having a well-thought solution. Members like a real estate developer and/or a Saudi
citizen could help getting real impression of how marketing people and end-users would evaluate the submitted schemes. In the *Business Center*, the jury lacked at least one urban design practitioner to join the academic members who were mainly specialized in architecture. The presence of a business person, as prospective end-user, could also have strengthened the panel to be more powerful. Passing to the last example, *Mount Khandama*, it is clear that the jury comprised of professional experts with good knowledge related to the project specialities. Being as the only example that didn't include client representatives, the panel positively combined jurors reflecting different trends and nationalities as well as mixing the theoretical with practical. The jury failed to include a member representing the local legislating authority in Makkah to give a clear interpretation of the topography and its problems reflected on the site.

5.4. Achieving the fruition: the eventual results

Having analyzed the cases according to the pre-competition tasks, it is necessary to see how the performance of these tasks affected the achieved results. The *Saudi Houses* competition furnished the client with a numerous of unprecedented and outstanding schemes that could be adopted to refresh the design process of the Saudi house. The result shocked the professional field in Saudi Arabia due to the failure of the Saudi architects and students! The winning schemes, which belonged to an Italian architect in the professionals' category and to a German group in the students' category, were strongly criticized due to their unfamiliarity with the prototypical design of the Saudi house. The only drawback of the result was that there was no feedback from the professionals working in the building industry regarding the achievability and workability of some schemes, including the winnings, due to the mass production system that they used. In the *Business Center* competition, the winning scheme received a satisfactory reaction from the client and the concerned parties due to its creative concept which realized the client's vision. The public visited exhibitions presenting the winning scheme to see the "falling towers", as they named it, and to express their astonishment at the new generation of towers in Riyadh. Subsequently, the authors Oscar Bellini and Laura Daglio have selected the winning and the second prize schemes as inspiring buildings in the Arabian and Gulf region.\(^6\)

In the final example, the *Mount Khandama* competition, the lack of information in conjunction with the unsuitability of competitors definitely resulted in less-promising schemes. Most of the competitors have provided architectural level work, in addition to the inappropriateness of such details, did not respond to the Makkah's identity. In the absence of addressing many important issues such as project feasibility, phasing strategies and construction challenges, the client was baffled and ambivalent in dealing with the submitted proposals. Since the competition hasn't been published or introduced to the public, no general reaction can be reported.

<table>
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<th>Table 1: A comparison between the cases through the pre-competition tasks</th>
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<td><strong>Cases</strong></td>
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<td>The decision to hold a design competition</td>
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6. Conclusion and recommendation

This paper has identified the tasks of the pre-competition stage, and then examined the importance of these tasks through three empirical cases representing architectural design competitions that have been recently organized in Saudi Arabia. The paper has provided a chronological description of each competition to understand the reasons, motivation and the problems which are associated with each case. The appraisal went through every task to see how it was planned and performed in all cases, and the reflection of that in the eventual results. Having observed and learned from the cited examples, it can be respectively concluded that architectural design competitions constitute a crucial tool in developing projects that create and form our built environment. The importance of this tool should not make it difficult to recognize that competitions are only methods or approaches to reach an optimum solution for a problem, and not objectives in themselves. Therefore, to achieve the objectives of a competition, careful attention should be given to making the necessary planning and arrangements of such a competition. The major phase of any competition is the pre-competition stage, which includes many tasks starting with the decision to hold a design competition in the first place, but including the formation of a qualified managing team, collecting the existing and required data, preparing the Terms of Reference (TOR) and selecting the appropriate candidates to judge the entries. It has been said that "a competition succeeds or fails to a substantial degree depending on the process of conducting it. Casual programs, confused information and careless juries are a disaster for the ultimate architectural product" as Richard Miller reported. Failing to understand the importance of the pre-competition stage or undertake any task in an appropriate way will highly affect the competition output and therefore a huge effort of competitors and considerable amount of client's resources can be wasted. There is nothing more frustrating to consultants or disappointing to clients than having a badly-initiated and managed competition that ends with an unworkable product or undesirable reaction from the end-users.
To conclude this paper, and in order to initiate and organize a well-tailored competition that achieves its objectives and will be a positive addition to the architectural practice, I recommend the following when starting to think of holding a competition. Firstly, the client should acknowledge the sensitive nature of this tool, and appoint an expert body or team who are familiar with architectural design competitions to take the responsibility of controlling the whole event. This delegation, from the beginning, would assist the client in running the thorough discussion on the feasibility of conducting a competition in the first place, and to choose the appropriate form and type accordingly. It is very important to have a specialized team rather than one professional advisor to guide the process of the organization from the outset, since a wide range of skills and the creative art of management are required. Secondly, the organization team should develop a methodology that considers the tasks of the pre-competition stage, driven by the objectives of the competition and aims at how to assist competitors achieve the desirable result. Finally, the art of managing architectural design competitions still needs more exploration in terms of bridging the gap between professional codes and real practice. Finding a way to enhance the positive side and annihilate the negative points of conducting a competition could only be assured by increasing the awareness of how competitions successfully work. This comprehension would definitely help improve the actual practice of architectural design competitions to produce well-liked projects that satisfy their clients and positively add to our built environment.

Notes
1 ) Grabmeier, Jeff (no date) "Design Competitions don't result in well-liked buildings"
3 ) Same reference as above
6 ) Building Arabia: expanding the limits of architecture (no date), white star publishers
7 ) Nassar, Jack (2006), Design by competition: making design competition work
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Collaborative Design Workshops: Explanation of an Analysing Model for Knowledge Exchange

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Abstract

During the period of 2006-2009 a workshop setting to train Collaborative Design Teams was developed as part of the Dutch Program for Permanent Education for Professionals. This Collaborative Design Workshop has to stimulate members of collaborative design teams, Architects, Roofer and Installers, to share, use and develop collectively specific information of innovative roofs. The aim of the workshop is to support design activities by the use of Integral design method with its design tool Morphological Overviews (MO) to structure information and knowledge exchange between and with commitment of all participants to optimize design solutions.

The paper describes the set up for analysing design team’s explicit knowledge exchange and knowledge development. By using the Design Research Methodology a step by step approach is executed to develop the supportive method. First the development of the analysing approach is described. The second part shows the final procedure; how the data are collected and the different ways to analyse them; the Morphological Analysis and the Functional Sub-solution Video Analysis. First results of the analyze of the Collaborative Design Workshop are presented and discussed.

Keywords: collaborative design, analyzing model, design tools, morphological overviews
1. Introduction

A lack of innovative designs in the Dutch Building industry can be observed for roofs. A design is defined as a basic scheme or graphic representation that affects and controls function or development for a subject that has to be constructed or manufactured. Innovative designs show smart improvements in design solution by using experiences, and experiments or improvement actions for the design that improves its purpose and functioning greatly. Sub-optimal interaction and cooperation between solutions and construction in design practice of roofs is presented by professional parties as main cause of the lack of innovative roofs (EURACTIVE ROOF-er 2005). During the design process, teams generate new knowledge by exchange and develop information about the design to be produced. Such a design process for the design of a (new) product is called a Collaborative Design (Bento et al. 2004). Within such a setting, actors like Architects and Roofer, differ in cultural backgrounds, their way of working, and have a different motivation of collaboration (Korbijn 1999). Architect and Roofer collaborating on the roof design, acting as representatives of their discipline can be described and defined by their Competence Profiles which is expressed in their design activities as Dorst (1997) explains. Due to interdependency between the participants (Latour 1987) knowledge exchange and sharing is needed by their interpersonal communication and using preferred communication tools (Emmitt et al. 2008).

To identify the various types of knowledge of Architects and Roofer it is necessary to define more specific typologies of knowledge. Van Aken (2005) discriminates object- and realization-knowledge as part of the process-knowledge. This process knowledge through collaboration will link the needed requirements for innovative designs; the object knowledge and the realization knowledge (van Aken 2005). The types of knowledge stated, are communicated between Architect and Roofer (both having another educational background and differ largely in competences and skills) through different kinds of representation (Brereton 1998). Object knowledge can be defined as knowledge on the characteristics and properties of artefacts and their materials. Finally, the third type of knowledge, realization knowledge, can be identified as knowledge on the various physical processes to be used to realize designed artefacts (van Aken 2005). We use only explicit knowledge because this knowledge is notated in a way that it can be administrated and communicated within the team and with other participants, such as advisors and clients, during the process. The design situation of Collaborative Design is described by the set-up of the Collaborative Design Workshop. The design activities as both rational (Simon 1973) and reflective (Schön 1987), for structuring and develop the object- and realization-knowledge, are identified through the use and effects of the Morphological Overviews (Savanovic 2009).

Our research with workshops – learning by doing – for Design Teams in practice with professionals, both for development and evaluation, is ongoing from the year 2000 through the study Integral Design (Quanjel & Zeiler 2003). A new research started by Savanović (2009) in 2004 sets the methodological basis for the knowledge based research in a Collaborative Team-setting. Related to the type of research – technological design – an appropriate methodology is necessary to design the setting as well as the analysing method(s) needed. The main theoretical knowledge used are the Methodical Design model (Van den Kroonenberg and Siers, 1992) and the Design Research
Methodology (Blessing and Chakrabarti 2009). With the help of Design Research Methodology a framework was developed to couple the Design Model of Methodical Design (Zeiler, 1993) and the theory of concepts and knowledge; the CK-theory (Hatchuel and Weil, 2008). This resulted in the ID-method, executed through workshops and the use of a specific support tool – Morphological Overviews (Savanovic 2009) – representing a set of necessary conditions for the creation of integral design concepts for design teams with equal educational background. The Morphological Overviews are used to introduce, discuss and structure the different kinds of knowledge (object- and realization knowledge) of the participants in order to generate more optimal or new design solutions. In this research the focus is on the explicit knowledge exchange between Architects and Roofers / Installers in the setting of Collaborative Design (Collaborative Design Workshops), and the influence of a structuring support tool (Morphological Overviews) on this knowledge exchange.

Parallel to this design a model for collecting and analysing the validated data related to the knowledge exchange and knowledge development had to be evolved. The second paragraph describes the design of the model for collecting and analysing the data from the Collaborative Design Workshops. The third paragraph will focus on the final Collaborative Design Analysing Model. In the last paragraph first results of the executed analysing model will be discussed.

2. Development of a model for analysing collaborative design workshops

As part of the model for Collaborative Design Workshops we had to develop a model with effective and efficient methods to analyse the Collaborative Design Workshops results and the influence of Morphological Overviews as design support tool. This model for analysing methods was developed iteratively mainly based on reflections and redesign practically using the DRM-methodology. DRM consists of four stages: Research Clarification, Descriptive Study I, Prescriptive Study and Descriptive Study II. Several variations of the methodology are possible and necessary to suit the focus and constraints of a particular project (Blessing and Chakrabarti 2009). The four stages of the DRM-methodology could be seen as a problem-solution structure, which is seen as the benchmark of quality of research in many fields. A clear consequence of framing research as motivated by a problem is the need to define criteria for the successful solution of the problem. DRM emphasises the need for formulating success as well as measurable criteria. These criteria need to be defined in the first stage of the DRM research, so that they can be measured against in the fourth and final stage of DRM. This paper focuses on the Descriptive Study II, described in this chapter, and the Prescriptive Study as described in the third chapter.

Research on support tools related to Collaborative Design is in general very much technology driven and less based on a theoretical approach. Most of the research started in 1992 and can be divided in 6 main areas; 3D Virtual Environments, Asynchronous and Synchronous applications, comprehensive systems, community participation and tools (Achten 2009). The research described in this paper focuses on a synchronous application; a tool that supports collaboration by design team members that takes place at the same time. The results – data – are the used representations of explicit object- and realization-knowledge by Architect, Roofer and Installer. There is done much research on analysing
models for design meetings focusing on different aspects of the design (Tang 1990; Cross et al. 1996; McDonnel and Lloyd 2009). From 1994 on the Delft-workshop the protocol analysis was the common method. In recent years a wider variety of research methods have been used, drawn from the social sciences and other methods used previously in design thinking research as for instance interaction analysis (Tang 1990), viewpoint methodology (Detienne et al. 2005) or functional linguistics (Mc. Donnell 1997). The protocol analysis method generates a lot of data which could actually show us ways of communication related to the explicit knowledge exchange, but only in combination with the explicitly produced data and or video-recordings. As the focus of this research is on representations of explicit knowledge the protocol analysis method is a very time-consuming method for all the workshop-data. Until now we had two pre-workshops with in total about 45 students, four pre-workshops with in total 55 professionals. After these primarily experiments two Collaborative Design Workshops existing out of 4 comparable design tasks were executed with in total 48 professional participants. After the workshops we started with developing a improved model for analyzing the results, which has to add the aspects of ‘used by the participants’ and ‘notated in text or sketch’. That marked the starting point to collect the produced outcomes of the different participants, individual but especially in a Collaborative Design-setting.

To describe the development of the model to analyze the Collaborative Design Workshop we used the DRM-methodology with five criteria which make it useable as a method. These criteria are: aim or outline, steps within the development, evaluation, communication and testing. The aim and outline for each step in the development has to be described before executing this step. The aim should cover each time the criteria which are necessary to function as a method. This defines the next characteristic; the method should have clear steps to be taken to develop and execute. Through evaluation of each step, related to the criteria, the definition of the next step(s) or aim(s) is generated. This makes the method able to test the specific aims in the specific context. Aspects of time; is the organisation of the method time-consuming, and functionality; is the method easy and to use in the correct way, are related to testing the method. Next the development of the three pre-workshops (WS 03, 04, 05) related to the characteristics is described (Quanjel 2008).

The first workshop with professionals (WS 03) was started after two workshops with students with different educational background. Specific methods were used related to communication in search for a suitable method; the Bales-Interaction Process Analyzing Model (Bales 1950, Emmitt & Gorse 2007). The Bales model was tested in these two workshops by three researchers. The analysis of the use of Bales as a method in our research was that the focus of Bales is too much on communication aspects themselves and not on the results or relationships – explicit knowledge – of the communication. Also appeared that the method was difficult to use and very time-consuming related to the data we had from the workshops. Therefore the next step was to modify the analysis-method to a more interaction-design subject-related method and to test it in the WS 03-setting. The setting was In-Company with good circumstances to monitor. We used master-students for assistance to make photographs of the team results each 10 minutes, to prepare the video’s for recording and for monitoring with the Interaction format. The result of this setting was that coding the knowledge flow or knowledge interaction through the use of the Interaction-format was still too difficult to use correctly in real-time and with video-analysis. Second objective was that the results of the analysis was not precise enough related to the use, exchange and development of explicit knowledge by the
team-members. Also the workshop-setting was not good because the steps within this model of WS 03 did not create situations to compare teams using the design method or not.

For the second workshop (WS 04) we decided not to focus on the workshop-setting but only on the definitions of the terms ‘functionalities, aspects and sub-solutions related to the use by the participants and the analysis of the output by the researchers. The workshop-setting was designed to compare predefined functionalities, aspects and sub-solutions from a web-based Database with the developed items within the used Morphological Overviews. Within this setting we succeeded to find definitions which could be used correctly and time-user-friendly within the research-approach and the coupling with the Competence Profiles of the different professionals. These Competence Profiles, delivered by the Professional Vocational-Organisations, describe what should be the knowledge and skills related to a specific function within this profession. Through this Competence Profiles we could identify the object- and realization-knowledge and compare it through analysing the results of the workshops with the ‘real knowledge in practice.

The third workshop (WS 05) we remodelled the workshop-setting from the findings in WS 03 in steps were we could collect the data in different settings. The settings were; individual, in teams (Architect-Roofer and Architect-Installer); with and without the use of MO, with using for each changing team the tool twice to monitor the learning-effect. In combination with the correct setting we worked on the circumstances and technique to monitor with photographs and video-recordings so that they could be used by the post-master students correctly and within the time-schedule.

3. Collaborative Design Analysing Model

The goal of the Collaborative Design Analysing Model is to detect the knowledge exchange and – development between professional Architects, Roofers and Installers in Collaborative Design in the preliminary phase of the design and the influence of the use of the support tool Morphological Overviews. The final product of this model is that the Analysing Model can be used as a method to fulfil this goals in the developed Collaborative Design-Workshop-settings.

First step is to identify what are the knowledge and skills related to object- and realization knowledge connected to the professional Roofer, Installer and Architect. In practice the Vocational Organisations use Competence Profiles to describe these aspects related to a specific function. Through the Competence Profiles we are able to describe the knowledge fields of the different professionals related to functionalities / aspects and sub-solutions. This gives a basis to compare with the results from the design-tasks during the Collaborative Design Workshops. A more practical insight of the real situation is gathered by the use of Case Studies; executed projects which are related to the subject of innovative roofs, roofs with new developments incorporated related to the use of sustainable energy systems. By choosing three pilot projects for the use of Sun-energy in big-scale projects and analyse the preliminary designs on design- and realization aspects – translated in functionalities, sub-solutions and solutions – we get data from a practical situation. These data we can compare with those of the Competence Profiles. Those items which are similar in both steps we can use for comparison with the data from the workshop analysis.
The setting of the Collaborative Design Workshop is designed in such a way that we can subtract comparable data. This is done by introducing three comparable design tasks for three different situations; the individual situation, the team situation without using the Morphological Overviews and the team situation with using the MO for the second time. From the individual situation we can get the profession related functionalities and sub-solutions. By simultaneously take step two, for separate teams working with and without using MO, we avoid a learning effect or influence of these two team-settings. The functionalities and sub-solutions from these two settings we can compare with the individual setting and the third step-setting. In the third step, with changing team-members and executed after one week, one team will work for the second time with MO and the other for the first time. From the results of this steps we can determine if there is a ‘learning effect’ related to the use of MO.

The data collection from each step is the same. All the design-sketches and notations by the participants from all design tasks are collected immediately after the design task is completed. Each participant or team has a code which has to be on all these design-representations. This is checked by post-master students. From all sessions of each team photographs are taken by the students of the design-representations of each coded team, each ten minutes. Finally video-recordings with sound are taken from 3 team-sessions per situation. The tapes are coded by the researcher harmonized with the team-codes. The technical aspects of the video-recordings are done by the students. All data are checked and collected immediately after each design-task and archived in coded maps.

The analysis of the Collaborative Design Workshop data is the next step. These step is first done by the researcher with two different analysing methods; the Morphological Analysis and the Functional Video Analysis. The results of these two methods are the basis of the data-comparison with the results from the Competence Profiles. These methods will be briefly explained. The two different analysis are done separately in time; the first analysis done is the Morphological Analysis. All Analysis are first done by hand and notated by hand before they are digitalized in the different formats.

The Morphological Analysis (figure 1) uses the found functionalities and sub-solutions from all design-representations from each design-situation. All outings are coded and digitalized. By hand each separate design is analysed on type and amount of functionalities and sub-solutions. The found items are marked and coded on the paper-copies. From each design-situation a Morphological Overview is made; all found functionalities (vertical axis) and sub-solutions (horizontal axis) of the members or teams of the same situation are in one MO. Through this method we can compare the different design-situations on amount and type of functionalities and sub-solutions. Theoretically the items from the individual design-situation could be compared on which of those items, belonging to a specific profession, is ‘found in the next team-design-situations.
Figure 1: Example of the Morphological Analysis format (fragment). One format for all found functionalities (vertical axis) and sub-solutions (horizontal axis) of one design-situation. In this example all the items for Installer in the individual design-situation. Delivered amount of functionalities (F), sub-functionalities (SF) and sub-solutions in red below of the overview. The solutions are presented by the coloured lines which connect the used sub-solutions.

The Functional Sub-solution Video Analysis (figure 2) is done separately in time from the Morphological Analysis. Additionally to the MO-Analysis the FSV-Analysis will generate data which will connect the functionalities and sub-solutions to aspects of send, acknowledged and processed. Through coupling these communication aspects with the type of representation and type of knowledge we can get insight into the knowledge flow between the participants. Types of representations are speech, text or drawings and MO. Types of knowledge are related to the CK-theory (Hatchuel & Weil 2009); used only as general functionality or sub-solution not related to the design-task; knowledge re-used and related to the design-task and new knowledge or Concepts. Concepts are an indication of Collaborative Design were the two participants, through the knowledge flow, come together to a ‘creative leap’ where ‘new knowledge is developed needed for the new design solutions needed. The analysing format is split up in time-zones of 2 minutes on a horizontal axis up to 60 minutes.
Figure 2. Example of the Functional Sub-solutions Video Analysis format (fragment). One format for all found types of functionalities and sub-solutions colour coded to communication-type (send, acknowledged, processed) and coded related to type of knowledge (functionality, knowledge, concept) and type of representation (talk, sketch, Morphological Overviews). Horizontal axis is the time-schedule with the 2-minutes time-zones up to 60 minutes. Vertical axis shows the knowledge representations. Each block-segment in colour represents one used functionality or sub-solution; the colour represents the communication-type.
Through experience this time-zone appeared to be functional to monitor. For each participant the types of knowledge and representation is on the vertical axis. For the communication typology a colour-code is introduced representing type of communication related to each time one item (functionality or sub-solution). Through this coding system the type and amount of functionalities and sub-solutions can be determined and compared with the results of the MO-Analysis. Final step is that these results are compared with those of the Competence Profiles and Case Studies, related to type of functionalities and sub-solutions.

For the Competence Profiles is important that the information used is from a classified source and with the latest update; the Competence Profiles are set-up by the Vocational Organisations which are responsible for the correct data. Working with Case Studies the secure selection of the projects related to the participants involved in the process is important. The projects should be state-of-the-art which can be checked through Governmental involvement and participation of crucial parties from knowledge-innovation organisations like for instance ECN, TNO or Syntens.

We selected also on projects which were part of a innovation program for use and development of sustainable energy systems. The data available and the source from which the data can be obtained are connected to the parties involved. Official program-projects have the task and responsibility to archive the data very secure. This can be checked through counter-check the data with other participants in the same program and or literature study. By choosing three comparable projects the tendency can be corrected.

The data-collection of the workshop design-task-results is a strict procedure with a check-list, coding and archive-system for each part. These aspects were prepared by the researcher and executed with help of the post-master students; the researcher has the final check for each item per part. Basis of the data-collection are that the steps in the workshop-setting are done correctly as well as the group-lay-outs for each team (team-change) for each step (design-task). All produced data from the teams is copied and digitalized. The photographs and video-recordings are coded and copied with on two separate back-up hard-disks.

By describing the different steps and evaluation unambiguous with the use of the workshop-script, the check-lists, coding-system and archive-system for the different parts the method is prepared for use by other parties. The rules or guidelines are part of these documents. Necessary for the organisation part are preparation meetings with all participants at least three months in advance because of the planning for location, technique, marketing / public relations and speakers. This is also part of the cooperation with the students. For each new workshop a new class is participating. Their role is important while they assist with the execution-part and data-collecting part. Back-ground information is therefore arranged through in advance lectures about the theory of Integral Design and Morphological Overviews in relationship with the Collaborative Design Workshops as part of their curriculum.

The pre-workshops for development of the model took about one and a half year of preparation and execution. For each Collaborative Design Workshop we start 3 months in advance with the first actions; this is work for 2 people about 1 day a week. The knowledge needed is that of a good office-manager with knowledge about the Building Industry preferably with Architects, Roofers and
Installers. A good office-administration of one of the Professional Organisations is necessary to organise the workshops in time and money.

The analysing of all the data needs the described strict data and basic knowledge about the Integral Design and Morphological Overview theory as well as training with the use of the different analysing methods. The analysing is a time-consuming activity. For one Collaborative Design-Workshop the Morphological Analysis will take about 7 days to analyse. The Functional Sub-solution Video Analysis takes more time because the videos are the full length of each design-team; with 6 video-recordings for each design task. We compare 12 design team-recordings per Collaborative Design-Workshop, first by hand and then digital. The total Functional Sub-solution Video-Analysing part takes about 14 days to execute. Equipment needed is the coded and digitalized video-data, hard copies of the data, paper and a laptop. Overall it takes 3 months for each Collaborative Design Workshop, which means at least 12 months to execute and analyse three sessions with the same model of Collaborative Design-Workshops.

To apply the analysing method correctly needs the background knowledge and training of the use of the methods. Until now the researcher developed and used the methods within the described time-schedule and with correct results. With the first Collaborative Design-Workshop we started a parallel trajectory of an analysing design-task with post-master-students, only for the Morphological Overview-Analysis. We choose only for one method because of the time needed to use the method correct in combination with the available time within their curriculum and the Design Methodology Course. The Morphological Overview-Analysis is also the most important part of the research as well the most interesting in connection with Integral Design and the Methodology Course. This first testing will be executed at the end of 2009, beginning 2010. We intend to do the second test at the beginning of next year and the final testing during spring 2010.

4. Discussion

This research is a reflection on the main questions about design thinking and practice (Cross and Dorst 1996, Mc Donnell and Lloyd 2009). By focussing on a specific field – knowledge exchange and knowledge development of explicit knowledge – and a specific setting – Collaborative Design for professionals in the early design phase – we try to capture the main problem; ‘which data to capture’ (Mc Donnell and Lloyd 2009, p. 3).

Through a step by step approach, within the setting of the developed Collaborative Design Workshop and based on the a grounded theory (Savanović 2009), we explained the Analysing Model for monitoring and analysing collaboration in a practical setting. With the use of data from practice, Competence Profiles, we are able to make a comparison with the ‘existing practical situation’ with the situation needed for future new solutions; data from the Collaborative Design Workshops. Through the use of two developed and different analysing methods, the Morphological Analysis and the Functional Sub-solution Video Analysis, we can capture verified data from this situation. First results show that this Analysing Model can be used as a working method. Two of the three proposed Collaborative Design-Workshops are executed and the third one will be executed and analyzed in
spring 2010. On the basis of the comparison in use of the Analysis Model in the third Collaborative Design Workshop this tendency can be confirmed or neutralized.

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Does Integrated Procurement Reduce Building Cost and Project Time?

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Abstract

Integrated procurement and private finance initiative (PFI) is often seen as the solution to develop better buildings. It is assumed that the improvements in terms of enhanced collaboration, better knowledge exchange, less transactional negotiations and supply chain optimizations will result in more on time deliveries, less cost, better innovation potential and higher quality. However, there is not much sound empirical evidence that these benefits are actually realized. Only a few studies exist, of which the most in the civil engineering sector, and they are commonly based on interviews instead of real project based comparisons. This might be due to the fact that within building construction, projects, project teams and the project environment, all are rather unique and therefore difficult to compare.

In this paper a method is presented, that can be used to objectively compare different building projects on cost and time delivery. Six case studies are performed, two of which were traditionally contracted and four as Design & Construct. Remarkable differences on time and cost performance were found between projects that were Design Bid Built contracted or as Design & Construct.

Keywords: integrated procurement, design & construct, esign Bid Build, cost and time efficiency
1. Introduction

Design & Construct (also known as Design and Build) is a Construction Process Organisation (CPO), in which the design and the construction of a building is executed by one contractor. Since the UAV-GC 2000 (the Dutch standard procurement procedures for integrated contracts), there is a growing interest in the integration of design and construction in the Netherlands, not only for large public construction projects but also for smaller civil initiatives. However at this time it appears that in only 10-15% of all construction projects, Design & Construct (D&C) procurement is applied in the Netherlands (RRreport 125, 2006).

Loulakis (2003) reports on two large US surveys done (Songer & Molenaar (1996) and a survey of the DBIA; the Design Built Institute of America (2000)) each with around 100 different professional clients on the reasons why they chose D&C. Loulakis found that shorting the project duration was the overwhelming first choice followed by cost and risk reduction, and reducing claims. Other factors mentioned are project size, constructability and innovation.

Although not much literature is found on the effects of integrated procurement by implementing D&C, a rather immense amount of literature is published on partnering projects and large scale PPP (Public Private Partnerships) and PFI (Public Finance Initiative) projects for all kind of sectors. Also in these instances stimulating integration by means of specific forms of procurement and contracting is the main aim. In case of PPP and PFI a concession for providing a more or less integrated service for a defined period of time is transferred from the public to the private sector claiming that integrated contracting, on one way or another, leads to lower cost, better value for money, shorter delivery times and higher quality in the end product. On the other hand the nature of competitive bidding, in which functional responsibilities are separated, is often seen as an obstacle for innovation, effectiveness and efficiency (Leiringer, 2001).

As stated, not many publications can be found on the achieved advantages applying integrated contracts in smaller construction projects or more specifically the effects of applying D&C project delivery methods compared to Design Bid Build (DBB) procurement. The only Dutch report which is found is of Roges (2009). In the report of Roges (2009) some Dutch contractors report between 5 and 15 percent cost savings in case of the use of integrated contracts. Remarkable findings are reported by Molenaar, (2003) based on one US case study, stating cost ‘savings’ up to (minus) - 23 percent and time savings up to 16 percent in case of civil engineering work.

Table 1 based on, beyond others USDOT FHA (2006) and Loukalis (2003) provide an overview of studies on time and cost savings of D&C compared to DBB.

Noticeable studies concerning the effects of D&C on building construction are the studies of Bennett et.al. (1996) and Konchar et.al. (1999), because of the large data sets used. In the study of Bennett et.al. 330 UK projects were analysed representing a cross section of building projects while comparing DBB and D&C projects. They tried to define general performance measurements and found that not the procurement delivery method is the highest-ranking variable on cost and time but –
not surprisingly—project size and type. They also found that D&C projects produce significantly lower quality than traditional ones and therefore recommend a design-led approach in D&C projects.

Konchar et al. (1999) did a similar study in the US on 351 projects comparing D&C and DBB projects. Also here a cross section of building project types from industrial offices to multi-story dwellings was surveyed. Using univariate and multivariate regression—analysis they found significant advantages in time and cost performance for D&C compared to DBB projects.

It’s remarkable that although almost all findings of the studies listed in table 1 point into the direction of cost and time savings for D&C in favour of DBB the results are varying to a large extend (cost savings minus 23% to plus 18%; time savings plus 16% - 60%).

Table 1: Studies into the time and cost performances of Design & Construct projects

<table>
<thead>
<tr>
<th>Buildings:</th>
<th>Data set</th>
<th>% less costs compared to DBB</th>
<th>% less time compared to DBB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bennett, Pothecary &amp; Robinson (1996)</td>
<td>330</td>
<td>13%</td>
<td>30%</td>
</tr>
<tr>
<td>DBIA (1998)</td>
<td>?</td>
<td>14%</td>
<td>18%</td>
</tr>
<tr>
<td>Konchar &amp; Sanvido (1999)</td>
<td>351</td>
<td>6%</td>
<td>34%</td>
</tr>
<tr>
<td>Allen (2001)</td>
<td>110</td>
<td>18%</td>
<td>60%</td>
</tr>
<tr>
<td>Roges (2009)</td>
<td>?</td>
<td>5-15%</td>
<td>?</td>
</tr>
<tr>
<td>Civil works:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ellis, Herbsman &amp; Kumar (1991)</td>
<td>11</td>
<td>5%</td>
<td>36%</td>
</tr>
<tr>
<td>Ohio Department of Transportation (1999)</td>
<td>6</td>
<td>Less costs</td>
<td>Significantly lower</td>
</tr>
<tr>
<td>Ernzen &amp; Feeney (2000)</td>
<td>1</td>
<td>Unknown</td>
<td>30%</td>
</tr>
<tr>
<td>Molenaar (2003)</td>
<td>1</td>
<td>-23%</td>
<td>16%</td>
</tr>
<tr>
<td>Ernzen, Williams &amp; Brisk (2004)</td>
<td>13</td>
<td>4%</td>
<td>22%</td>
</tr>
</tbody>
</table>

Partly this might be explained by the fact that almost all the available studies are based on the expert judgement of the involved parties, which raises doubt about the objectivity of the findings. Sometimes the used data sets are relatively small to make proper generalizations. Often the studies found are weak in description of the methodology used. In general recently some more rather critical studies on validity of methods, too much optimism and not logical reasoning concerning positive effects of all types of integrated procurement used, are published of which Leiringer et al. (2009) is one of the most interesting. Leiringer (op. cit.) founds in his study that within large service led PFI projects, the maintenance parts of PFI contractors tends to operate as regular sub-contractors in which managers invariably struggle to have any real impact on design and construction decisions. “Such decisions remain dominated by an institutionalized mindset that prioritizes traditional cost cutting over any consideration of through life operational value.” If the same would be true for the integration of design and construction, in for instance D&C contracts, benefits on construction cost and time might be reported on over optimistic.
Nyström (2007) in a study on partnering in construction argues the same on the shortages in methodological approaches when studying advantages and disadvantages of specific types of contracting. He states that for proper evaluation three conditions have to be fulfilled:

- The research has to be based on project facts and not personal perceptions,
- The research has to be based on a comparative analysis,
- The research must control for other project variables that can affect outcomes

Nyström (op. cit.) in his PhD study report on partnering, states that no studies can be found in which all these conditions are fulfilled and that most studies are based on anecdotic evidence. Nyström in his research assessed a large series of different studies on the above conditions and did several case studies himself, and concluded that average results presented on positive effects of partnering has to be drastically reduced as he couldn’t find any significant trend for or against partnering strong into contrast with the majority of research publications.

According to the investigations in this research the same might and seems to be valid for studies directed at the effects of integrated procurement for construction projects. Even more to our knowledge no studies exist that compares small regular civil projects, systematically, on time and cost performance in relation to the procurement and delivery type.

### 2. Research objectives and methodology

Often the primary objective of D&C is to increase the efficiency of the building process in terms of cost and time. Especially, for the Dutch market no systematic studies are done whether or not this objective is actually reached in case of small civil projects. The aim of this study was to systematically evaluate the cost and time efficiency of comparable civil building projects procured traditionally or with an integrated contract. Integrated contracts are advocated since long, but as stated convincing empirical evidence is still lacking. In addition, this study strives to develop a more objective method to measure time and cost efficiency of different construction projects, which methodologically seems to fulfil the 3 conditions mentioned by Nyström (2007) for proper evaluations of construction projects as mentioned above.

To reach this objective the research methodology consists out of four steps: (1) determine the theoretical influences of the chosen construction process organisation on the cost and time efficiency of the construction process through a short literature survey; (2) developing a method to measure the cost and time efficiency; (3) collecting authentic data from some D&C-projects and DBB projects from actual drawings, contracts and planning’s; (4) Comparing the chosen construction process organisation D&C, with the DBB construction process organisation, on their cost and time efficiency. For practical reasons, the study focuses on Dutch projects only.
3. Characteristics of construction process organisations

3.1 Definitions

In this study the construction process is defined as the *chain of successive activities or processes which are aimed at the realisation of construction projects* (Pries 2006). The construction process organisation (CPO) is defined as an *organisation which is formed temporarily per project and where the manner to cooperate between parties and the distribution of risks and responsibilities are held together by contracts* (Woude 1999).

Holstein et. al. (2004) executed an extensive literature survey into different procurement routes and delivery methods. They concluded that in theoretical literature and reported case studies terminology on procurement types seems harmonized, but that there are significant differences in interpretations between and even within countries. An in-depth case study of one professional client organisation revealed that even within one organisation the same procurement label was used for what appeared to be different procurement routes. To objectively determine the type of CPO, the following so called Essential Characteristics of Construction Organization and Process points have been formulated based on Dorée (1996) and Holstein (2004).

- **Transfer point;** the moment of the transfer of responsibilities and duties of the client to the contractor.

- **Affiliation designers at which organisation;** are the designers hired by the client or the contractor.

- **Competition;** how is the contractor selected.

- **Reward system;** lump sum, indirect, etc.

- **Management structure;** this characteristic can be split up in the management structure used of the design phase and of the construction phase.

- **Design responsibility;** which party is responsible for the design.

- **Financial responsibility;** which party is responsible for the finance.

- **Operating responsibility;** which party is responsible for the operating phase.

With the above mentioned characteristics the differences between traditional and Design and Construct CPO’s can be more clearly defined as is shown in table 2.
Table 2: characteristics of CPO comparing DBB and D&C

<table>
<thead>
<tr>
<th>Characteristics of CPO’s</th>
<th>DBB</th>
<th>D&amp;C</th>
<th>Difference / equal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Transfer point</td>
<td>After the specifications phase</td>
<td>After the programme phase and before the development phase, on the basis of a specification possibly including drawings</td>
<td>Difference</td>
</tr>
<tr>
<td>2) Affiliation designers</td>
<td>At the client or an independent organisation</td>
<td>At the contracting organisation</td>
<td>Difference</td>
</tr>
<tr>
<td>3) Competition</td>
<td>All alternatives possible</td>
<td>All alternatives possible</td>
<td>Equal</td>
</tr>
<tr>
<td>4) Reward system</td>
<td>All alternatives possible, main point is fixed price</td>
<td>Fixed price</td>
<td>Equal/Difference</td>
</tr>
<tr>
<td>5) Management structure of construction phase</td>
<td>At the client or an independent organisation</td>
<td>At the contracting organisation</td>
<td>Difference</td>
</tr>
<tr>
<td>6) Management structure design phase</td>
<td>Constant possibility for exercise of influence</td>
<td>Go and no go moments</td>
<td>Difference</td>
</tr>
<tr>
<td>7) Design responsibility</td>
<td>At the client</td>
<td>At the contracting organisation</td>
<td>Difference</td>
</tr>
<tr>
<td>8) Financing responsibility</td>
<td>At the client</td>
<td>At the client</td>
<td>Equal</td>
</tr>
<tr>
<td>9) Exploitation responsibility</td>
<td>At the client</td>
<td>At the client</td>
<td>Equal</td>
</tr>
</tbody>
</table>

3.2 Impact on performances

The above differences as mentioned in Table 2 between D&C and DBB can have a positive and negative impact on the cost and time performance of construction projects. These impacts are being reflected in the table 3 and are based on Pries (2004) and de Koning (2001). These findings are to a large extend in line with the international literature on the broader topic of integration in construction (see for an extensive review e.g. Nyström, 2007; Loulakis, 2003; USDOT FHA, 2006).

4. KPI’s and correction factors

4.1 Efficiency

To actually measure time and cost performance of construction projects two key performance indicators (KPI’s) have been used, based on In ‘t Veld (2002): Cost Efficiency (CE); the standard amounts for the construction costs + advisory costs (the standard construction costs Cs) of the project (based on cost estimation according to NEN 2631 methodology), divided by the actual costs (Ca) of the project: CE = Cs / Ca.

Table 3: effects of D&C

<table>
<thead>
<tr>
<th>Positive impact on D&amp;C</th>
<th>Negative impact on D&amp;C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonisation of design and construction. Possibility of fast-tracking. No full specifications necessary.</td>
<td>The specification is more complex and demands more time.</td>
</tr>
</tbody>
</table>
- The contractor will understand the design better and visa versa.
- Risk of time delays are transferred to contractor in an earlier stage.
- Innovative solutions can be considered in design and construction.

<table>
<thead>
<tr>
<th>Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Harmonisation of design and construction.</td>
<td>- The specification is more complex and demands more costs.</td>
</tr>
<tr>
<td>- Risk of an incomplete design is smaller when the contractor takes full responsibility.</td>
<td>- The tender for D&amp;C can result in less potential contractors and therefore in a less competitive price.</td>
</tr>
<tr>
<td>- Due to low participation of the client, he has lower costs.</td>
<td>- Risk repurchase of the contractor brings extra costs with it.</td>
</tr>
<tr>
<td>- Tenders that are deposited by subcontractors by D&amp;C are realistic and better competitive.</td>
<td></td>
</tr>
<tr>
<td>- The contractor will understand the design better and visa versa.</td>
<td></td>
</tr>
<tr>
<td>- Risk of cost overruns are transferred to contractor in an earlier stage.</td>
<td></td>
</tr>
<tr>
<td>- Innovative solutions can be considered in design and construction.</td>
<td></td>
</tr>
</tbody>
</table>

Time Efficiency (TE); the standard development time (Ts) of the project, divided by the actual time (Ta) of the project: $\text{TE} = \frac{\text{Ts}}{\text{Ta}}$.

Higher CE or TE scores reflect increased cost and time efficiency in relation to the benchmarks for cost and time.

### 4.2 Corrections and elimination factors

There are many variables influencing the cost and time efficiency. To determine the impact of DBB versus D&C, on the construction costs and construction time, the projects must be corrected for other factors of influence. Because of the difficulty of correcting the standard amounts for cost and time (Cs en Ts) for some variables, all cases in this study are selected on being similar on the following variables: Clear location, no cellars, steel skeleton, industrial building, low complexity, box shaped, no strive for technological innovation and no `high ambition' projects.

It is assumed that other project characteristics for Dutch projects will not lead to significant impact on time performance. Merely a correction is made for unworkable days, e.g. when the temperature is below 0 °C during project execution. As prices are influences to a larger extend by region, price developments, and technical qualities, correction factors are defined in paragraph 4.2 and 4.3 for these factors. Because of the similar building characteristics the functional quality is ignored and thus only the technical quality has been researched in this paper.
5. Modelling

By comparing the actual project data with the determined reference benchmark for cost and time, projects can be compared directly. The actual costs and time are derived for all cases from the project data and the drawings and building parameters are used for the standard costs and time estimation. Based on this comparison it is possible to measure the efficiency increase or decrease in relation to the procurement type.

5.1 Case study characteristics

Based on the procurement type, DBB or D&C, and the characteristics on which the cases must be similar, six cases have been selected. In four of these cases integrated procurement and delivery as D&C project was used and in two cases DBB was preferred. In table 4 the project criteria of the six studied cases are summarised.

Table 4: project criteria case study

<table>
<thead>
<tr>
<th>Project criteria:</th>
<th>Case D&amp;C-1</th>
<th>Case D&amp;C-2</th>
<th>Case D&amp;C-3</th>
<th>Case D&amp;C-4</th>
<th>Case DBB-1</th>
<th>Case DBB-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>RH BM Hoofddorp</td>
<td>RH Nijmegen</td>
<td>RH Nijmegen</td>
<td>Takenaka</td>
<td>RH BM Hoofddorp</td>
<td>Misset</td>
</tr>
<tr>
<td>Location</td>
<td>Nieuw Vennep</td>
<td>Rotterdam</td>
<td>Rotterdam</td>
<td>Amsterdam</td>
<td>Bleiswijk</td>
<td>Den Bosch</td>
</tr>
<tr>
<td>location circumstances</td>
<td>Company area</td>
<td>Company area</td>
<td>Company area</td>
<td>Company area</td>
<td>Company area</td>
<td>Company area</td>
</tr>
<tr>
<td>Technical quality:</td>
<td>No cellar</td>
<td>No cellar</td>
<td>No cellar</td>
<td>No cellar</td>
<td>No cellar</td>
<td>No cellar</td>
</tr>
<tr>
<td>Precence of cellars</td>
<td>Steel</td>
<td>Steel</td>
<td>Steel</td>
<td>Steel</td>
<td>Steel</td>
<td>Steel</td>
</tr>
<tr>
<td>Skeleton</td>
<td>Company hall + office</td>
<td>Company hall + office</td>
<td>Company hall + office</td>
<td>Company hall + canteen</td>
<td>Company hall + office</td>
<td>Company hall + office</td>
</tr>
<tr>
<td>Function /type</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Complexity</td>
<td>Box</td>
<td>Box</td>
<td>Box</td>
<td>Box</td>
<td>Box</td>
<td>Box</td>
</tr>
<tr>
<td>Spatial form</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
</tr>
<tr>
<td>Technical innovation</td>
<td>No typical 'high ambition' project</td>
<td>No typical 'high ambition' project</td>
<td>No typical 'high ambition' project</td>
<td>No typical 'high ambition' project</td>
<td>No typical 'high ambition' project</td>
<td></td>
</tr>
<tr>
<td>Aesthetic importance</td>
<td>Gross floor surface</td>
<td>3.336 m²</td>
<td>10.923 m²</td>
<td>36.416 m²</td>
<td>22.546 m²</td>
<td>13.695 m²</td>
</tr>
</tbody>
</table>

5.2 Actual costs and time

Based on the price level during development the costs have been corrected. This correction was based on the construction price development as provided by the Dutch so called BDB-index and BDB market indicator. These indexes are made specifically for industrial buildings and can adjust the costs of a project to a former or later time. After this correction, the costs are also corrected by a regional correction factor while using the data provided by Archidat and Bouwkostenkompas: this result is the
actual cost \( (C_a) \). The actual construction period \( (T_a) \) can be determined after the conversion to weeks and workable days.

5.3 Standard costs and time

The cost standard is calculated through the use of an element budget calculation. The calculation is based on used qualities and quantities for each case and is done by means of a cost database. The advisory costs are determined by the advisory fee formulas in the SR (1997) and the RVOI (2001) (Dutch standard regulations for design and engineering services). The result from this calculation is the standard estimated costs \( (C_s) \). For the time standard, the standard for construction time is calculated firstly. This standard has been based on the Dutch ‘bouwkostennota’ (Building Cost report; 2007), in which 165 projects were classified based on the construction costs and the construction time. The regression equation that is obtained by regression analysis based on the observed projects \( (n=165) \), is used as a standard in this research. Secondly the design time is calculated through the relationship of the design time of DBB projects, compared with the architect fee (which can be obtained from the advisory fee formulas). A reference (benchmark) equation for the design time is based upon this data. The sum of the construction time and the design time is the \( T_s \).

6. Results

6.1 Quantification

The outcomes of the two key performance indicators (KPI’s), TE and CE are graphically shown in figure 1. The dark grey dots represent the D&C projects and the light grey dots denote the DBB projects, the size of the circle indicates the project size in gross floor area. TE and CE scores above one indicate that the studied project performs better than the determined benchmark concerning construction costs and construction time.

![Figure 1: CE and TE of the cases](image)

Figure 1 illustrates that all projects outperform the benchmark in terms of costs and time. Furthermore, it is noteworthy that time and cost efficiency seems to be related, projects with high CE scores generally also exhibit high TE scores. Apart from the fact that only a small number of cases have been examined, visual analysis of the results also indicate, according to expectations, that D&C projects have a significant higher time and cost efficiency as compared to traditionally procured...
projects. The darker dots (D&C) are almost always consistently higher than the lighter dots (DBB); this is especially true for the Time Efficiency (TE). The difference in time efficiency between cases DBB-2 and D&C-1 is remarkable, given the notion made by Bennet et.al. (1996), as presented in section 1 of this paper, that project size is a more important factor than procurement and delivery method. This is also true for DBB-1 and D&C-2 which are also similar in size. Based on our study the findings from Bennett et.al. on the effect of project size are thus not approved in this study.

6.2 Cost Efficiency

The cost standard estimates (Cs), as mentioned before, are based on cost databases derived from a large Dutch construction cost consultancy. The calculated cost represents the average cost of a DBB building. Therefore the expectation, based on the consultant’s daily experience, is that the actual cost (Ca) will fall within a 5-10% range of the cost standard. When we take a look at Figure 2 the DBB cases are within this presumed range. D&C cases 2, 3 and 4 are however a lot more cost efficient (CE scores are above 1.1). Only D&C case 1 has the same CE as the DBB cases. Further analysis of this case revealed that the reason for this might be related to the late point of transferring the design responsibility to the contractor: an important advantage of D&C procurement in comparison to DBB procurement as pointed out by Pries (2004) and de Koning (2001).

![Figure 2: CE of the cases](image)

6.3 Time Efficiency

As shown in Figure 1 the Time Efficiency for all D&C-project is a lot higher then the efficiency for the DBB cases. In Figure 3 the actual building time for these cases are compared to the cases used in the earlier mentioned Dutch Building Report (2007). The steepness of the determined regression equation is correct, but the line is too high in comparison to the D&C cases. Therefore, it can be concluded that the D&C cases are being build more time efficient then there DBB counterpart.

![Figure 3: Time Efficiency](image)
Figure 3: Actual time versus standard time

6.4 Statistical tests

To determine if the procurement type, DBB or D&C, has a significant influence on the cost and time efficiency a MANOVA analysis has been performed. MANOVA can be thought of as an ANOVA for situations, in which there are several dependent variables (Field 2005), as is the case in this study (i.e. cost and time efficiency). An alternative would be to perform separate ANOVA for each dependent variable; however this would inflate the familywise error and increases the chance of making a Type 1 error (i.e. we might find a significant effect when in fact there is none). Furthermore MANOVA has the advantage that it takes account of the relationship, correlation, between outcome variables and tells us whether groups (i.e. DBB or D&C) differ along a combination of dimensions (i.e. cost and time efficiencies) (Field 2005). If the MANOVA statistics are significant the analyses is generally continued with separate ANOVA analyses.

Table 5 reports the descriptive statistics of the sample. Means and standard deviation for each group (DBB or D&C) are reported. The descriptive statistics illustrate the same pattern as was observed in figure 1: the cost and time efficiency seems to be considerable higher for D&C projects (the CE and TE measures are higher for D&C projects than for DBB projects, indicating increased cost and time efficiency for D&C projects).

Table 5: Descriptive statistics

<table>
<thead>
<tr>
<th>Procurement Type</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost Efficiency</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DBB</td>
<td>1.0700</td>
<td>.00000</td>
<td>2</td>
</tr>
<tr>
<td>D&amp;C</td>
<td>1.2475</td>
<td>.14385</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1.1883</td>
<td>.14428</td>
<td>6</td>
</tr>
<tr>
<td><strong>Time Efficiency</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DBB</td>
<td>1.0800</td>
<td>.05657</td>
<td>2</td>
</tr>
<tr>
<td>D&amp;C</td>
<td>1.6450</td>
<td>.32624</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1.4567</td>
<td>.38682</td>
<td>6</td>
</tr>
</tbody>
</table>

Before continuing with the multivariate tests standard assumptions for MANOVA were tested, including the Levene’s test to test if the assumption of homogeneity of variance holds (e.g. equal variance between the D&C and DBB groups). The Levene’s test was non significant for the two dependent variables indicating that the assumption was met.

Table 6: Multivariate Tests

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
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<td>2.000</td>
<td>3.000</td>
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Wilks’ Lambda 
Hotelling’s Trace 
Roy’s Largest Root
ProcType
Pillai’s Trace
Wilks’ Lambda
Hotelling’s Trace
Roy’s Largest Root

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</table>
| a. Exact statistic
b. Design: Intercept + ProcType

The four multivariate test statistics (Table 6) are all non significant at the conventional level (Sig. < 0.05). From these results we should probably conclude that the procurement type has no significant effect on cost and time efficiency. However, due to the small sample size and explorative nature of this study, separate univariate tests (ANOVA) were still performed for cost and time efficiency.

Table 7: Parameter Tests

<table>
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<th>Dependent Variable</th>
<th>Parameter</th>
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| a. This parameter is set to zero because it is redundant.

The univariate tests (Table 7) confirm the results of the multivariate test. Non significant effects at the conventional level of significance < 0.05 of procurement type on the time or cost efficiency were found. The significance of procurement type for time efficiency was 0.083 and for cost efficiency 0.175. The parameter estimates (column B in the table) have the expected sign, D&C procurement type increases the cost and time efficiency in relation to DBB. It should be noted that the impact on time efficiency seems to be bigger and that it is significant at the less conventional level of p<0.1, which might be acceptable due to the small sample size and indicative character of the statistical interference.

7. Conclusions

While the visual analysis and descriptive statistics seem to confirm that the application of D&C is likely to have a positive impact on the cost and time efficiency, this relationship could not be proven by means of a MANOVA analysis. It is plausible that this is due to the very small sample size. The mean statistics for the D&C and DBB projects demonstrate a 52% higher time efficiency if D&C procurement was applied and 17% higher cost efficiency. When separate ANOVA’s were applied, the
time efficiency (TE) was significantly increased, at the less conventional level of p<0.1, if the D&C procurement was used instead of DBB procurement. The cost efficiency remained non significant (p=0.175) even if a less restrictive significance level was used. It seems reasonable to assume that the analysis lacks statistical power due to the small sample size, repeating the study with a larger sample is therefore strongly recommended!

One of the – implicit – pre assumptions was that the studies presenting similar results, as they are generally based on expert judgement of project participants, are influenced by the beliefs (wishful thinking) of the ones who provided the data. This also might be a reason for the rather large differences in findings presented in the literature (cost savings range from -23 to + 18%; time savings 16-60%). Therefore, in this study a systematic and more objective method was developed for analysing cost and time efficiency of projects that have applied various procurement types. While the results are far from conclusive, it’s the conviction of the researchers that the presented method provides more objective comparison than studies based on expert judgements.

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Physical Mockups as Interface between Design and Construction: A North-American Example

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Abstract

The growing use of modern construction technologies with different tolerances and installation requirements in buildings has made the reliance on full size mockups essential for examining the various interfaces between design and construction. Over the past ten years, 3D/4D digital models have been introduced and developed to this end, and they are now seen by some as eliminating the need for physical mockups. In this study, based on the on-the-job experiences and project management records of the construction of one very significant building in North America, the authors argue that, notwithstanding the recognized capabilities of digital models, physical mockups are still needed for capturing and eliciting the tacit knowledge that characterizes many construction operations, and which cannot be visualized fully by the digital world. This is because some field conditions are very difficult to foresee and represent; as a consequence, construction workers may not achieve on the ground what seems achievable on design documents. Depending on situations, the process of constructing and successfully completing a mockup is still the essential locus where some (but not all) field conditions can be verified, the outcome of craft-based efforts can be observed and evaluated, and design intents and construction procedures modified accordingly. This argument is developed by illustrating the challenges experienced in the erection and testing of a full size mockup of Simmons Hall — an architectural award-winning dormitory completed at the Massachusetts Institute of Technology in 2002 — particularly in terms of constructability and functional requirements. By looking at the relationship between initial designers’ agendas and constructed solutions, and by considering the parameters informing specific project decisions, it will be argued that digital and physical models must be considered complementary tools in the realization of design intents.

Keywords: simulation, constructability, tolerances, coordination, communication
1. Introduction

The successful transformation of design intents into physical reality has always been a challenge for the parties involved in a construction project — clients, designers, contractors and construction workers. This is because the making of a building results from a process during which different types of knowledge are generated, visualized and communicated among many project participants. In a sequentially phased project, clients’ needs are interpreted and transformed into a set of coordinated working drawings by the architect and her consultants. The contractor then analyzes these documents and predicts their effect by developing a set of construction methods and sequences as well construction time schedules, before the start of site operations. Finally, construction workers deploy their manual capabilities in transforming design and construction plans into physical reality. A large proportion of the knowledge generated and communicated during design and pre-construction activities has an explicit nature (Polanyi 1962). Explicit knowledge can be articulated in symbolic or visual form, such as calculations, drawings and sketches, which can be communicated to and understood by receiving parties. Differently, the knowledge deployed by construction workers is of a tacit nature, in the sense that it cannot be easily visualized or communicated (Polanyi 1962); it can be observed and learned only in action. The challenge of predicting the intended construction outcome can be seen in masonry construction, the history of which is characterized by full-size models of building sections, erected to assess the quality of expected finishes and workmanship before actual construction (King 2001).

More recently, the visualization and communication of design and pre-construction activities have been greatly enhanced by the use of 3D and 4D digital models (Eastman et al 2008; Hartman and Fisher 2007). In addition, CAD/CAM based applications have promised to provide a seamless integration of the supply chain of building parts (Kolarevic 2003; Schodek et al 2005).

In this paper the authors argue that, the enhanced visualization and communication capabilities of digital modeling notwithstanding, the transformation of design into physical reality must still rely on the use of physical mockups.

Design activities are a continuum that extends well beyond the work carried out during the conventionally termed ‘design phase’ of a project. Much additional design is undertaken to realize design intents, when a contractor receives contractual plans and specifications, and develops the shop drawings accordingly. In this activity, which we label ‘design realization’, the interaction of project participants normally requires a different type of support: the construction of a physical model to solicit the additional knowledge needed for completing the design. This critical interface has not received enough attention in the specialized literature, particularly in the U.S.A., the construction practice of which is addressed in this paper. Past contributions, in fact, have focused mostly on the design (i.e., working drawings and specifications) of building parts and their manufacturing, devoting scant attention to their assembly at the construction site.
2. Knowledge and the building process

As stated in the opening section, the building process unfolds from expertise that manifests itself in two forms — explicit and tacit. According to Nonaka (1991), explicit knowledge can be easily expressed, captured, stored and reused. It can be transmitted as data and is found in books, guidelines and rules of thumb. Differently, tacit knowledge is “highly personal. It is hard to formalize and, therefore, difficult to communicate to others. Tacit knowledge is deeply rooted in action and in the individual’s commitment to a specific context” (Nonaka 1991). Technical or manual skill, intuition and insights are typical examples of tacit knowledge. In construction, for example, a master craftsman with years of experience cannot typically articulate the principles of his know-how as acquired through a period of apprenticeship, i.e., “by working on the job with someone knowledgeable, observing their methods, investing in the tools of that trade, absorbing that culture, practicing under their scrutiny” (Groáök 1992). Explicit and tacit knowledge are complementary entities, in that they interact with each other in the creative activities of people. In this case, tacit knowledge is shared through personal interaction.

From this follows that the building process can be thought of as an information process in which the initial building representation is progressively enriched and completed through a process of accretion by bits and pieces that takes place during the, and by means of, interaction of project participants. In the design/engineering phase, this interaction is supported by visual tools such as drawings, sketches and models, which capture and communicate design and engineering content, and which are used to verify/refine this content eventually to reach consensus amongst different stakeholders (Straus and McGrath 1994). The design (architectural and engineering disciplines) and the following preconstruction (e.g., construction sequencing and time scheduling) activities are based mostly on explicit knowledge that is supposed to be predictive (Hartman and Fisher 2007). Design intents and construction plans, in other words, must be deemed to be constructable and feasible. In practice, such a prediction does not fully eliminate the uncertainty of the construction phase, as this is driven by the one-of-a-kind, contingent nature of production in construction. From this perspective, every project is unique. Past positive construction experience may or may not be repeated in future projects, subject to variables such as field conditions and work processes, and the capabilities of available construction workers. Thus, previously successful routines cannot be fully codified into predictive explicit knowledge. During construction, tradesmen generate and apply much tacit knowledge, particularly in joint problem-solving situations generated from the difficulty of fully controlling the actual construction process in advance. In this context, the human interaction of joint problem-solving is supported by another knowledge visualization tool: the physical reality of the building part under construction.

3. The design realization phase of the building process: the case of external facades

The design, engineering and construction of the external facade is one of the most intensive undertakings in a building project, particularly in the case of high-rise or bespoke projects.
Technological complexity and the need for integrated engineering capabilities are typical challenges. The facade, in fact, is made up of multiple materials as well as interdependent and often custom-made components, the combined performance of which must be carefully engineered and tested. Moreover, the system requires multiple design and engineering contributions as well as multiple trades for production and assembly — all characteristics that call for an extensive and sustained coordination effort. In this regard, the proper visualization of design and engineering content is of great importance for integrating distinct contributions successfully. And, since the overall time schedule of the building envelope is always on the critical path of a project, pre-construction activities are critical for the timely completion of the system.

A most important phase of the pre-construction process consists of the generation, review and approval of shop drawings. In this process, the intents of working drawings — i.e., what to build — are interpreted and transformed into discrete detailed descriptions of construction process and methods — i.e., how to build (DeLapp et al 2004). The importance of this additional design activity has been recognized by other U.S. studies and has been termed ‘design realization’ (Pietroforte 1995, 1997; DeLapp et al 2004). Shop drawings show instructions about the engineering of each component, its fabrication and assembly with other components, and finally the erection of these sub-assemblies. Their approval is the absolute condition for the subsequent fabrication, assembly and erection of the facade components. Shop drawings embody a type of knowledge (e.g., how the cladding is attached to the structure, how it is fabricated, assembled and erected) which is to be found mostly amongst specialty contractors and manufacturers, and rarely amongst architectural designers. Typically generated by multiple parties (e.g., cladding erectors and manufacturers), shop drawings undergo a lengthy review process that aims at verifying their compliance with the intents of the design documents, evaluating and negotiating the proposed engineering solutions, checking the dimensional accuracy and completeness of details, and coordinating the various descriptions of components in order to maintain the functional continuity and aesthetic character of the facade. 2D visualizations and related engineering calculations (these submittals also include material samples and product specifications) are reviewed by the general contractor, the architect of record, and her consultants — often geographically dispersed. Comments, corrections or requests for information/clarification are annotated next to details of a given drawing sheet. The lengthy duration of the review process (typically many months), the number of notes (often hundreds in a full set of shop drawings), and the reviews (typically 2 or 3), suggest that the use of paper drawings is not efficient for ensuring real time interaction among generators and reviewers. Only in job meetings does this type of interaction takes place, which then allows for negotiations, compromises and solutions to be reached. Furthermore, 2D drawings are often inadequate in their ability to visualize geometries, assemblies, and technology cum trade interfaces (Pietroforte 1997; Hartman and Fisher 2007). These shortcomings characteristically lead to the possibility of varying interpretations of design and construction intents. For example, 2D representations tend to be stratigraphic rather than volumetric, showing material for more than one level on the same planar space. Thus, as Boehmig (1990) has explained, they do not show the full information needed by the trades when installing the material on the field.
4. Digital representation in cladding design realization

Fortunately, in the last ten years, digital representation has become the standard representation medium in the architecture, engineering and construction (AEC) world. Electronic mark-up applications have facilitated the processing of comments and corrections. These capabilities, together with internet transmission, have considerably reduced the duration of the shop drawing process. More recently, 3D-modeling applications have enhanced design/engineering representation and the planning of construction. The use of digital modeling has been somehow spurred by recent development in architectural expression. The unconventional curtain walls and building facades realized by the office of Frank O. Gehry and Partners are a typical example. These walls are curved, sloped or zigzagged, and incorporate unusual combinations of materials. Since the nature of the curves is considered an integral part of the architectural design, the firm has been relying on the use of CATIA, software that constructs curves mathematically and maintains a high level of accuracy. This capability cannot be achieved by traditional CAD packages that approximate curves. Because of its ability to translate numerical instructions into shop tickets, the software defines lines and curves in ways that are usable by fabricators. In this case, enhancing the accuracy of geometries and dimensional fitting of assemblies facilitates the manufacturing of building parts.

In addition, by integrating information distributed over multiple 2D drawings, digital models have improved the coordination of both the interfaces amongst the several work packages that often make up a curtain wall, and the interfaces of the wall with other interacting building parts, i.e., structure, ceiling and partition systems. More recently, 4D-modeling, or time-lapsed series of 3D models, has been used to visualize the construction process and improve the sequencing and scheduling of construction activities. These include staging, the planning of handling, and storage of materials (Hartman and Fischer 2007). 4D-modeling represents a marked improvement on traditional scheduling techniques such as Gant charts and CPM diagrams, the abstract representation of which could create misunderstandings and omissions. This newest system, however, still remains essentially Taylorist and technocratic in its approach, for it envisions a work process (ideally) controlled by skilled workers in the various trades associated with the industry (Applebaum 1982). Possibly as a result, digital scheduling has not yet been able to solve the hurdle of accurately defining the duration of work activities in advance, particularly in the case of new architectural expressions that require non-traditional construction methods and procedures.

In conclusion, the superior visualization capabilities of digital modeling empower the interaction process amongst project participants with more knowledge-generation and communication opportunities than that based only on traditional 2D drawings and time scheduling diagrams. Better interaction increases the probability that design and engineering performance will be satisfactory, and field erection activities undertaken efficiently. However, the constructability of design intents and functional performance are still a prediction that must be verified. Its advancement notwithstanding, digital technology cannot yet capture some aspects of physical reality such as craft-based construction activities or the experience of the “real” object, nor can it simulate physical phenomena such as air or water flows, or the chemical compatibility of materials (Gonchar and Reina 2003). This is the purpose of the physical mockup.
5. The mockup as a verification of constructability

Mockup activities signal a shift in the type of visualization strategies used in generating and exchanging knowledge during design realization. A physical object, rather than a graphic or digital display, becomes the context of social and technical interaction during which tacit, rather than explicit, knowledge, is deployed to devise solutions to design and construction problems.

Figures 1 and 2: Simmons Hall, MIT, Cambridge, U.S.A.

To illustrate this function, Simmons Hall (Figure 1) — an architectural award-winning project completed in 2002 at the Massachusetts Institute of Technology (MIT) — can be examined. Supported by a mat foundation, the structure of Simmons Hall consists of a combination of load bearing precast exterior walls and cast-in-place columns, beams and floors. The exterior wall is made up of more than 290 panels (typically 10’ tall and 20’ long) and approximately 6000 2’x2’ windows, and is covered with two types of cladding systems consisting of solid and perforated aluminum panels (Figure 2). These features posed several constructability questions concerning the horizontal and vertical interfaces of the precast panels, the tolerances of the cladding systems, and the efficient installation of the window units. To this end, a mockup of a full room with annexed corridor was constructed from November 2000 to October 2001, as required by the construction specifications. The erection of the mockup showed the typical challenges that result from the use of a custom-made cladding system, and that is the interfacing between materials, components and construction methods with different tolerance, clearance and quality requirements.

The superstructure of Simmons Hall features precast and cast-in-place parts. The load-bearing precast concrete panels forming the perimeter of the structure were connected to the cast-in-place concrete foundation wall that, in the mockup, was specially constructed to resemble the actual building foundation. As shown in Figure 3 (both sides of panel reinforcement), the horizontal joining of the adjacent panels called for cast-in-place interfacing members, or wet joints (Figure 4).
The project team needed to ensure vertical and horizontal structural continuity by using two technologies (precast and cast-in-place concrete) with different construction tolerances. Vertical continuity was obtained by matching the location of the foundation dowels (up to 40 per panel) with that of iron sleeves cast into each mating panel. This task required the exact layout control of the foundation dowels, which was seldom achieved in practice. Consequently, the dowels on the mockup required adjustment, which was easily accomplished by the ironworkers, given their small diameter. This adjustment, however, would be far more difficult in the actual building because the rebar dowels were much larger in diameter and much harder to bend and move. In retrospect, the accurate layout location of dowels, as obtained in the digital form (CAD) of the shop drawings considered, might not be achieved in practice.
As far as horizontal continuity, Figure 4 shows three different types of horizontal “wet joint” connections, two of which were eventually constructed in the mockup (Figure 5, next page). Option 3 (bottom of Figure 4), Bar Lock transition couplers, was ultimately used in the building because it was easier to build as experienced by the trades. This is a reminder that, although modern buildings embody many building components that are factory-built using digital processes, a sizable portion of construction is still based on site production that cannot be fully predicted with the graphic or digital world, and must be verified on the field. Moreover, the fitting of cladding components easily obtainable in a 3D model (as in the case of this project), may be more difficult to achieve during actual construction, as addressed in the following notes. The cladding of the wall consisted of clear anodized L-shaped solid aluminum panels that were installed between the square windows (Figure 2). After the application of the waterproofing membrane on the precast panels, first the coloured window pans and then the windows were installed, followed by the installation of rigid insulation between windows and against the sides of the window pans. Window pans had to be centered, both horizontally and vertically, in the slanted openings of the precast panels. Their exact location was determined by the condition required for the fastening of the solid L-shaped aluminum panels to the corner edge of the resulting squared assembly, as shown in Figure 6. Fastening proved challenging, because there was very little allowable horizontal and vertical adjustment of the aluminum panels, and pans had to be manually adjusted to maintain alignment with the panels. At the same time, the adjustment of pans and fastening of panels made the maintenance of the plumb and level of the window and panel joint lines more difficult.

Figure 5 (left): The wet joint connection under construction
Figure 6 (right): Installation of L-shaped aluminum panels

The development of the Simmons Hall mockup provided a number of other lessons about the building and the ease of its constructability, particularly in relation to the installation routines expected from, or employed by, tradespeople, and the combined effect of multiple tolerances (or eventually lack thereof) on the realized structure. But even the simple example provided on the structure drives the point home: physical mockups perform a socially connecting function within the building process, in that they literally bring into contact design ambitions and construction realities.
The development of the mockup helps the design team recognize that every component in the building has an installation tolerance and a timeframe, and that regardless of the effort and level of care put forth by the craftspeople, the outcome does not always meet expectations. Similarly, it requires craftspeople to understand the design intent and strive to meet it. In fact, although production requirements (e.g., pace of assembly activities) prevail, the purpose of a mockup is always to subject these requirements to the constraints of the original architectural design objectives. In the design realization process, the mockup signals a shift toward the physical form of knowledge visualization away from the graphic (or digital) form. The completed object becomes the repository of the tacit knowledge elicited in its making, and deployed by the trades for realizing design intents. The observation of the mockup construction suggests that this type of knowledge encompasses capabilities such as planning the sequence of activities, computing dimensions and locating reference points when laying out work, selecting proper tools and materials, finger and manual dexterity, eye-hand coordination to use hand tools and manually-controlled tools when executing work to close tolerances, and form perception as required in activities such as inspecting work to verify acceptability of surface finish. In addition, the mockup represents the opportunity for the various trade specialists to familiarize themselves with the various manual tasks of assembly and construction, to become aware of the constraints of the field conditions, to solve the different tolerances of used materials and components jointly, and to devise solutions accordingly. In other words, the process of constructing the physical mockup represents the foundation of the team effort and spirit, without which it is difficult to complete actual construction successfully.

6. The mockup as a verification of functional performance

The construction and successive testing of a full-size facade mockup aims at verifying the performance of the design/engineering content of the shop drawings and the efficiency of the fabrication, assembly and erection instructions of these documents. A testing program assesses whether engineering content meets the environmental (i.e., air infiltration, static and dynamic water infiltration, thermal cycle performance) and structural (e.g., positive and negative wind loads) requirements of the wall.

The successful completion of the water infiltration test is one of the most critical tasks of the testing program. According to Sakhnovsky (whose CRL laboratory has tested more than 3,000 mockups in 50 years), water leakages occur in about 75% of the tests in the first attempt (Wright 2003). In this regard, the impossibility of a watertight wall is recognized by U.S. specifications that define the specific characteristics of "controlled leakage". Typically, the wall is assembled against a chamber that can be pressurized or depressurized during a water or air infiltration test. As observed by one of the authors in eight mockup tests at the CRL laboratory in 1990, the detection of a leak source is not always an easy task. At times it is obtained by pressurizing the test chamber and wetting the curtain wall with soap water. The climate of uncertainty and empiricism that permeates the detection and solution of testing problems is summarized by Sakhnovsky (1990): "Sometimes it is difficult to ascertain the problem, and repeated testing takes place over a period of days with trial-and-error remedial work being performed between tests." This statement underlines the importance of the physical context in understanding the forces behind the leak first (be it gravity or surface tension of
air pressure differential), and then deploying the know-how for coping with these forces. This capability, which is nothing else but a form of tacit knowledge, is elicited in action, through the continuous interaction with the constructed object. In the observed tests, water leakages resulted from both design mistakes/omissions (e.g., missing flashing) and poor adhesion of joint sealants. This last problem reflects the fact that construction sites are not controlled environments and the preparation of substrate surfaces for sealant applications could be ineffective if subject to contamination of airborne pollutants or improperly applied cleansing solvents. Water leakages sometimes were created by the work of the general contractors themselves, or the procurement criteria used for delivering a given cladding system — all issues that cannot be successfully predicted nor addressed with digital models. According to the records of CRL, in two of the eight tests considered, the same source of problem emerged: the leakage was caused by the unresolved interfaces between the specialty contractors involved in the manufacturing and erection of the wall (that is, lack of coordination between separate work packages). In retrospect, this problem could have been lessened (if not solved) if general contractors had used 3D digital models (not available at the time), which could visualize the scope of work to be undertaken by each individual specialty contractor in a more comprehensive way. As Gibb and Neale (1997) observe, “contractual arrangements sometimes exacerbate interface problems — either too many individual contractors or too much unfamiliar work managed by one specialist contractor”.

7. From wall assembly to building process thinking

The comment reported above serves to frame the broader dimension of this discussion, which, although used external facades as an example, is in fact concerned with the general relationship between forms of theoretical and practical intelligence, and the difficulty of codifying the prescriptions of the construction project in relation to the latter.

Developments in the construction industry make this interface increasingly important today, particularly when considering the structural changes in the supply and retention of construction labour on the one hand, and the performative complexity of building artefacts on the other. While the realization of projects relies on pools of workers with great range of experience and skills (the composition of which is more and more difficult to foresee or plan in advance, given the level of contractual fragmentation now in vogue and the pressures from the industry) the tolerance for the improper erection of technological assemblies gets reduced as buildings become more ambitious in their post-construction behaviour. As Groák (1990) noted many years ago, technological sophistication may indeed produce in-built fragility.

The problem arising from the difficulty to predict the eventual interaction of technical and social components on a building site is made more acute by the internationalization of construction business and that of design and engineering activities. In this situation, construction documentation is shipped back and forth across the world, to instruct people who may have different degrees of familiarity in the erection of component combinations and the organization of gang work or different understanding the intended ‘rules of craft’, and the evaluation of results.
Building Information Modeling (BIM) and CAD-CAM synergies are expected to dilute the risks of cultural dislocations or insufficient training by detecting the potential for physical clashes between building systems, and by simplifying manufacturing. Yet neither strategy seems to have, for the moment, what it takes to verify design decisions as they relate to site activity and localized craft: BIM visualizations offer 3D experiences of each part of the building object, but as constructed — after human intervention in a sense. CAD-CAM systems optimize a world of production that pre-dates the building site, at most indicating on-site handling patterns for the components and materials supplied.

8. Conclusions

To conclude, the transformation of design intents into physical reality has been presented in this paper as an information process in which the initial building description is progressively enriched through the interaction of project participants. Such an interaction is supported by knowledge visualization tools that assist in generating and communicating the evolving building representation. A critical phase of this transformation is represented by design realization, when the unitary architectural representation of the working drawings is transformed into a set of discrete descriptions for the fabrication, assembly and erection of main building parts (i.e., shop drawings), to be used during the construction phase. The design realization process builds upon the knowledge of the necessary means in the making of a building. This type of knowledge, as articulated in the discussion, has some tacit aspects that cannot be fully elicited with digital representation. Thus, the completion of design realization needs a different type of supporting tool, a physical mockup that compensates for the lack of contingent reality in digital modeling. Electronic technology, in fact, cannot capture or simulate the manual character of construction activities such as leveling, adjusting or finishing, the sensory experience of the spatial and physical object with its light, colour or texture, or even the coalition of skills assembled on site. Paradoxically, then, the more digital technology continues to support the design of new architectural forms, the more the physical reality and experience of mockups will be needed to verify the constructability and functionality of digital architecture, with its unproven translucency, colour and weightless plasticity. In this sense, digital and physical models should be considered as complementary tools in design realization. The former visualize the explicit contents of design and engineering knowledge while the latter physically realize such knowledge within the landscape of production determined by circumstances. The enhanced visualization capabilities of 3D models of course facilitate the construction of a physical model, but its ultimate testing is what, in the end, verifies their design and engineering intent.

References


Mass Customization in a Knowledge-based Construction Industry for Sustainable High-performance Building Production

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Abstract

Today, with recurring resource shortages, striking economic crisis and evolving social standards a new paradigm arises forcing industry not only to focus on competitiveness but also on designing sustainable products and manufacturing processes with equal respect on economic, social and environmental impacts. From that point of view, industrialization has particular advantages compared to conventional construction as it allows addressing various parameters relevant for sustainable construction consequently and in a controlled and predictable way. Industrialized construction could help to reduce material and energy consumption, minimize waste production, improve safety and working conditions, support the supply with affordable housing and enable deconstruction, reuse and recycling. Throughout the recent history of industrialized construction several large-scale industry projects have been conducted and various technologies and high-tech based methods have been applied, each of them addressing a certain sustainability issue. The present paper first gives an overview over those projects, technologies and methods and further develops a framework for future industrialization in construction based on the integration of sustainable best-practices. The framework outlines how different industrialization systems and sub-systems could be integrated to ecologies of factories, intelligent devices, high-tech equipment, resources and human beings by knowledge-based systems to efficiently control economic, social and environmental impacts.

Keywords: industrialization in construction, sustainable manufacturing, mass customization, robotics, reverse logistics
1. Introduction

The paradigm of sustainability gradually pervades all industrial sectors, all levels of value creation and all aspects of daily life, leading to a new 21st century industrial revolution where the importance of environmental and social factors finally becomes equipollent to plain economic efficiency. Legal frameworks, financial incentives and market/price developments urge more and more industries to change their processes and to shift from economic growth to sustainable development. Besides a change in organization, new process technologies, microelectronic devices, ICT, flexible automation, robotics and knowledge based logistics are at the heart of that revolution. Industrialized structures and standardized, exchangeable products and processes, which are deployed in most industrial sectors, are a solid basis for a gradual development towards a sustainable economy. However, in construction industry industrialized structures are merely developed and advanced technologies, which are state of the art in other producing industries, are still rejected. Construction industry has the lowest productivity of raw material input [26] [21] and about 40% - 50% [30] of global raw materials are used for the construction of our environment. Construction waste states the largest waste fraction even in highly industrialized countries [21] and the capability of that waste to be recycled with low environmental impact is rather low [31]. Moreover, the working conditions for construction workers in highly industrialized countries as well as in emerging economies as India or China are changing. The number of workers older than 50 is remarkably low and there are nearly no construction workers older than 60, although the retirement age is 65 which means nothing else as that after the age of 50 many construction workers become invalid and/or unemployed [16]. Buildings are among the most expensive goods that we produce [23] and although we have achieved that complex high-tech products as cars and computers are affordable for everybody, we have not brought simple low-tech products as buildings to a comparable level. Finally, this becomes even worse when we look at the lifecycle performance of our built environment and the fact that in a time of dynamic societies and fast changing needs built environment can hardly be changed, adapted, rearranged or deconstructed [25]. Industrialized structures and technologies in construction could help to enhance resource productivity, reduce waste, improve safety and working conditions, support the supply with affordable housing and enable continuous deconstruction, reuse and recycling. Once industrialized processes are installed, gradual process improvement could be achieved similar to other industrialized sectors and the aspect of modularity of architecture, building structure and industry itself, as an inherent requirement for industrialization, could address the problems of flexibility, deconstruction and remanufacturing. The present paper outlines that prefabrication, logistics, ERP, automated on-site construction, construction robotics, robotic-co workers, systemized deconstruction and other new industrial methods or technologies could be seen as complementary elements able to be co-adapted to create sustainable construction processes and a continuous and controlled flow of information, workforce, energy and resources for on-demand industrially customized buildings. Up to now a multitude of industrialization attempts have been conducted around the globe. Each of them addresses different parameters evident for sustainable construction. Yet, sustainability as we understand it today relies not on single parameters, but on integrative solutions with equal respect on economic, social, environmental and technological impacts. Therefore the present paper first gives examples of specific sustainable practices in construction industrialization and further develops a framework for integrating their advantages to an industrialized, flexible and sustainable building production network by advanced ICT and knowledge based systems.
2. Examples for high performance industrialized construction

Throughout recent history in industrialized construction several large-scale industry projects have been conducted and various technologies and high-tech based methods have been applied to introduce industrialized systems or sub-systems. All of those projects, technologies and methods have addressed different issues relevant for efficient and sustainable construction and have therefore focused on dedicated ecological, environmental, social or technological aspects. Moreover, those projects, technologies and methods exemplarily stand for subsequent steps of the technological value chain from customized prefabrication and “production pull” systems to on-site automation and on-site robotic cooperative systems to controlled deconstruction, reverse logistics and recycling. This chapter gives an overview over recently deployed large scale industrialization systems which have efficiently addressed particular parameters relevant for sustainable high-performance building construction.

2.1 On-demand individual customization in locally-based minimal-waste factories

Both the productions of Sekisui and Toyota are based on the principles of “pulling” and “lean” [2] production. As only demanded and customized housing products are fabricated overproductions and thus wasted materials or processes are avoided. In a “pulling production” only the effectively needed materials, modules and components are ordered and produced. Further materials, modules and components are organized just in time just in sequence to the final assembly process allowing a lean production with minimized stocks. Today the emerging strategies of “Mass Customization” [6] carry on that ideas and integrate them with other advanced technologies. In conventional construction a huge amount of the used materials and components is still prepared on the construction site causing cut-off waste and unnecessary transportation processes through waste materials. Often the waste produced on the construction site is not sorted and recycled to its full extent. On the contrary, in Japanese prefabrication factories waste is reduced on one hand through on-demand order of compatible elements. On the other hand, waste that is produced during the production is fastidiously collected and sorted in up to thirty different kinds of factory waste boxes. Throughout the whole completion process every piece of waste is immediately fed into a connected recycling system [32]. This is showing that factory production has a distinct advantage in controlling the flow of materials.
and waste. Further especially in building production which is from its nature and history closely related to local habits and resources locally based production plays an important role. A good example how to handle this in an industrialized construction industry can also be found in Japan’s prefabrication industry. Japan is a country with quite contrasting climate regions, which have generated different habits and tastes. In south areas as Kyushu and Okinawa the climate is humid and even sub-tropical, in the winter it merely has below zero degrees and the life style of the people is different from that in the metropolitan areas Tokyo or Chiba. In the north, as for example in Sapporo, winters are cold and snow levels up to 1 meter are normal. Houses need thick insulation, pitched roofs and smaller windows and the taste of the people concerning designs is different. Considering that Japanese people today particularly demand for individuality, different regional preferences are a basic challenge for every company delivering industrialized houses. Therefore the prefabrication company Sekisui Heim offers different types of houses fitting to Japan’s regional, cultural and climatic differences. Customers can choose from these particular types and then adjust them to their individual needs through an off-line configuration system. To get closer to the customers, regional based model parks in strategically important areas [25] have been established each of them showing house types relevant for a specific area. Specially trained local staff is able to consult according to locally based needs. Accordingly, factories are placed in each of those different areas finishing houses to the preferences of the region. So Sekisui Heim’s “Chezdan” [33] house type as well as its’ product variants and individual derivates, have thick insulation, windows, roofs and design styles fitting to colder regions. Chezdan house types are finished in a factory near Sapporo. This strengthens the relation to the customer as factory processes and logistic networks are adjusted to the specific resources of an area. Moreover, this strategy reduces logistic efforts to minimum and locally based craftsmen and suppliers are supported.

2.2 On-site/off-site combined fabrication

From 2002 NCC Sweden had worked on developing an industrialized concept for multi-storey residential buildings and according to that from 2005 to 2007 it had been running a test project called “NCC Komplett” [20]. This system had been a manufacturing system combining factory prefabrication with a mobile on-site assembly hall. In the off-site factory concrete walls were customized according to customers’ demands and the architects’ plans. Also most of the fit-out work was done in the factory and technical installations as electricity, sub-components, windows, doors, radiators and fixed furniture modules for bath and kitchen were pre-installed. Thus wall and ceiling modules had been completely finalized in the off-site factory and in most cases even wallpapering, flooring and electrical switches had been pre-attached. The completely finalized modules were transported to the construction site just in time and just in sequence and the final assembly took place in a mobile, closed and heated assembly hall that protected the whole on-site assembly from weather influence. All in all, four assembly workers and one assembly foreman were needed per average building and the flow of materials, components and resources was highly controlled through an advanced logistics systems and the combination of controlled off-site and on-site processes.
2.3 Expert Systems for Complexity Management

Sekisui Heim, famous for its legendary “Unit-Method” introduced its’ HAPPS (Heim Automated Parts Pickup System) [8] in the 70s and started to deliver industrialized houses with individual floor plans. HAPPS was one of the first ERP solutions enabling continuous workflow management for industrialized production of individual products. Today it allows extremely fast and efficient 80% factory production of individual houses. Through HAPPS the customers are free to choose their preferred degree of customer integration. The configuration process is done in several steps guided by trained customer contact staff helping the customers to make decisions as quick as possible (off-line configuration). Once an individual design is fixed the HAPPS automatically generates parts list and coordinates working tasks, logistics, fabrication processes and material flow in a minimal waste factory.

2.4 Semi-automated high-rise construction and human-machine-cooperative systems

Obayashi announced the development of an Automated Building Construction System (ABCS) in 1989 and it has been applied five times up to now. Through these projects, the ABCS has been improved gradually and adapted to various building designs and construction sites. Moreover the automatic level of the system has been lowered gradually to achieve a higher efficiency. In the latest ABCS project finally conventional construction and automated construction have been combined to a new hybrid system. In this project the inner area equipped with the “Super Construction Factory” [9] was constructed by the ABCS meanwhile the outer part of the building was constructed by conventional construction supported and supplied by the SCF logistics and control system. Both SCF and conventional construction created synergies to each other and worked simultaneously. A contrasting approach to on-site automation and semi-automation is at the moment developed by Korean researchers aiming not only at automation but also at introducing small-scale robots capable of supporting construction workers with their tasks in direct interaction and cooperation. The Korean researches have developed their promising approach from the assumption that construction robotic systems normally have to solve problems in unstructured and dynamic construction sites. One of the solutions to address these problems is supposed to be a technology of “human-robot cooperative” [12] systems combining the intelligence of the human worker with the force power of the robotic system [23].

2.5 Reverse logistics and remanufacturing

All buildings of the Japanese Prefab Maker “Sekisui Heim” can be accepted as “trade-ins” [25] for a new Sekisui Heim building. Therefore the deconstruction process is a modified and reversed version of the construction process which was based on unit factory completion and rapid on site assembly of prefabricated units. For deconstruction first joints between steel frame units are eased and then the house is transported to a special dismantling factory unit by unit. There the outdated finishes are dismantled and fed into advanced reuse cycles established around factories. The steel frame units are
further inspected, refurbished if necessary and then equipped with new finishes and fit-outs desired by a customer who has chosen to buy a reused house. On a Web-Platform for “Reuse System Houses” [22] Sekisui organizes a matching of people who want to sell their modular house for reuse and people willing to buy reused house modules for further customization. Renewed units are reorganized and customized in the factory, transported to other customer's building sites and then assembled on a new foundation in a new site. For Reused and reorganized Houses Sekisui Heim offers the same guarantees, supports and maintenance services as for newly built ones. With a growing number of customers willing purchase a house of the reuse system a community will be formed serving as basis for a highly efficient component circulation, reverse logistics and remanufacturing.

3. Framework for the future development of sustainable and industrialized construction

For future construction industry the question will not be if conventional construction should be kept or industrialized methods should be applied. More important will be that construction addresses all items relevant for sustainable construction bringing together economic, environmental, social and technological issues. From that point of view industrialization has particular advantages as it allows the gradual implementation of new technologies for reducing energy, material and waste consumption and for upgrading working conditions, health and low wages. Further, industrialized processes, methods and technologies are crucial for developing affordable and thus sustainable housing. Sustainable efficiency in construction and building industry in a bigger scale would closely be related to industrialized construction practices and advanced structures for reuse, reorganization or recycling as discussed above. The following chapter derives a framework for integrating and implementing the advantages of those practices with other emerging production technologies being under development in other industries in flexible construction clusters of bigger scale with a focus on advances in robotics and knowledge-based support technologies.

3.1 Ecology of industrialized sub-systems

Prefabrication of components or units, logistics, ERP, automated on-site construction, construction robotics, robotic-co workers, systemized deconstruction and other new industrial methods could be seen as complementary elements forming a continuous ecology of factories, devices, equipment, resources and human beings. Those different system components should be integrated to create synergies and thus sustainable construction processes [23]. A continuous and controlled flow of information, workforce, energy and resources over the whole life cycle and especially during the construction time could help to create a high efficiency concerning economic, environmental and social issues at once. In the 1980s General Motors invested more than 80 Billions US$ in innovative flexible production systems and appending information technology. Yet General Motors had to face huge economic losses in early 1990s meanwhile compared to its flexibility it could produce only a few different models. GM missed to change product development, modularity, style of management, human resource planning and market strategies in the same way as it updated its production with innovative technology. Today we know very well about the “complementarities of activity” [6] as a
means to achieve economic success. Similar, Milgrom and Roberts state in their management theory that changes in industrial strategies should be done consequently: “Coordinating the general directions of a move may substantially ease the coordination problems while still retaining most of the potential benefits of change. Moreover the systematic errors associated with centrally directed change are less costly than similarly large but uncoordinated errors of independently operating units” [3]. In a similar way, in construction industry, the development of stand-alone intelligent equipment and processes could be more harmful than helpful. Changes in construction industry should be done consequently towards a strategy which equally addresses the whole value chain and combines product design, prefabrication, on-site automation, modular robotics, deconstruction and reuse systems to a synergistic ecology of factories, devices, equipment, resources and human beings.

3.2 Flexible fabrication technologies for mass customization

In recent architecture and construction industry customization is often interpreted as a tool for forming highly differentiated 3D shaped components or buildings. This surely is not wrong and it is an important aspect for architecture, yet it only covers one of a variety of co-adapted sup-processes in that what customization -seen from its original economic or management point of view- really means: Customization is a strategic means for delivering user adapted or even personalized products at same or even lower cost than standardized mass production [6]., it aims at enhanced efficiency meanwhile creating user centered innovations. Therefore Customization is not based on the plain control of a single process or CNC machine but on creating new organizational structures corresponding with streaming and intelligent information flows between enterprise, product, machinery, robots, customers and all sub-processes related to these fields. Customizations’ heart is information and communication technology used for forming continuous IT structures on which those information flows are then created. Customization is deeply based on the evolution and interconnection of all computer based technologies. The extension of classic ICT by advances in robotics and intelligence will even create more efficient customization structures. Today the definition of robotics widely differs depending on application area, profession and culture. Sure is that robotics more and more emerges from its’ original application area in classic production industry. Robots are on the way to be used in all parts of our life: from construction, to households, to health, to service. Similarly a change from defining robots as “multifunctional manipulators” which can be programmed to a definition which rather sees robots as “cooperative systems” is taking place [24]. Further the increased demand for flexibility or one-piece-flow production of individual products in complex and dynamically changing production clusters leads to a new design paradigm for robots. For the design of future robotic construction equipment, automation systems and construction robots that can be used on-site or off-site, three main paradigms could be identified:

Human-Robot-Cooperation: The next generation of robots will work in the direct operating range of human workers in order to achieve a maximum of flexibility, which is accounted as basic requirement for customization and individual product fabrication by industrialized means. Robotic systems of the next decade will rather be “assistants” [24], helping human workers to perform complex tasks, than fully autonomous systems. New interaction concepts, interfaces, numerous concepts for lightweight robots, integrated force-torque sensors and teaching systems are therefore now developed by robotic companies around the world.
Robot-Robot-Cooperation: The next generation of robots is designed to cooperate with each other to perform tasks in dynamically changing and flexible groups of intelligent (robotic) devices. This will mainly be done by distributing processes and tasks over several devices and robots. Moreover robots will increasingly be able to receive information of environmentally embedded Microsystems technology and sources as sensors, actuators and other microelectronic systems distributed in the production environment. Long-term strategies even aim at globally distributed robotic cooperating systems which could be part of decentralized and locally-based small scale production networks. [24]

Modularization and Standardization: Parts and components of robots and specific automation systems that are increasingly needed by a multitude of operators within an industry are usually becoming part of a design evolution making them increasingly modular and interchangeable [24]. As shown by computer industry economic efficiency is closely related to the evolution of shared design rules [29] for modularization and component systems.

3.3 Product design for distributed fabrication

A holistic product conception is determined by a planned and integrated design of the production system’s performance from supply chain to production line. With the system architecture of the final product or building, not only its’ visible shape but also its’ modular structure and thus the ability to be fabricated with certain processes, technologies or production networks are determined [1]. In that context, today, CAD programs could be developed further towards “Virtual Assembly Platforms” [27] which are already under development in automotive industry. Those virtual platforms could be used for digital and production oriented architecture helping to design and virtually test the interdependencies of the applied building products, processes and resources. Further, extended program functions are needed which support variant development and variant management of highly customizable industrialized building component systems. With the introduction of industrialized processes and new co-operative equipment in construction industry, virtual commission planning for lines, flexible production cells or on-site construction processes as well as the virtual modeling of human actions or inter-actions on the construction site – which are already state of the art in other advanced industries, f. e. “body-in-white-assembly” [34] in automotive industry – have to be addressed for fully using industrialization’s potential. Those technologies could reduce construction failures, enhance safety and moreover help to design healthy and acceptable off-site or on-site working environments for the future construction workers. Further, the development and gradual implementation of ERP systems in construction should have high priority. As explained above, buildings fabricated industrially in the factory or on-site by automation and/or robotics should be finished individually according to customer demands, and regional styles. Therefore it is an important process to select and pick up about 30,000 components correctly for single house, out of about 350,000 components building up the solution space and feed them to the production line just in sequence [25]. Thus parameter based ERP system should be implemented supporting the whole workflow: customization, planning, receipt of order, logistics, fabrication and delivery. Integrated ERPs could help to generate parts and component structures and parts lists from CAD floor plans. Based on the information generated from the CAD models also detailed location information concerning parts, components, cables could be generated to build up a object oriented virtual house. Out of that construction ERPs could schedule logistics and fabrication just in time and in sequence of
processes and work tasks. Around a combined industrialized off-site/on-site production, construction companies could install a systemic supply network. This supply network could be bound together by an advanced modular product architectures and Construction ERP systems scheduling and controlling material supply, processes, workers, automated machinery and modular and distributed industrial robots. Considering that people today particularly demand for individuality [6], different regional preferences state a basic challenge for every company delivering industrialized houses. Therefore companies prefabricating elements or housing units should supply different types of building components fitting to regional, cultural and climatic differences with locally-based factories integrated in a distributed and flexible factory network [4]. Customers or other companies purchasing components could then choose from these types and adjust them to their individual needs. To get closer to the customers and the regional materials, regionally based factories in strategically important areas should be established. This strategy could minimize transportation efforts enormously. Bigger component suppliers or prefab makers could run several factories each of them producing predominantly the types of houses required in the surrounding region. Yet, basic production layout could be similar in different factories and thus also the basic product structures and production processes. In general, production structures are shifting from centralized to more modularized and decentralized structures, as those are more flexible and offer the possibility to deliver highly customized products. Moreover, the principle of distributed fabrication has already successfully been practiced by the automotive industry where huge car companies (OEM) contract small and medium enterprises (Tier-n) to deliver subcomponents and subsystems. The advantage of the implementation of a distributed, but industrialized fabrication concept in the construction industry would be, that highly specialized companies or craftsman may use their modular (robotic) high-tech equipment not only for one specific product but for several products for many customers or various building fabrication networks. The introduction of a decentralized fabrication system would allow that small scale construction enterprises could be supported. Also, this would offer the ability to react flexible on various customer demands. Equipping small scale enterprises with flexible and ICT-based construction equipment and further deploying advanced supply chain communication could thus be seen as basic enablers for distributed industrialized building fabrication.

3.4 Eco-factories, deconstruction and resource circulation

Eco-factories are factories that produce at high efficiency and in accordance with environmental needs: carbon neutral, powered by renewable energy, zero-waste. An essential factor in most industries today is the implementation of factories with low or even no environmental impact [18]. Moreover, with the implementation of industrialized structures eco-processes once established could be improved gradually. Eco-factories are often established through introducing so called “Environmental Management Systems” [28] combined with other advanced resource control technologies. Therefore factories are increasingly able to manage the circulation of all resources and materials efficiently. Further, technologies for using renewable energy, solar modules and cogeneration systems are gradually deployed in industrial facilities to generate electricity and heat for the production, meanwhile waste and heat recovery systems allow a passive-house-like energy circulation within the factory. The vision here goes into the direction of more or less autarkic factories which even could process their own waste. Moreover, the reduction of waste through continuously
improved production processes and advanced production equipment is another aspect which shows the advantages of moving material-intensive processes from the construction site into the controlled environment of the factory. Further, systems for reverse logistics, remanufacturing and recycling as discussed in section 2.4 could be closely linked to those eco-factories creating structures for hyper-sustainable resource and component circulation.

3.5 Towards a knowledge-based construction industry

In most high-tech based industries knowledge-based information and software systems are crucial for making complex decisions. Once information and communication structures, sensors, RFID tagged components [15] and networks are introduced in construction industry intelligent decision making software could be deployed to control, manage and operate a distributed, flexible and complex network of modular high-tech equipment, locally based factories and other resources. In an industrialized and decentralized construction industry, as described above, it would be difficult to adequately coordinate the inevitable multitude of complex operations and to make rational decisions without the help of intelligent knowledge based systems [5]. As ICT in an industrialized industry becomes an inherent part of most processes, knowledge-based decision support systems could make real-time use of the operation data or help to analyze them for further decisions or operations [14]. Appropriate decisions in complex industrialized networks would enhance the efficient flow of information, materials, components, energy and other resources. In construction industry knowledge based systems could also be used to organize, classify and analyze data from previous projects and activities as well as different building variations and their related lifecycle performances, in order to support sustainable short-term and long-term decisions on system architecture, modularity and construction processes.

4. Conclusion

New organizational structures, new process technologies, microelectronic systems, ICT, flexible automation, robotics, human-machine-cooperative systems, tagged equipment and building components and knowledge based logistics are key enablers of a necessary shift from economic growth to sustainable economic development. Industrialized structures would be a solid basis for a gradual development towards a sustainable construction industry. Therefore in this paper examples have been given which outline best-practices in sustainable industrialized construction. Further a framework for future industrialization has been presented, which suggests to combine several industrialization methods to a synergistic ecology of factories, devices, equipment, resources and human beings. Prefabrication, advanced logistic structures, automated construction, modular high-tech (robotic) equipment and systemic reverse logistics are various proofed stand-alone industrialization solutions. Those state of the art industrialization methods could be integrated and developed further to large scale sustainable building fabrication networks producing sustainable buildings with determined economic, environmental and social impact. In the presented approach, production oriented architectural design structures, appropriate modularization and standardization of building structures, logistics, equipment and processes would serve as fundamental integration tools. Customized and demand oriented industrialized prefabrication could then be able to supply
construction sites with individual elements and a modular pool of flexible automated systems, robots and robotic co-working systems could support a limited amount of trained workers to do positioning, joining and finishing operations. Knowledge-based construction ERP systems could support overall organization as well as a lean and demand oriented industrialized construction based on just-in-time and just-in-sequence resource supply. Locally based and distributed factories grant identity, support small and medium sized enterprises and reduce logistic effort. Moreover, integrated industrialization should not only be limited to the fabrication but also link systems of controlled deconstruction and component reuse to a network for continuous component circulation. Advanced tools for resource planning on the enterprise level (ERP) and knowledge based systems on the level of management, greater networks and real estate could support appropriate decisions in complex industrialized networks and thus enhance the determined and sustainable flow of information, materials, components, energy and other resources. With the gradual implementation of a compatible ecology of industrialization sub-systems, construction industry would have the chance to simultaneously address various parameters relevant for sustainable economic, environmental and social development consequently and with greater efficiency than with conventional construction methods. Industrialization could help to reduce material and energy consumption, minimize waste production, improve safety and working conditions, supply affordable housing and enable deconstruction, reuse and recycling. Moreover processes once systemized and industrialized have the potential for continuous adaption and improvement. Further research will focus on the detailed design of building structures and modular building platforms designed for knowledge-based production in flexible networks of small and medium sized construction enterprises.

References


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[35] Fig.01 Copyright Bock, T; Linner, T.

[36] Fig.02 Copyright Sekisui Heim, Japan
By holding design professionals accountable for occupational health and safety in the life cycle of buildings or structures, legislative changes have recently been enacted in Victoria, Australia that require greater consideration to OHS in the construction industry at the early design stages of a project. Such legislation assumes that design responsibilities for OHS, as well as other aspects of design, lie within the exclusive domain of those who can be officially labelled ‘designers’. This view of the construction industry fails to acknowledge the complexity of the design process, the social division of technical knowledge, as well as the permutations of the numerous procurement processes that disperse project decision-making beyond a single responsible party. A pilot case study focusing on the generation of latent hazards, and undertaken as part of an Australian Research Council Discovery project, seeks to investigate the nature of design decision-making processes as applied to building projects in Victoria, Australia. Preliminary findings suggest that intricate inter-organizational relationships, information dependencies and discretionary decision-making shifting at various stages in the delivery process couple with budget sensitivity and risk incertitude to make that of OHS a complex operational landscape. Thus, in order to achieve better OHS outcomes, it is critical to understand the manner in which work is developed rather than to attribute OHS responsibility simply to abstract socio-technical categories, such as the designer.

Keywords: architectural practice; design management; occupational health and safety, educational facilities, school design.
1. Introduction

1.1 OHS legislative control

Responsibility for occupational health and safety (OHS) control in Australia lies with each individual state and territory, and as a result, legislation is characterised by a lack of uniformity in control and approach nationally. In 2002, the National OHS Strategy 2002-2012 was established to address OHS reform, with the elimination of hazards at the design stage as the fourth of its five national priorities (NOHSC 2002). This priority identification in OHS management has arisen due to perception that design has been a contributing factor in the incidence of workplace injuries. Reviewing data for a two-year period ending 2002, Driscoll et al assessed that 37 per cent of workplace fatalities were definitely, or probably, design-related. However, 80 per cent of these cases involved machinery, mobile or fixed plant or transport. Furthermore, it was found that 26 per cent of design-related fatalities occurred in the construction industry (Driscoll 2008). The European Union has set OHS obligations for designers that have been operative since the early 1990’s. In the UK, this has been mandated through the *Construction (Design and Management) Regulations 1994*. Despite addressing OHS upstream in the design and planning stages of the building project, it is not conclusive whether or not this has resulted in a reduction of incident frequency rates (Bluff 2003).

Nonetheless, in 2004 the State of Victoria redrafted its OHS Act in an effort to carry OHS responsibility upstream into the design stages of building projects by placing obligations on designers to ensure that, where buildings are to be used as workplaces, they are designed to be safe and without risk. The introduction of the legislation in this state has been contentious for the building design profession, as it introduces an overt responsibility that goes beyond contractual liability and professional negligence. It also establishes a level of performance-based requirement that is discretionary in its assessment by not being controlled through the building regulation regime or supporting mechanisms such as the Australian Standards. The Act does not define the terms ‘design’ or ‘designer’, nor does it provide any guidance on the mechanisms for compliance. The key clause for designers is Section 28:

“A person who designs a building or structure or part of a building or structure who knows, or ought reasonably to know, that the building or structure or the part of the building or structure is to be used as a workplace must ensure, so far as is reasonably practicable, that it is designed to be safe and without risks to the health of persons using it as a workplace for a purpose for which it was designed.” (OHS Act 2004)

This very broad wording seeks to place responsibility for dealing with OHS design issues at the feet of the ‘designer’, and in doing so makes the assumption that the designer has the capacity to ensure that the building or workplace is designed to be safe and without risk. In effect the legislation is a single (and yet very generic) source approach, as it identifies the designer, without defining the term, as the sole entity who deals with OHS design issues in building projects. In case one associated, as natural, the ‘designer’ with professional designers, e.g. architects, the legislation fails to account for
the permutations that can arise in the contractual arrangements of the building procurement process, the role that the various stakeholders to a project play in design decision-making, or the factors that bound the designer’s capacity to influence OHS outcomes. Research undertaken as part of an Australian Research Council funded grant aims to identify, across a range of different building typologies, some of the issues and processes that may influence an architect’s capacity to ensure buildings are safe and without risk. An initial pilot case study, consisting of several completed educational building projects, seeks to investigate the nature of design decision-making processes and the factors that came to bear by tracing the pathology of hazards commonly encountered in such project types by focusing on items existing as potential or latent hazards.

2. Approach

An indirect yet important objective of the study is to assess the adequacy, for achieving OHS risk-reduction through design, of current professional profiles of contributors to design decisions in a construction project. To this end, the investigation of the decision-making processes relevant to the OHS performance as they are reflected in completed buildings is methodologically relevant. Using data compiled from the industry sectors of the Victorian Workcover Authority regarding the nature of injury classification and mechanism of injury classification, a list of generic or common hazards and risks was compiled for each of the particular industry sectors. Whilst the broader research project looks at case studies that cover a diverse range of building typologies and procurement methods, the initial pilot projects were chosen from the education sector due to ready availability of recently built projects. Architectural practices registered on the Victorian Department of Education and Early Childhood Development’s (DEECD) 2009 ‘Principal Consultants’ Register (Architects)’ were approached to provide case study buildings to track the design decision process for a selected list of generic hazards common to the education sector. The initial pilot case studies consisted of two new state government primary school buildings, built as part of the Victorian State Government’s Education Building Programme. Pilot study 1 was a new classroom and library facility building for an existing school of approximately 250 students. Pilot study 2 was a new library, administration and classroom building for an existing school of approximately 300 students.

A building inspection of each facility was carried out by research team members using the Victorian Workcover Authority’s mechanism of injury classification data for ‘Primary Schools, Non-Private Sector’ (2004 to 2009) as a guide in the identification of ‘latent hazards’. A hazard is defined as ‘a source of potential harm or a situation with a potential to cause loss’ (Standards Australia 2004). Latent hazards, for the terms of the study, are conditions that may lie dormant, present but not actualised as hazards. Hazards that arise from the design stage of a construction project may also be deemed 'latent' because they arise as a result of influences, pressures and interests that are temporally and organizationally distant from the situations in which they become manifest (e.g. the erection, occupation or maintenance of a building). This facility review concentrated on contributing factors to the following mechanism of injury classifications: falls, trips and slips, body stressing, chemical substances, and mental stress factors. For the period 2004 to 2009 (during which OHS designers’ obligations have been operative), there has been no appreciable change in the number of incidents across these mechanisms of injury classifications.
Prior to the building inspection, each school principal was interviewed to determine the processes instigated by the school council to address OHS issues at the design stage and to obtain input on the OHS post-occupancy operational aspects. A preliminary briefing interview was conducted with the architectural practice design team to obtain an overview of the project and an insight into the background of the project related to OHS from the perspective of the architect. It is proposed that further detailed interviews will follow to specifically track the design decision making dynamics related to the latent hazards identified by the research team members.

Even at this early stage, however, preliminary research suggest that although architectural design decisions play a part in OHS risk reduction, a greater level of complexity may prevail beyond the allocation of design responsibility to a single professional entity. A broader range of factors may need to be taken into consideration to determine the practical degree of decision-making power and influence by the various contributors to construction design.

### 3. Preliminary findings

#### 3.1 Legislation perceptions

An undesirable early outcome of the legislation has been that design practices and their clients are fearful of the exposure and liability they now carry under the legislation. This response has been commented on by others as being one of the most commonly cited barriers to improving design for better OHS in the construction industry (Gambatese et al 2005). Conversations with the two architectural firms participating in the pilot studies suggest that they were unsure how they are required to demonstrate compliance with the legislation; as such, they were mindful that their procedures could be deemed to be insufficient by the legislative inspectorate, Worksafe Victoria. Furthermore, as OHS design is not specifically covered by the building regulations and the review process provided by the building surveyor, they were unsure whether the determinations they make in hazard identification, risk assessment and determining risk control will be considered to be reasonable. Clients are equally concerned of being scrutinised, as witnessed by the inability of some of the architectural firms approached to obtain approval from their clients in the provision of further case study buildings. This concern continues into wariness by client groups to provide guidelines for hazard identification and risk assessment for fear of such documentation being potentially used by Worksafe Victoria to support a compliance breach. Rather than being supportive of a collaborative approach to improving OHS outcomes in building design, the legislative changes may have contributed to the response of limiting one’s exposure through risk transference mechanisms being brought into the OHS arena. DEECD background material on the duties of designers for OHS to schools, extensively refers to compliance with Australian Standards and to third party OHS guide documents, however, fully developed hazard identification and risk assessment analyses for projects were not included in the project briefing documentation and are left for the consultant to develop in conjunction with the school.
Furthermore, in order to demonstrate compliance with the legislation, architectural practices are developing generic checklists for their projects. One of the pilot project practices had developed a generic hazard identification checklist for school projects which they view as a formalised OHS procedural document, using this as a basis to review OHS issues in consultation with the school principal as the representative of the school council user group. The inspectorate is reluctant to fully endorse such procedures as they determine this to be too general in nature and not targeted to the specifics of the project. The risk lies in not identifying a hazard that is unique to the project.

Practices acknowledged that designing for workplace OHS safety is an important issue, and one they mostly felt they took into consideration prior to the introduction of the legislation. They also acknowledged that the legislation has brought the issue to the fore in the design process and formalised previously ad hoc methods. However, with the introduction of the legislation and the requirement they felt they now had to bear to demonstrate compliance, has carried with it an additional administrative cost that they do not have the capacity to recoup from their clients in charging additional fees commensurate with the time taken to go through these more formalised recording and compliance procedures. The legislation has increased their overhead costs and a broader education programme is being called for to inform clients not only of their obligations under the Act but also to acknowledge that professional costs have increased as a result of its introduction. The dilemma for a practice lies in reconciling commercial imperatives dictated by fee levels and structures with their legislative obligations.

Due to the discretionary performance-based nature of the legislation, the recommendation to clients for the need of a separate consultant to advise on OHS issues related to the design of the building is compelling. Practices were unsure how their procedural systems and approach would be considered by the inspectorate, whereas, this mechanism of having independent advice for the client and the practice may be read as the consultant having taken reasonable steps in meeting their obligations in a professional manner. This carries with it a built-in risk, given that one cannot contract out of one’s obligations under the OHS legislation. Appointing another professional consultant would not exempt the architectural practice from its responsibilities under the Act.

Furthermore, the engagement of an additional consultant would increase the overall consultant fee. Under the current consultant engagement terms, all consultant and sub-consultant fees are submitted as one fee proposal by the architectural practice, which also administers it. Under the fee bidding regimes considered to apply, practices felt this increase in fees would compromise their ability to be competitive in winning projects, and hence have been reluctant to pursue this option. They felt, however, that the engagement of a separate consultant would be of benefit by allowing them to demonstrate compliance with their obligations and offer a risk management strategy that is currently lacking by not having OHS controlled by a regulatory regime. The competitive fee bidding processes that apply to publicly funded projects under a single consultancy agreement was identified as a major factor in practices making a commercial decision to not engage a specialist OHS consultant for the provision of OHS design advice for projects.
3.2 Project timeframes

Since 2007, as part of economic stimulus initiatives ramped up in response to the global financial crisis, the Federal and State governments in Australia have been investing heavily into capital works building programmes in the education sector. The Victorian State Government has developed ‘The Victorian Schools Plan’ which seeks to rebuild, extend or renovate every school across the state by 2017 (DEECD 2008). A common refrain from architectural practices involved in these programmes is the short timelines that are set for these building projects, which they consider to be more directed at generating economic activity than considered design outcomes in the education sector. Master planning, cost planning, design and documentation have short lead times and, with multiple projects coming on stream, heavy demands are placed on the resources of architectural practices. The aspect of dealing with OHS in a highly considered manner for each particular project gets subsumed by the demands of meeting short timelines on key deliverables along the project timeline. Practices commented that although they are obligated by their clients to demonstrate compliance with Section 28 of the OHS Act, no consideration in the project timeline is allocated to meet these obligations. Furthermore, there has been no increase in consultant fees in recognition of the additional resources required. Moreover, a practice’s ability and leverage to negotiate project delivery times and fees, particularly with a government client, is severely limited. It has been identified that tight schedules and budgetary constraints make it impossible to address OHS effectively (Bluff 2003). Such factors have the potential to impact significantly on an architectural practice’s capacity to meet its obligations under the legislation. Firms considered that these were the two most significant aspects that compromised dealing effectively with OHS at the design stage. This suggests that the prevalent risk transference approach of contractual obligation to OHS design, without commensurate time and financial allowance, is not conducive to ensuring stakeholders’ interest for OHS in project delivery. Firms are solicitous that these factors would not be considered grounds by the inspectorate in demonstrating legislative compliance even though they may have been the most significant operative mechanism that prevented comprehensive OHS design resolution.

3.3 Design brief

Due to the nature of the client structure, where funding is provided by the DEECD while formal design resolution, following department guidelines, is done in association with the user group, i.e., the school council, a two-tier level of responsibility develops for employer obligations. Under the department’s capital works program ‘Procedures Manual’ (DEECD 2006) the school council carries an obligation to comply:

‘with the “Client Responsibility” sections of the Occupational Health and Safety Act 2004 relevant to this Capital Works project, and provides commentary and response to the Principal Consultant regarding OH&S hazard identification and risk management’

However, the OHS Act does not contain any specific sections identified as being ‘client responsibility’, potentially contributing to the school council finding it difficult to determine their specific obligations under the Act and how these may differ from those of the funding body. One
school principal interviewed highlighted their inexperience in building procurement, building design and contract administration procedures, and was unsure of their role in the process as well as their capacity to address OHS issues via the provision of comprehensive design guidelines for their particular project. School councils are made of educators and education administrators as well as school community representatives, usually parents. These individuals may not be experienced in building procurement procedures and are invariably not experienced in OHS risk management or in drafting guide documents for the building design team. Hence, consultation may occur in an ad hoc manner with the school councils heavily reliant on the architectural design team to assist them in this process. This has the potential for incomplete briefing design guidelines being produced and places an inappropriate burden on the design team to interpret and formulate hazard identification and risk management strategies into the building design.

Often, the nature of the design brief itself in privileging factors such as building performance and lifetime operational and maintenance costs may contain a built-in mechanism contributing to potential OHS hazards. For example, the ‘Building Quality Standards Handbook’ issued as the general design guide document for education buildings by DEECD states that ‘simple roof forms are required, with guttering outside the line of external walls (i.e. no box gutters)’ (DET 2003). The design of roofs is required to incorporate a provision for enabling any water overflow to escape outside the building. This establishes that buildings are designed to have eaves and eaves gutters, and thus sets up a built-in fall-from-height design risk by precluding the design of parapet walls which offer the capacity to serve as a restraint barrier to the perimeter of the roof area. Although both pilot study buildings made provision for roof restraints and anchor points, the risk associated with working adjacent to an unprotected roof edge remains as a result of the mandatory roof design brief requirements. In one of the projects, the requirement to design for roof drainage only using external gutters led to access difficulties which could have been avoided through conservative box gutter design. This risk was further compounded by sections of the building being more than one-storey in height.

3.4 Project budget

A number of potential OHS issues arose due to the nature of the budget and budgetary constraints. Two common examples from both pilot projects exemplify how issues related to the budget may impact on the designer’s capacity to influence OHS outcomes. On one project, in many areas of the building there was a lack of storage provision by way of shelving units and cupboards. This led to material being stacked in small storage rooms, rooms that were designated for other purposes but also used for storage or stacked in areas adjacent to circulation paths. The material was often arranged in such a way that rendered it not secure and potentially requiring handling above shoulder and below knee height. This raised a number of hazards by way of stored material potentially falling, material being handled in confined spaces, potential trip hazards and body stressing. On review with the school representatives it was advised that fixed and portable joinery did not form part of the capital works budget. Although the school had a new building there was insufficient provision for materials that were required for the running of the educational facility. Funding availability often followed well after building works were completed with internal furniture and fixed joinery layouts not formally designed in consultation with the building design team. In one project, the expansion of material for
the school library necessitated the installation of storage compactus units adjacent to the main circulation spine of the building, resulting in a potential hazard along the primary access route for the building.

In both case study projects, the only spaces that were mechanically air-conditioned were those that were dedicated spaces for information communication technologies. All other spaces were naturally ventilated with some designed for cross flow natural ventilation as well as for night purging. However, window security screens and fly screens did not form part of the capital works budget and as such were never installed as part of the works. Windows were rarely opened due to the ability of insects to enter the rooms, resulting in the building not operating to its full design capacity. As a further consequence, night purging did not eventuate due to the security risk this presented in having windows open after operational hours. Some users commented that some spaces became uncomfortably warm and the school principal in one of the schools had to plan who could use particular spaces and how long classes could be timetabled during summer. With some spaces fully occupied, indoor air quality suffered even though the natural ventilation of spaces based on passive design principles had been considered at the design stage.

These two examples serve to suggest that the makeup of financial and budgetary planning of buildings serve as factors that lie outside the domain of building designers in controlling OHS outcomes.

### 3.5 Education pedagogy

The Victorian Department of Education and Early Childhood Development have been encouraging a reassessment of educational delivery methods, seeking to link pedagogy and building design (DEECD 2008). One of the pilot projects reviewed included new open plan teaching spaces commensurate with the new education pedagogy being adopted. This space was designed as an open plan flexible learning hub, facilitating multiple learning settings conducive to a range of pedagogical approaches (Fisher 2005). However, the space had been divided up into four classroom regions being used permanently by four different teachers. Two of the classroom spaces retained their open planning configuration; however, the teachers within two of the spaces had rebuilt the classroom walls using bookshelves and furniture. These teachers acknowledged they did not feel comfortable in the space and had not fully embraced the educational pedagogical model that underpinned flexible learning spaces geared around collaborative teaching and activity centred spatial models. They reintroduced spatial divisions to reclaim ownership of a traditional classroom configuration. These spatial divisions introduced circulation barriers and trip hazards into a space not designed for ‘walls’. Unsecured bookshelf units, ‘permanent’ student work displays and furniture adjacent to primary circulation paths established a potential hazard, as did furniture located adjacent to power supply points making servicing access difficult. Research investigating the relationships between pedagogy and building design have highlighted the difficulty that some teachers are encountering in conceiving how space may support new types of learning (Newton 2009). Mental stress claims are second to trips and falls in the non-private education sector and until the present transition period passes in embracing the new teaching methodologies that underpin open plan flexible educational spaces, school management strategies for OHS are required that lie outside the realm of design.
School buildings are now seen as a community asset not only servicing the needs of its students but also the broader needs of the community. The opening of school facilities to community groups adds an additional layer of complexity by extending the operational hours of the building and requiring a different hazard and risk assessment regime. Community groups who use the building facility rarely provide input into the building design process with their profile often being unknown at the design stage. As such, they can only be considered in a generic rather than detailed fashion. The school principals acknowledged that they were not aware of the detailed operational workings of the various groups that used their facilities, with individual OHS assessments rarely undertaken. Designers were unsure of the extent of their responsibilities to such groups and were nervous about the potential liability they carried to a user group with whom they had had no contact.

4. Conclusion

Preliminary research of two recently completed primary school building projects tracing the background to OHS latent hazards suggest that there is a complexity of factors shaping OHS design decisions in construction projects, as well as considerable diversity in the interplay of actors and influences on design decision-making.

Such factors as the perception of designer’s responsibilities under the OHS legislation and the lack of clear guidelines within a climate of the legislation being ‘untested’, are contributing to a fear and uncertainty of how the legislation will be interpreted and applied. This uncertainty is reinforced by the perception of the inspectorate as a policing agent enforcing compliance, and being the arbiter of architectural practices’ professional OHS procedures within regimes that are performance-based and hence interpretative in nature. The fear of procedural auditing by the inspectorate is also leading to a generic approach to hazard identification and risk management to demonstrate compliance in operative procedural mechanisms. Suspicion of the role of the inspectorate may also be contributing to the lack of openness by commissioning agents in the development of a fully developed OHS brief for design consultants. Risk transfer mechanisms in highlighting consultants’ obligations to Australian Standards and OHS authority guide documents (in lieu of a fully developed user group hazard analysis) reinforce a ‘finger pointing’ approach to OHS rather than setting up a cooperative framework in which OHS issues can be more fully identified and addressed at the design stage.

Competitive fee bidding under single consultancy engagement procurement mechanisms potentially leads to commercial risk weighting decisions by architectural practices in accepting OHS design responsibility at the expense of obtaining expert OHS consultant advice for projects.

Tight project delivery times established for project delivery contribute to insufficient time being allocated to the full consideration of OHS issues at the design and documentation stages. This, in conjunction with tight budgets and the makeup of the project budget, leads to inherent inconsistencies in the process and consequent partial outcomes from the design decisions made initially. More importantly, it is likely to contribute to the manifestation of OHS latent hazards in projects. The nature of the design brief in privileging other factors than OHS may also create a built-in hazard that
requires the design professional to make a judgement on what is reasonable in mitigating an embedded OHS risk.

Furthermore, school design is playing a larger role in the reassessment of education pedagogy and curriculum development. The type and use of space is being reassessed with education design undergoing a transition period in education delivery via different education modelling regimes. The adjustment to these differing models is potentially resulting in the generation of OHS hazards and risks, where the building design offers a different education container which as yet has not been fully embraced by teaching practice and building users. In addition, the opening of school facilities to community groups adds an additional layer of complexity as they rarely provide input into the building design process, with their profile often being unknown at the design stage and hence only able to be considered in a generic rather than a detailed fashion.

The augmentation of this research into a broader spectrum of projects, both in procurement systems and building type will hopefully contribute to the identification of patterns in the source of decisions influencing design OHS. If so, it will enable the development of terms of reference for the allocations of responsibility for design OHS in construction projects, thereby offering the potential to improve OHS performance on building projects and the workplaces they facilitate.

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References


Abstract

The goal of this paper is to discuss if knowledge from Project Start-Up theory can be of benefit in the initiation of architectural design projects, and if so, which and what form it should take. Previous research showed that Project Start-Up is a method that can improve the result of a project (Halman & Burger, 2001). In our own study we transformed the Project Start-Up terminology into terms that commend to architects. Then a survey among members of the Royal Institute of Dutch Architects (BNA) has been conducted to verify the need for improvements in project starting procedures. We asked them which issues are involved in present initiations of architectural projects, which issues are underrepresented, and which issues rank high in priority. This formed the basis for a series of simulations, with and without the Project-Start-Up procedure. The simulations were conducted with volunteer architects and clients who supplied project information drawn from ongoing real projects. The simulations were video-taped and the respondents were then debriefed.

The participants in the simulations using the Start-Up procedure were found to address more of the Project Start-Up issues than did the participants in the simulation without a Start-Up procedure. Using the Start-Up procedure, the architects were quite dominant in the conversations, initiating far more issues. As such, the Project Start-Up delivered the expected benefit in terms of addressing important issues at the outset of the project. Further, it helped architects to establish an authoritative role within the project team. However, this came at the expense of the team-building value of the freewheeling and product oriented conversation occurring without the Start-Up procedure. It can be concluded that the Start-Up procedure could be valuable for some projects in that it helps clients and architects to more completely cover the range of issues need to be discussed at the outset of the project. However, the Start-Up procedure needs to be further developed to include elements of the more informal and creative conversation that now characterizes the initial conversations between client and architect.

Keywords: Architectural design, design project, Project Start-Up, Client, Architect
1. Introduction

Architecture is a service industry. Ryd (2004) and Kamara et al (2000) have shown that the quality of service delivered to clients is becoming ever more important. Clients are demanding an increasingly high level of service, not just in regard to the quality of the design produced by their architect, but also in terms of the process they undertake with their architects. The impression of the quality of service delivered depends to a large extent on what clients thought they would or ought to receive (Sharma & Patterson, 1999). The present research project attempts to determine the value of applying aspects of the project management technique Project Start-Up (PSU) in architectural projects. We explored the possibility that a more highly structured start-up procedure that obliges the architect and client to address a pre-determined range of issues pertaining both to the design product and to the design process will lead to a better start to the project.

It might be argued that architects have a long tradition of how to initiate design projects. However, in spite of a range of manuals or guides outlining a particular approach to carrying out an architectural project (RIBA, 2000; Green, 2001; Chappell & Willis, 2005; Van Doorn, 2004) very little has been reported on architects’ discussion of project organization issues at the inception of a project. Current guides focus mostly on issues concerning the design product – site, brief, and budget – rather than on issues concerning the process – expectations, responsibilities, expertise, task division, communication, and so on. Our own survey of the membership of the Royal Institute of Dutch Architects, discussed at greater length below, has indicated that Dutch architects are not satisfied with how their clients currently initiate projects. Further British research has shown that communication between clients and architects is a major cause of project failures (Brown, 2001). Recent research (Kamara, Anumba & Evbuomwan, 2000) points to the importance of achieving clarity in project processes and ensuring that the envisioned processes are carried through. Specifically, the use of the Project Start-Up technique improves the results of projects (Halman & Burger, 2001). It helps to improve team building and to make clear appointments about what is needed and how to realize the project (Fangel, 1984; Eggington, 1996). It seems therefore reasonable to speculate that an attempt to study empirically how architects and clients initiate projects, and to examine the possibility of applying insights drawn from Project Start-up to architectural projects, would be valuable. The outcome of this study suggests that the application of elements of Project Start-Up is indeed useful in improving architectural project and service quality.

2. Research methods

The research design included a mix of quantitative and qualitative approaches:

1. An analysis of PSU literature, and a translation of PSU issues into terms more commonly used by architects.

2. A Survey of the members of the Royal Institute of Dutch Architects, to determine current practices, and establish the need for improvement.

3. Interviews with three architects in order to further explore on the survey results.
4. The composition of a revised list of issues for the Architectural Project Start-Up.
5. A simulation experiment in which the application of the Architectural Project Start-Up is contrasted with current practice.

2.1.1 Analysis of PSU literature

For the purposes of this research Project Start-Up is taken to be a specific project management technique for the initiation of projects. We have used the definitions and techniques outlined in PRINCE2 (Office of Government Commerce, 1996) and have also drawn upon discussions of the application of Project Start-Up techniques in engineering contexts (Fangel, 1991; Egginton, 1996). Specifically, Project Start-Up is an initial meeting of the project team intended to set the terms under which the project will be carried out. Egginton (1996) distinguishes two components in a Project Start-Up: the project organisation as well the project content. As there is a substantial body of literature addressing project briefing (Blyth & Worthington, 2001; Peña & Parshall, 2001; Ryd, 2004; Van Der Voordt & Van Wegen, 2005) (to name but a few), there is substantially less literature over the conduct and organizational content of an initial meeting of the project team in an architectural context. Among architectural handbooks and guides, Chappell & Willis (2005), Green (2001), Thompson (1998) and Tunstall (2000) all discuss a number of issues that should be discussed with the client at some time during the initiation phase. But none of them mention an initial meeting, nor when and how to discuss the issues indicated with the client. Further, none of these sources describes or refers to empirical research. In the scientific literature we were able to find a single paper examining communication between architect and client concerning project organization at the outset of the project. Gameson (1996) made a detailed study of the conversation between clients and architects at an initial meeting, finding that clients varied in their behaviour, and that architects would need to be able to adapt their communication strategy to different clients. His concern, however, was on the conversational dynamics and not on the content of the meeting. Several authors address the discussion of organizational issues in the project management context (Winch, 2002; Williams, 1996; Gray & Hughes, 2002). Of these Gray and Hughes provide the most extensive advice. They recommend a ‘project start-up’ meeting be held at the beginning of each phase of the project. However, each of these provides only very brief guidance concerning who should be present and what should be discussed. Again, no empirical evidence is referred to or cited.

Fangel (1991) examines the problem of when Project Start-Up should and should not be used. His general conclusion is that where a project is not routine in character then PSU is appropriate. This is true of most architectural projects in the sense that while the parties may all be experienced, the particular coalition of parties is often unique and that site specific characteristics can have a major effect on how even the simplest projects develop. In Prince2 (OGC, 1996) and in Fangel (1991), the PSU itself consists of a series of discussions in which a number of issues are discussed, and agreed upon by the different parties, or participants, in the project. Egginton (1996), on the other hand, advises the use of additional techniques such as role-play in order to make the discussions more concrete. We have chosen here to limit ourselves to explicit discussion of the recommended issues. Based on a review of the literature discussed above and additional references (Lawson, 1998; Ryd,
2004; Brown, 2006; Tunstall, 2006; Smulders et al, 2007), we made a list of Project Start-Up issues and translated these into terms commend to architects (table 1).

### 2.1.2 Survey

The survey was based on the list of PSU issues developed in the previous step. The questionnaire consisted of four questions, each broken down into a series of sub-questions for each individual PSU issue. The questions were:

1. Are the Project Start-Up issues important during the design process?
2. In which project phase does the architect typically obtain (what) PSU issue information?
3. Does the architect explicitly discuss the PSU issues with their clients?
4. In which project phase does the architect want to make use of information on PSU issues?

#### Table 1: List of Project Start-Up Issues

<table>
<thead>
<tr>
<th>Categories</th>
<th>Project Start-Up Issues + Main phases of inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Feasibility and measurability of the project goals (1,2,4)</td>
</tr>
<tr>
<td>Nature and scope</td>
<td>The scope and desired results (1,2,4)</td>
</tr>
<tr>
<td>Result/output</td>
<td>Image of the result/output of the project (2,4)</td>
</tr>
<tr>
<td>Background</td>
<td>Background and reason of the project(2,4)</td>
</tr>
<tr>
<td>Decision-making power</td>
<td>Managing the project according to the most important criteria (3)</td>
</tr>
<tr>
<td>Assessment criteria</td>
<td>Go/No Go (2)</td>
</tr>
<tr>
<td>Documents</td>
<td>1. Fit between the design and the project brief (3,4)</td>
</tr>
<tr>
<td></td>
<td>2. Schedule (3,4)</td>
</tr>
<tr>
<td></td>
<td>3. Project information (3,4)</td>
</tr>
<tr>
<td>Design of the organisation</td>
<td>1. Working methods (3)</td>
</tr>
<tr>
<td></td>
<td>2. Cooperation with other parties (3)</td>
</tr>
<tr>
<td></td>
<td>3. Structure of the project (3)</td>
</tr>
<tr>
<td></td>
<td>4. Role of the project members (3)</td>
</tr>
<tr>
<td></td>
<td>5. Information and communication systems (3)</td>
</tr>
<tr>
<td>Design leader</td>
<td>Role of the leading designer(s) (3)</td>
</tr>
<tr>
<td>Parties involved</td>
<td>1. Role and influence of the client (1,2,3,4)</td>
</tr>
<tr>
<td></td>
<td>2. Role and influence of other parties (1,2,3,4)</td>
</tr>
<tr>
<td></td>
<td>3. Users and their opinions (1,2,3,4)</td>
</tr>
</tbody>
</table>

1= getting to know each other; 2 = briefing phase; 3 = contract phase; 4 = design phase

In total 332 Dutch architects participated in the survey, representing a response rate of 10,9% of all BNA members (3,045 architects). Not all respondents answered all questions. Question 1 was answered by 216 respondents (response rate 7%; reliability 93,4%); questions 2-4 were answered by 145 respondents (response rate 4,7%, reliability 92,1%). Of the respondents 83% of the respondents
had active projects of less than 5,000 m² GFA; 17% of the respondents (also) had larger active projects. Furthermore 24.5% of the sample is active in commercial buildings, 59.7% in dwellings and 15.7% active in both.

### 2.1.3 Interviews and composition of improved PSU issue list

Semi-structured interviews with three architects were used to explore further the PSU issues with architects i.e. the applicability of the issues, its effects, if architects are able to discuss the issues with their clients, and if sufficient information is available. On the basis of the list derived from literature, the survey and the interviews, a final list of PSU issues was composed (Table 2).

**Table 2: Reference List of Project Start-Up Issues**

| Role and influence of the project owner | Working methods       |
| Role and influence of other parties    | Go/No Go              |
| Users opinions of the project         | Cooperation with other parties |
| Fit between the design and the project brief | Structure of the project |
| Background and motivation for the project | Managing the project according to the most important criteria |
| Goals                                 | Role lead designer(s)  |
| Scope and desired results             | Role of the project members |
| Image of the result/output            | Project information    |
| Schedule                              | Information and communication systems |

### 2.1.4 Simulation of the start of a design process

Using the improved list of PSU issues a series of simulations of project initiation meetings was held. Simulations were chosen as they provide a controlled setting in which to observe the behaviour being studied. They also permit behaviours to be observed when there are practical problems with observing them in the field. In the case of initial project meetings, confidentiality is a significant barrier to observation. From the observation of a controlled simulation one can abstract features of the system under investigation and build a model that will permit one to understand the behaviour of the system in the field (Duke, 1980). In this case, the intention was to observe simulated project initiation meetings, both with and without PSU, and to evaluate the usefulness of PSU. The observations consisted of determining the number of issues addressed by the participants in the simulations, the party raising the issue, and the length of time spent discussing each issue. Further we were able to make some observations of the way in which each issue was addressed. The participants were later debriefed in order to obtain their views on their experience with the simulations. The simulations were conducted with two volunteer architects and two clients who provided project information drawn from ongoing projects (Table 3). Three simulations were conducted: one without using any formal start-up procedure, and two using the PSU agenda.

**Table 3: Simulation schedule showing combinations of architect, client and brief.**
3. Findings from the survey and the interviews

From the survey we determined that 70% of the respondents discussed project content in the initial meeting while 66% discussed project organisation. The most frequently discussed issues were the parties involved, the background of the project, documents, assessment criteria, goals, results/output and nature and scope of the project (Table 4). Nearly 92% of the sample responded that the importance of Project Start-Up issues depends on the kind of project and on the client. Slightly more respondents indicated that organization was important than did project content (64% versus 58%).

The issues seen as most important to be discussed were the design leader, documents, result/output, parties involved and the design organization (Table 4). A bare majority of the sample indicated that discussing the working method is not important at all: “the working method is something you should not bother your client with as working methods are not the reason your client hired you.”

Table 4: Actual occurrence and perceived importance of Project Start-Up Issues

<table>
<thead>
<tr>
<th></th>
<th>% of respondents indicating that the issue is discussed in the initiation phase</th>
<th>% of respondents indicating that the issue is very important in the initiation phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>69%</td>
<td>54%</td>
</tr>
<tr>
<td>Nature and scope</td>
<td>63%</td>
<td>58%</td>
</tr>
<tr>
<td>Result/output</td>
<td>68%</td>
<td>69%</td>
</tr>
<tr>
<td>Background</td>
<td>79%</td>
<td>54%</td>
</tr>
<tr>
<td>Decision making power</td>
<td>57%</td>
<td>57%</td>
</tr>
<tr>
<td>Assessment criteria</td>
<td>71%</td>
<td>56%</td>
</tr>
<tr>
<td>Documents</td>
<td>77%</td>
<td>70%</td>
</tr>
<tr>
<td>Design organization</td>
<td>59%</td>
<td>62%</td>
</tr>
<tr>
<td>Design leader</td>
<td>52%</td>
<td>75%</td>
</tr>
<tr>
<td>Parties involved</td>
<td>81%</td>
<td>62%</td>
</tr>
</tbody>
</table>

The architects were also asked which phase of the process would be the best moment to discuss content and organizational issues of Project Start-Up. Table 5 shows for each design phase what kind of Project Start-Up information is found in current practice and which information is desired by the respondents. It turned out that architects prefer the introduction phase and briefing phase to being
focused on the content, and the start of the contract phase being focused on organization issues. Most architects prefer more Project Start-Up information in the earliest phases and less Project Start-Up information later on. Less then 50% of the respondents agree that at present the Start-Up information is being discussed in the preferred phase. In addition to the survey we interviewed three architects to get a more detailed understanding of Project Start-Up in comparison to the current design process. We asked whether they believed that the Project Start-Up technique could be applied in a design process, and whether sufficient information is available to discuss each of the Project Start-Up Issues (Table 6).

Table 5: Project Start-Up information

<table>
<thead>
<tr>
<th>Phase</th>
<th>Project Start-Up information current</th>
<th>Project Start-Up information desired</th>
<th>% of respondents that agreed Start-Up information is current and desired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Content, Organisation</td>
<td>Content</td>
<td>48%</td>
</tr>
<tr>
<td>Brief</td>
<td>Content, Organisation</td>
<td>Content</td>
<td>20%</td>
</tr>
<tr>
<td>Contract</td>
<td>Organisation</td>
<td>Organisation</td>
<td>35%</td>
</tr>
<tr>
<td>Start meeting</td>
<td>Organisation</td>
<td>Organisation</td>
<td>26%</td>
</tr>
<tr>
<td>Sketch design</td>
<td>Content</td>
<td>Content</td>
<td>24%</td>
</tr>
<tr>
<td>Preliminary design</td>
<td>Organisation</td>
<td>Organisation</td>
<td>19%</td>
</tr>
<tr>
<td>Later in process</td>
<td>Organisation</td>
<td>Content, Organisation</td>
<td>15%</td>
</tr>
</tbody>
</table>

The interviewees’ comments are in agreement with the management ideas behind the Project Start-Up technique. According to the interviewed architects most themes should be discussed. But it is also clear that not all information required for a proper Project Start-Up as defined in management literature is available in architectural projects. In design projects the architect and the client are part of a temporary coalition of separate businesses, which makes some aspects of Project Start-Up more sensitive. According to one of the architects “You can not ask your client in the earliest stages of the project if he is capable of leading the project or if he has enough decision-making power… One starts a project with assuming that the client is capable … Even if your client appears to be incapable, it is quite difficult to discuss”. Similar arguments came up with regard to the role of project members. “You do not discuss the role of members, determined by the client. What you can do is to add the aspects you, as an architect, find important. The nature of the design process plays a role as well: “Assessment criteria can be determined in a early stage, but during the design process criteria can become more important, less important, not important at all or not realistic.”

Table 6: Project Start-Up Issues: sufficiency of information for discussion. ‘+’ indicates sufficient information, ‘-’ indicated insufficient information, and ‘+/−’ indicates that there is not always sufficient information.
<table>
<thead>
<tr>
<th>Project content</th>
<th>Categories</th>
<th>Project Start-Up Issues</th>
<th>Judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Feasibility and measurability of the project goals</td>
<td>+/-</td>
<td></td>
</tr>
<tr>
<td>Nature and scope</td>
<td>The scope and aimed results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Result/output</td>
<td>Image of the output of the project</td>
<td>+/-</td>
<td></td>
</tr>
<tr>
<td>Background</td>
<td>Background and reason of the project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision-making power of design leader</td>
<td>Way of managing the project using important criteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessment criteria</td>
<td>Go/NoGo dependent if the design meets the criteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documents</td>
<td>1. Brief and framework of the project</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Time Schedule</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Project information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design organisator</td>
<td>1. Working methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Cooperation with other parties</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Structure of the project</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Role of the project members</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Ways of information and communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design leader</td>
<td>Role of the leading designer(s): Who is in control of the project, job description, responsibilities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parties involved</td>
<td>1. Role and influence of the client</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Role and influence of other parties</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Users and their opinions</td>
<td></td>
<td>+/-</td>
</tr>
</tbody>
</table>

### 4. Findings from the simulations

The simulations suggested a generally positive result for the use of PSU. The number of content oriented issues (goals, nature and scope, background) was seen to diminish when using Project Start-Up. Only information that is useful for the start of a project is being shared in the initiation phase. Not all information that is useful for the design is also important at the start of a project. On the other hand, more issues are being discussed with regard to the (aimed) results/output and the project organization, decision-making power, design organisation and design leader. Discussion about assessment criteria and documents increased as well, but more slightly. In the simulation without Project Start-Up procedure more information is shared about the project content. In addition to counting the number of issues that were discussed we also counted the speech time of both the architect and the client (table 7).
Table 7: The effect of Project Start-Up in the design process on the number of issues raised by the architect and by the client and the speech time (minutes). (Intervention refers to the time one of the researchers spoke clarifying what was expected according to the PSU technique.)

<table>
<thead>
<tr>
<th>PSU Issues</th>
<th>Simulation 1 Start without PSU</th>
<th>Simulation 2 Start with PSU</th>
<th>Simulation 3 Start with PSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of PSU issues</td>
<td>28</td>
<td>24</td>
<td>34</td>
</tr>
<tr>
<td>Architect</td>
<td>9</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Client</td>
<td>19</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Project Content</td>
<td>14</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Project Organization</td>
<td>14</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Speech time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1:02:11</td>
<td>0:23:34</td>
<td>0:45:44</td>
</tr>
<tr>
<td>Architect</td>
<td>0:29:24</td>
<td>0:17:40</td>
<td>0:28:23</td>
</tr>
<tr>
<td>Client</td>
<td>0:22:53</td>
<td>0:05:01</td>
<td>0:15:48</td>
</tr>
<tr>
<td>Intervention</td>
<td>0:09:54</td>
<td>0:00:53</td>
<td>0:01:33</td>
</tr>
</tbody>
</table>

By structuring the conversation according to Silverman (2007) from start to finish of an issue (or from question to answer), next to the changing communication we noticed a change in the way of interaction between the architect and the client. Without Project Start-Up usually the architect initiates an issue, whereas the client sometimes starts sub-issues. Quite often an issue was introduced with an open question, proposition or telling a short story, that lead to many ‘sideways’. If an issue started with a focused question the conversation continued with a strong focus and less ‘sideways’. The architect and the client stimulated each other to explore the issue and possibilities and limitations. Without Project Start-Up, the client generally concluded issues. After his answers to a question or proposition the architect or the client continues to discuss and explore a new issue. Issues also returned several times during the conversation. Without Project Start-Up procedure the client contributes more issues then the architect in order “to characterise his design problem” (Brown, 2001). But the architect speaks more time then the client. Half of the issues focus on the project organization and also half of the issues are content-oriented information.

With Project Start-Up the architect contributes more issues to discuss and the architect speaks even more of the time. In case of using Project Start-Up procedures the clients contributed more project organization information. The architect and the client are more focused on answering questions and less on exploring. Most issues were discussed only once and at the end being summarized by the architect before he starts to discuss a new issue. The nature of the conversation changes from conversation into answering questions. Finally we analysed our observations on applicability of a particular issue, the possibility to discuss details and the availability of sufficient information (Table 8). For this purpose we used a revised list of issues.
Table 8: The effect of Project Start-Up in the design process, concerning architect and client

<table>
<thead>
<tr>
<th>Reference List</th>
<th>Applicability</th>
<th>Discussable</th>
<th>Information adequacy</th>
<th>Observed change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role and influence of the project owner</td>
<td>+/-</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>Role and influence of other parties</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>Users opinions of the project</td>
<td>-</td>
<td>+</td>
<td>+/-</td>
<td>-</td>
</tr>
<tr>
<td>Fit between the design and the project brief</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Background and motivation for the project</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Goals</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
<td>+</td>
</tr>
<tr>
<td>Scope and desired results</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
<td>-</td>
</tr>
<tr>
<td>Image of the result/output</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
<td>-</td>
</tr>
<tr>
<td>Schedule</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>Working methods</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Go/No Go</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+/-</td>
</tr>
<tr>
<td>Cooperation with other parties</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
<td>-</td>
</tr>
<tr>
<td>Structure of the project</td>
<td>+/-</td>
<td>+</td>
<td>+/-</td>
<td>+/-</td>
</tr>
<tr>
<td>Managing the project according to the most important criteria</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Role lead designer(s)</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
</tr>
<tr>
<td>Role of the project members</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+/-</td>
</tr>
<tr>
<td>Project information</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Information and communication systems</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
</tr>
</tbody>
</table>

5. Discussion and concluding remarks

Our survey showed a remarkable positive attitude of architects towards this management tool. The responding architects recognised the information needed for Project Start-Up without any problem. Apparently Project Start-Up issues are not new for architects, but working with a list of Project Start-Up issues may help to looking more explicitly at information that is already included in the design process. The survey also showed that architect finds Project Start-Up information highly important, although some Project Start-Up information is difficult to discuss with the client, in particular when issues raise questions about the competencies and skills of the client. In comparison to the current design process, most architects want more Project Start-Up information in the initiation phase and less Project Start information later on.

Using the Start-Up procedure in a simulation, the architects were more dominant in the conversation, initiating far more issues. The results suggested that Project Start-Up delivered the expected benefit in
terms of addressing important issues at the outset of the project. Further, it may help architects to establish an authoritative role within the project team. The use of Project Start-Up moves the focus to project organization. On the one hand this is a positive effect, because the purpose of a Project Start-Up is to organize the project effectively and efficiently. But the benefits came at the expense of the team-building value of the freewheeling and product oriented conversation occurring without the Start-Up procedure. According to Brown (2001) communication in design is a continuous exchange of discussing the ‘problem’ space and ‘solution’ space. Without Project Start-Up this exchange seems to be supported in a better way because of the freewheeling character of the conversation. The use of Project Start-Up seems to reduce the ability to explore and exchange thoughts. In order to be a useful tool for the architect, an important success factor in using Project Start-Up is the right moment of issues being introduced in the design process. The use of Project Start-Up in the first introduction meeting is not supporting the design process. To use Project Start-Up in a design process it needs to be developed furthermore by including elements of a more informal and creative conversation. Furthermore it is recommended to improve the knowledge of both architects and clients on Project Start-Up issues and to develop some guidelines on how better to address them. Given the reference list and these guidelines the authors expect that both architects and clients will better able to address the desired range of issues at the outset and make a good start on their project.

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‘Conquering the Classroom’ - Tracking Architectural Controversies

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Abstract

How can buildings be perceived not only for their properties as stable objects and spatial organisation, but also and at the same time as series of transformations, as socio-material orderings, as movements? On the basis of a discussion between architectural theory and actor network-theory, the paper proposes that spatial visions can be followed as issues of dispute and investigation in distributed, cognitive processes. This paper is based on studies of the planning of a new secondary school, focusing on a spatial concept emerging during the course named ‘The X zone’ – a spatial zone for interaction. Through analytical emphasis on the visual materials and documents produced during the process, and through interviews with architects, clients and engineers, I describe the continuous efforts to establish and strengthen architectural motives, and how they eventually gain the ability to align other motives and other actors.

Keywords: architecture, architectural theory, actor-network theory, architectural process
1. Introduction

The main purpose of the paper is to contribute to understandings of architecture as series of transformations, as moving projects. It is also to demonstrate, that theoretical information for such an analytical stance can be provided by a meeting between architectural theory and the branch of Science-Technology-Studies (STS) known as ‘Actor-Network-Theory. (ANT). In order to face the rapidly increasing awareness of how much responsibility issues of sustainability pose on architecture and architectural theory, it is required to open buildings for the recognition of their properties as more than the stable, quiet objects in our cities. (Wang 2009). The overemphasis on a ‘final building’ in architectural theory will have to yield to perceptions of architecture that allow us to regard buildings also in terms of the longevity life of their different components and materials, the social mobilization they require and facilitate and their ability to adapt to the demands of a changing future

2. Literature review

2.1 Architectural theory

Although architectural theory is multiple and widespread, and not a tightly and well-defined area of research, it is possible to detect renewed awareness of, and analytical sensibility towards the practices of architects during the last decade. What is interesting here is to look at authors who re-question the issue of architectural medias as a mere ‘transportation of meaning’ from ‘idea’ to ‘completion’, and who at the same time seek to transcend the narrow classical philosophical focus on the relation between matter and form, and thus widen the understanding of agency in architecture. In his much quoted essay ‘Translations between drawings and buildings’, British architect and architectural historian R. Evans points to the relation between geometrical techniques and the architect, suggesting that there is a cognitive relation when stating how: “[…] the imagination and the technique worked well together, the one enlarging the other” (Evans 1997:178). Evans argues that it is not possible to separate the drawing technique applied by the architect from the imagination of the architect; they work together, so to speak, in performing enchanting transfigurations – “the one enlarging the other” (Evans 1997:181). This form-developing dynamic is a major subject with many architectural theorists from different fields. (See e.g. Kwinter 1994:98. For debates of the dynamic as a hermeneutic relation, see Vesely 2004:43-108 and Lotz 2008:89). With the Dutch architect N. J. Habraken, a notion of – and even a set of principles for – ‘an agency of form’ in the built environment are developed. The fabrication of the built environment is seen as a game play in different levels and scales, where architects are in line with developers and authorities amongst the players, exercising control in the built environment. Form is a materialisation of the varying dominance of players over the different levels and territories (Habraken 1998). The American landscape architect and theorist J. Corner delineates these expanded focuses in architectural and urban practises. He indicates how through urbanists such as R. Banham, E. Soja, D. Harvey, R. Koolhaas and B. Tschumi, anthropologists such as M. Auge, or philosophers such as H. Lefebvre or G. Deleuze, it becomes clearer to architects and planners that ‘space’ is more complex and moving away from physical objects and towards the variety
of territorial, political and psychological social processes that flow through space. The interrelationships amongst things in space, as well as the effects that are produced through such dynamic interactions, are becoming more significant for the intervention into urban landscapes than the solely compositional arrangement of objects and surfaces (Corner 1999). The American architect S. Allen suggests an opening towards an understanding of architecture emphasising its properties as active in its own process of becoming. In the almost paradigmatic statement: “[…] practices imply a shift to performance, paying attention to consequences and effects. Not what a building, a text or a drawing means, but what it can do: how it operates in – and on – the world” (Allen 2000:xxiv). Allen furthermore suggests a debate on what ‘meaning’ in architecture is, and advocates “[leaving] the representational stage in favour of the ontological construct” (Allen 1997). Allen is in line with Evans when he dreams of “[the possibility of writing] a history of Western architecture that would have little to do with either style or signification, concentrating instead on the manner of working” (Evans 1997:185). Also among the phenomenological informed branch of architectural theory, where the meanings and intentions in architecture occupies minds, a more nuanced debate on the relation between ‘representation’ and the built work arises in favour of a less rigid understanding of a one-to-one correspondence between the intentions ‘embedded in the idea’ and its ‘expression in the final building’ (Pallasmaa 1993, Vesely 2004, Perez-Gomez 2005).

2.2 STS and ANT

The research traditions of STS and ANT have followed the practices of scientists, engineers and physicians in and out of their workplaces, while insisting on – and developing methods for – keeping an analytical focus on technologies, visualisations and materials, giving them equal attention compared to humans in order to expand our notion of whom and what participate in, and constitute ‘the social’ – and how this is done. Many of these studies had their point of departure in ethnographical observations following actions in laboratories very closely; “the place where the labour of science is performed” (Lynch, 1985: 4). A distinctive feature of this tradition is that it does not access science through its products – the stabilised facts – but through the studies of the laboratory work of stabilising facts, of acquiring and producing knowledge. One of the main features of ANT has been its ability to demonstrate in specific details how the ‘body of knowledge’ in science comprises utterly heterogeneous knowledge forms and practises, entirely dependent on the materials and technologies involved (Latour & Woolgar 1979, Latour 1987, Stengers 1993, Pickering 1995). In recent years, studies with this ‘classical’ ANT approach have been carried out in the realm of architecture through thorough descriptions and analyses of certain very specific architectural practises conducted at architectural studios. In ‘Scaling up and Down’ from 2005, A. Yaneva studies how architects imagine, see, and define a distant object, which is meant to become a building, through the production and investigation of scaled models. This is described as a shared or distributed cognitive process among the participating architects and their models (Latour and Yaneva 2008). But STS literature – and that of ANT in specific – also counts studies in which a specific issue – or ‘thing’ – is tracked and analysed in a wide variety of settings where it performs and is performed in different ways through many actors. In ‘Aircraft Stories – Decentering the object in technoscience’ from 2002, J. Law investigates the planning of and disputes about the cold-war aircraft TSR2, revealing how the process momentarily succeeds to attain the singularity of the aircraft through the relations established
between humans and artefacts – and how this achievement accomplished through hard work is easily lost again in favour of disassembled heterogeneity. It shows how artefacts, humans and processes comprise multiplicities not coherent or singular at all, held together by a thousand different modes of arranging and organ-ising things and humans. It shows how much work it takes to maintain any kind of order and prevent it from deterioration. In ‘Body multiple’ from 2002, A. M. Mol shows how the practises of arthrosclerosis are many and different: patients, nurses, doctors, various clinics, relatives, methods of measurements and representations – they all ‘do’ arthrosclerosis in very different ways. Mol argues, that we do not possess a single body anymore, but inhabit ‘a body multiple’ that is acquired in an almost endless variety of ways in different practises. The studies are not confined to the setting of the laboratory or the clinic, but follows how seemingly stable objects (‘aircraft’, ‘body’) continuously oscillate between singularity and heteroge-neousness, being “more than one, but less than many,” as John Law puts it. These works form a methodological and theoretical point of departure for this article, in order to grasp how architecture works as both the singularised result and as the assembling, coordination and alignment of actors. Because the empiric and methodological tools are developed in order to study ‘science-in-the-making’ as opposed to ‘science made’ (Latour 1987:4), ANT might contribute to architectural theory when a similar analytical stance, ‘Architecture in-the-making’ as opposed to ‘Architecture made’, is asked for. The widely distributed and quite volatile set of theories and ethnographically inspired methods seems to have a lot to offer architectural theory, especially in terms of analytical tools that opens up to perceptions of the vast amounts of ongoing social coordination between human, material and technological actors needed to establish and maintain architecture.

2.3 On distributed cognition and translation

The notion of ‘translation’ in relation to the question of how drawings, models and spread-sheets end up as buildings in the streets seems appropriate here, as this touches upon the question of the function of visual objects in architecture. Evans and Latour both introduce the notion of translation, recognising its etymological implications of distortions of that which is translated along the way travelled. The suggestion, if only indirect, is that of a cognitive relation between architect, drawing and geometry. Such a relation between architect and drawing can also be recognised in the concept of ‘reflection in action’ formulated by D. Schön, who regards the act of drawing as “a conversation with a situation” in which local experiments on defining the problem take place (Schön 1983). The issue of a cognitive relation between drawings – or in a broader sense, all kinds of materials and technologies – and humans is studied by the American anthropologist E. Hutchins. Here, the empirical approach is to assume that processes of cognition imply the participation of both humans and ‘non-humans’. Consequently, studies of cognition will have to consider the entire cognitive system, instead of “placing too much within the individual” (Hutchins 1995:355). There are some striking similarities between the considerations of Evans and Schön on the cognitive character of the work of architects, and the investigations of what Hutchins has called ‘distributed cognition’. Similarities can also be found between the Latourian notion of ‘mediators’ who translate and distort whatever they mediate, and the way Evans applies the term ‘translation’ (Latour 2005:39). However here, a far-reaching difference in the implications of the notion occurs. In the Latourian edition, the term ‘translation’ is a cornerstone in the elaboration of the well-known, quite radical notion of ‘the social’, formulated in
Latour 2005:108. To Evans, translation is a vehicle limited in range to the enhancement of spatial cognition and creativity between architect, geometry and materials. This is of course a matter of enormous importance in architectural theory, but compared to the ANT understanding of how translations are conveyed between much wider arrays of agents, it has a more limited scope. There is a difference between regarding the drawing as a device for amplifying intentions embedded somewhere within the individual, and then understanding it—and all other kinds of visualisations and materialisations—as actors with the capacity to change the course of action in open-ended processes comprising many different actors, much more messy and contradictory situations. With Hutchins we can say that the cognitive properties of the individual differ significantly from the cognitive properties of a group.


The main empirical source (‘single-case’) of the papers is a building process for a new secondary school, from the planning of the programme for the architectural competition to the projecting and construction with particular analytical attention to the visual material generated. This paper demonstrates how an emergent architectural statement is recognised, researched and developed as a ‘putative agent’ (Law 1994:10, Lotz 2008:180), how it strengthens its networks by mobilising other actors and aligning them in alliances, and how it is eventually able to change the course of action of other actors. The classroom as the single most important spatial entity for learning and teaching has been contested in learning theory for decades. Quests for spatial configurations that are able to meet the changing perceptions of learning have engaged both public debates and professionals in planning and education for the last decades. Since the rise and decline of open-plan schools in the 1970s, learning theory has developed notions on differentiated ways or ‘styles’ of, and settings for learning. This has called for new ways of arranging space for teaching activities, and has thus set a new agenda for school builders (Gardner 1983 and 2006, Lave 1991, Dunn 2000, Kirkeby 2007). Through interdisciplinary processes involving a wide array of stakeholders such as teachers, students, pedagogues, planners, theorists of learning and a vivid public debate, architects have been involved in the formulation and visualisation of anticipation concerning the properties and qualities of future spaces for education at all levels: primary schools, secondary schools and universities. When the early planning for a new secondary school in Copenhagen called ‘The Secondary School of the Future’ (in Danish, ‘Fremtidens Gymnasium’), began in late 2001, no new secondary schools had been built in Denmark since 1984.¹ The regulating law on secondary education from 1907 had only been slightly updated in 1988, and at the time of planning the new secondary school, preparations were made for a more extensive reform of the law. The preparations for this included public debates on a number of issues concerning fundamental elements of teaching and learning, and the emphasis was on providing a wider array of possibilities for individual planning of education by making more subjects open to

¹ The following is supported by observations and empirical data gathered mainly through interviews conducted during the process by the author. This material was supplemented with interviews with the job architect and the job engineer of the secondary school, and the head of the office at the Administration of Children and Youth in the Municipality of Copenhagen, all conducted in February 2009 by the students of the TEK5 course at the Royal Academy of Fine Arts, School of Architecture: M. Kahr Nielsen, A. Johansson, E. R. Bruun and A. Suhr Laustsen.
the students' own choice. The law was agreed on politically in 2003 and implemented in 2005. At the time, the planners were faced with quite an open and unsettled situation in terms of how to formulate a programme for the later architectural competition, as in fact, they did not know what ‘a secondary school’ was or should be. During the debate on learning in primary and secondary schools surrounding the new law, the properties of the confined classroom were a major and recurring issue. The open-ended character of the debate is emphasised: “Organisation in fixed classrooms, fixed age groups and fixed schedules are under debate and transformation. Yet it is important that students are still rooted in stable and clear communities hitherto provided by the classroom” (Municipality of Copenhagen 2002a:5). The classroom has strong, historically durable allies as supporter of ‘stable and clear communities’ and it is not that easy to disintegrate and re-format its network around other kinds of spatial concepts. In order to create awareness, especially among political decision-makers, of the need for new kinds of spatial organisation of learning in secondary education, the administration of the Municipality of Copenhagen took a series of initiatives. These steps were also taken in order to qualify the programme for the upcoming architectural competition. Educational researchers were consulted, and workshops with students and teachers from a number of secondary schools produced a lot of visual materials with ideas for ‘The Secondary School of the Future’ (Municipality of Copenhagen 2002b). A series of workshop sessions were held, where teachers, clients and educational researchers worked together with three invited, young architectural firms. In this course, the visual and analytical capacities of architects were employed in quite direct cooperation between participants, and it thus constitutes a relevant situation for following the ‘inscription devices’ produced. Various ‘process techniques’ like the one described in the following, i.e. making use of the competencies of architects in order to involve users and stakeholders at an early stage of planning, have been developed especially within the field of education through the last decade, but they have quickly been disseminated to become widely employed in various areas dealing with planning of all kinds of public space. (Kirkeby et al 2003, Løssing 2005, Kirkeby 2007, Lotz 2008. The examples here are from Denmark, but similar trends can be followed in the rest of Scandinavia and England.). The programme for the workshops sums up relevant tendencies in the ongoing debate on secondary schools and political visions. It asks for different levels of investigations from participants on ‘different pedagogical spaces of learning’, on ‘new roles for teachers and students’ and on ‘spatial principles’. The audience for the results is broad, ranging from students and employees to decision-makers at all levels, including politicians. It specifically asks for ‘inspiration’, and not for a ‘proposal for any concrete school’. Consequently, the invited architects were explicitly asked not to produce concrete proposals for an actual building, but to prepare “…a general material describing and visualising pedagogical and spatial visions for the Future Secondary School” (Municipality of Copenhagen 2002a:3). Obviously, this has as a consequence that the works of the participating architects do not have the final building as a target, but rather the investigation and visualisation of possible spatial arrangements for different kinds of learning environments and their interconnection, where the classroom as a structuring unit needs to be translated into ‘general areas of study’. Equally, the special subject rooms are displaced by a “subject-toning of the general study areas with necessary facilities, installations and spatialities, thus making the general study areas more subject-orientated”.

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This is supported by a diagram as shown in Fig. 1, where five characteristic assemblies of figures are arranged so that they have overlapping spheres between them. Without making ‘concrete proposals’, the teams approach different possible spatial possibilities. The architect Dorte Mandrup Poulsen proposes to focus investigations on what she terms ‘vertical learning’. Her model in Fig. 2 suggests how spatial zones and planes might be separated, yet still interconnected. Here, the different zones of the diagram in Fig. 1 is transformed into a 3D figure, where each zone has its own plane, but remains in communicative contact with the other planes – in the vertical. In Fig. 3, the notion of an ‘X zone’ emerges in a diagram from the architects from the office PLOT, who continued the proposed investigation of ‘vertical learning’. The figure shows a layered diagram of planes, where the space in the middle, connecting other areas, is marked with an ‘X’. In the following material, the possibility of arranging floor decks around an open space is further investigated under the name ‘X zone’ (Fig. 4, 5a-d). These diagrams are further investigated – or translated – in small-scale models, where the arrangements of the different fields around a ‘split zone’ covering several floors with more or less open contact to all areas become more apparent through the use of transparent material for the decks.
3.1 ‘Putative agents’ and ‘Inscription devices’

A little handful of notions from the ANT affiliated literature volunteers in the sense that seemingly they hold capacities for grasping the situation evolving around the emerged ‘X zone’. Now, who invented this notion? Was it there from the start – in the diagram? In the preparations for the new law? What do the figures actually mean? These questions do not really
matter here. The interesting question is how it becomes able to travel between actors – how it starts to work. What matters is whether the material generated is able to establish a capacity, an authority, an amount (or in Latour, ‘a cascade’) of evidence of other kinds of spaces for learning, that have the ability to beat the classroom. John Law writes: “This is the process in which putative agents attempt to characterize and pattern the networks of the social: the process in which they attempt to constitute themselves as agents. Thus an agent is a spokesperson, a figurehead, or a more or less opaque ‘black box’ which stands for, conceals, defines, holds in place, mobilizes and draws on, a set of juxtaposed bits and pieces” (Law 1994:101). This is truly a ‘life or death’ issue! ‘Putative agents’! Agents that are supposed to decide on the orders, and they only get the chance to ‘become’ if they succeed in this. And if they succeed, they become ‘spokespersons’ in the network. These are the interesting questions and struggles to look at. The ‘how to’ get heard and seen in the processes of becoming; how it entails keeping others in place, defining them and concealing how inhomogeneous and numerous they are. The power of the ‘spokesperson’ is to conceal differences in order to make order. This is why it makes sense when Law describes the attempts and struggles to ‘become an ordering device’ as ‘Darwinian’, or rather ‘Machiavellian’. And how it becomes possible to talk of how some of them become bigger than others. It is murder out there: lots of killed darlings. The X zone manages to mobilise and draw on a large number of bits and pieces: the workshop programme, the arranging administration, the debate surrounding the new law etc. The workshop participants, architects, the arranging administration, materials from the earlier workshop, translations of various learning theories are all gathered in an A3 booklet. It is obviously not ‘an unbreakable whole’, and it does not hide the ways in which it has come about in a stabilised and closed ‘black box’. It is, rather an open dispute - a shared uncertainty. In order to account for the “strategies, techniques and manoeuvres” (in Foucault) in architectural practice, the studies of architectural becomings will have to follow these ‘putative agents’ in their relevant networks and describe how they struggle for survival. And things and humans will have to be given equally analytical attention, also in the way we assess their constant risk of facing extinction (see also Lotz 2008:180). The sketches, diagrams and models fabricated in this – architectural – setting can be regarded in the same way that ANT regards the ‘inscription devices’ of science. Diagrams, models and pictures, and even direct references taken from magazines of other kinds of architecture. The notion covers the notes and diagrams, numbers and tables that transform – or translate – rats and peptides and DNAs into paper. With Latour, we can sum up its abilities and properties as ‘inscription device’: the booklet is mobile and gains the ability to travel from the workshops among various administrations of the Municipality, among politicians, among the management of the new school and further into the programme of the later architectural competition. It is not changed while moving and is thus immutable, it is flat, the scale of inscriptions may be modified at will without any change in their internal proportions; and it can be reproduced at little cost. And since these inscriptions are mobile, flat, reproducible, still, and of varying scales, they can be re-shuffled and recombined; they can – and this is important – be made part of a written text (Latour 1990:44-47) (see also Latour & Woolgar 1979:51). But as Latour points out, the most important part is that the advantages of the ‘inscription devices’ should be seen in conjunction with the mobilisation process they accelerate and summarise. It has to do with how attachments and associations enrol different kinds of actors as allies in the network. Relevant actors have chosen the visualisations among the many available ‘inscription devices’ produced in the workshops. They have pointed them out, constituted them and mustered them. And thus, they have linked their own stakes, their own performance of authority and competence to them. (John Law has termed this ‘linking’ as
‘interpellation’ – with a loan from Althusser, see Law 2002:51). And this in favour of all the material, all the drawings, models and renderings that ended up in the dustbin; not pointed to by others, not lifted up and debated and furthered. Vast amounts of ordering attempts that died even before they were born. And they are only taken into account in this analysis in text, but take my word for it: they were many, and each of them might have influenced the course. It could have been different. It is not a manifestation of linearity in the analytical outset. But actors will keep the course on this linear track, as long as it is in their own interest!! Linearity and singularity are constructed all the time (Law 2002:53). It is also in that respect that the process resembles ‘the laboratory of science’, where data is continuously re-configured in new kinds of ‘inscription devices’, and it is these continuous re-configurations, or to put it more precisely, translations that allow for new actors to stabilise. The next suggestion is to regard the practices unfolded here as a formation of a ‘laboratory of architecture’ aimed at manufacturing evidence for ‘a future present in the present’ of ‘The Future Secondary School’. Evidence designed to make strong alliances among a wide variety of participants and interested parties such as planners, politicians, school people, students, parents and a wider public. The notion of ‘the laboratory of science’ as an unconfined space of specific interests is formulated by the Belgian theorist of science I. Stengers as a knowledge space in which those who have let themselves become interested, and who are already ‘in play’, propose and fight for statements that are subsequently widely distributed (Stengers 1993:92). Architecture lost its status as a science many centuries ago. But the resemblance is useful in order to give attention to how an analysis of the practices of architecture can expose the specific ways in which architectural statements are transported, translated and distributed way beyond the studio, and way beyond the confined hermeneutic or limited cognitive relation between the architect and her drawings. Now, the material travels from the workshops into the architectural competition. These two settings differ quite radically when it comes to the character of argument they are supposed to produce, and the procedures and social ordering devices employed also differ. As stated, architects are specifically asked not to produce ‘end results’, but merely ‘investigations’ during the workshop. Obviously, the purpose of the competition procedure is to stabilise a single proposal as the best solution and to announce its architects as the competition winners. The requirement to the entries is that they have to take into consideration all the different requirements to the regulations of the site, building technologies, climate, structure etc. Thorough studies of the contingency of the architectural competition as a ‘decision machine’ has been made, and it is not the purpose of this paper to enter this debate (see e.g. Bjerg 2002, Kreiner 2006 and 2007). Rather, the purpose is to point at how the already achieved durability of the argument of an X zone eases its journey and makes it a favourable alliance for other kinds of arguments and concerns in the winning entry and in the construction of the building. In the programme for the architectural competition, the notion of the X zone was formulated as follows: “The X zone is the secondary school's crossdisciplinary, public space, which internally reflects and communicates the untraditional academic meeting and the secondary school culture as a whole. The X zone is to be in touch with study zones and the common zone, and it should move elastically through all floors vertically and horizontally, where areas, room heights, physical layout and spatial characteristics are adapted to the given context. The X zone will contain various spatial qualities from public to more intimate spaces, as it contains the secondary school's traffic distribution, niches for in-depth studies, study environments and crossdisciplinary areas. [...] The X zone is the inspiration space that renders the crossdisciplinarity visible and exposes the study zones' activities to the public life of the secondary school.” (Municipality of Copenhagen 2003). In the winning proposal
from the Danish office 3xN, a series of diagrams depicts the vertical flow through the house, starting with the ‘X zone relation’ in the upper left corner (Fig. 6).

Figure 6: 3xN, winning entry

The job architect explains: “The X zone is a common working environment, where you meet across the different departments. We have tackled this very concretely by making a boomerang shape, which results in a zone that overlaps the zones below by rotating them in relation to each other. Using this approach, we achieve a continual movement down through the house. That's sort of the idea: Everybody has their own floor, but they also have an affinity with the large space. When you are there, it feels like it is almost one huge space, whereas actually it is only a part of the area, 2/3 of it is of normal floor height. What happens at this point is that it goes from 2 to 3 to 4 to 5 stories out here, and that makes it possible to create these islands with different study environments. This zone is an architectural parti, you might say: it resolves the issue of both the X zone they want for people to meet in and at the same time ensures lots of light and air, although the building is very compact. It also resolves the issue of circulation in the central atrium.” The job architect does not think of the proposal as bearing resemblance to the visualisations of the workshop architects, but acknowledges it as a work aimed at “moving some boundaries in relation to an old-fashioned tradition in order to prepare users and contractors not to make classrooms and passages”. But despite his reluctance to recognise the resemblance between his own proposals and the models from the workshop, what he does is to enrol the X zone – whose formulation in the programme is a translation of these models – as a major ally for ‘the architectural parti’ of the whole building. The distribution of light, the circulation in the central atrium – all gain authority from the X zone through alliance – and vice-versa. It would have required a lot of work from the competing architectural firms to establish an architectural proposal that did not align with the notion of the X zone and still convince the competition jury of its feasibility. Such a proposal would have had to re-open the debate on the classroom. It would have required the establishment and stabilisation of architectural motives capable of beating the X zone. Several of the competing proposals do not manage to convince of their translation of the X zone, and are not taken into consideration by the jury. Not only does the process re-format or re-obtain ‘secondary education’. It also re-formats architectural competence in several ways. Firstly, it questions architectural competency as something hidden within the architect in favour of placing it more with the specific formations of relations around architectural motives – or ‘putative architectural
agents’. Secondly, it questions the role of the architect as the one who proposes ‘what no-one expected’. Obviously, the specific spatial arrangement of the winning entry was not foreseen or asked for. It could have been different. But the degree of specifications for the X zone was quite high, and the amount of actors assembled to back up this notion was considerable.

### 3.2 Obligatory passage?

During construction, the specific way of marking the floor decks in the facade becomes an issue. It is regarded by the architect to be of importance, because it emphasises the inner ‘boomerang’ organisation of the decks that is the main feature of the open X zone. It is difficult to achieve these horizontal beams in the facade for many reasons. It is difficult to reach a sufficient level of insulation and it is difficult to achieve the necessary precision in the in-situ casting of the beams. In spite of this, the motive is sustained because of its strong connection to the X zone. We might even say that the X zone has been stabilised as an actor to consider to the point where other motives associate with it in order to get by – daylight, circulation, composition of facades. Other architectural motives strengthen themselves by ‘passing through it’. In the Latourian vocabulary, ‘an obligatory passage’ is an actor that no-one escapes – all have to pass through it. A scientific fact, for instance, is an obligatory passage. If it is a well-established fact, all subsequent scientific actions will have to take it into account. When facing the difficult horizontal emphasising of the decks in the facade, references are made to the X zone in order to stabilise the motive. It is not a question of ‘the rhetorical defence of the architect’. It is a stabilisation of a specific materialised, spatial cohesion between specific building parts and the conception of space, established not only in the building, but in the socio-material network it is an integrated part of. Obviously, the X zone is not stabilised to work as ‘a singularity’, neither is it ‘black-boxed’ to the point where all the work done to make it cohesive is hidden. Of course, it is up for grabs throughout the process. In that respect, it is more a story of how “the work of object coordination and object disaggregation goes on and on” than of the “black-boxed work of architecture” (Law 1994). But the network of the X zone has achieved the stabilisation of a spatial concept with the ability to compete with, and knock, ‘the classroom’ out of the game. At the same time, it aligns with and supports specific architectural choices throughout the building, which by this aligning traffic between different architectural motives obtains a high degree of architectural cohesion.

### 4. Conclusion

The arguments developed by ANT authors seem to volunteer to contribute to the branches of architectural theory that has as an ambition to be able to analyze buildings more as processes and less as ‘stable artefacts’. ‘The social’ and ‘the material’ worlds are not apart, but interdependent in a continuous re-ordering and becoming. Both ‘humans’ and ‘non-humans’ should be granted agency. The advantage of following the emerging architectural motives and making them subject of analytical scrutiny at the level of the practices of the planners and architects of the building by means of the analytical tools derived from ANT allows us to perceive the emerging building as an oscillation between its ‘thing-ness’ and its ‘process-ness’ To suggestions for further development of architectural
theory can be posed: First, to do away with the historically derived reluctance to deal with notions of ‘the social’ and the power distributions taking place in architectural production. Second, to leave a traditional under-standing of ‘representation’ and instead starting to talk about a kind of ‘agential realism’ in relation to the technologies of the architectural process – most evident the visualisations of architects (Lotz 2008:229). In this way, the analysis developed in this article can be seen as a reply to Stan Allen's open quest: “not what architecture means – but what it does”.

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Promoting Architectural Firms in the Netherlands

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Abstract

This paper reports on a project to survey the promotion practices of Dutch architects. Although it is not difficult to find marketing advice for architects there has been very little research into the actual marketing practices employed. What is clear, and is often repeated in the literature, is that it is generally assumed that architects do not devote adequate energies to promoting their practices. The researchers felt that it is necessary to first establish the actual practices of architects before formulating generalized advice for the profession.

The research was based on three empirical methods: a survey of the members of the Royal Institute of Dutch Architects (BNA), a series of case studies of architectural firms, and a series of interviews – not only of architects but also of clients, project managers, and marketing consultants. The intention of the interviews was to make possible a comparison between the supply and demand sides of the market.

Through the survey it was established that the majority of architects are actively working to promote a specific image of their offices. This includes both internal promotion – informing the staff of the firms image – and external promotion. 40% of architectural firms have a long term strategy, 42% a promotion plan, and 50% have some knowledge of how they are perceived in the market. This is a better picture of the situation than was given by the consultants in their interviews. No clear pattern of relationships emerged between promotion practice and type of firm, with the exception that larger firms were more active in promotion than smaller firms, and strangely, that firms active in the public sector were more active (this despite the fact that public sector work is obtained through the European Tendering procedure).

Interviews of clients showed that the individual clients follow different strategies in selecting architects than do professional clients or project managers. However, reputation and name familiarity play a large role in both areas. The findings lay to rest the common assertion that Dutch architects, at least, to not actively promote their practices. What remains is the need to improve the design and implementation of promotional strategies to more closely match the desires of their clients.

Keywords: architectural management, architectural firms, promotion, marketing
1. Introduction

Although quite a few authors have made a great point of the urgent need for architects to attend to the promotion of their firms, very little is known about what architects actually do. Aside from an interesting set of case studies by Kioussi and Smyth (2009), and the examples provided by various marketing consultants in their books (clearly unrepresentative), almost nothing has been published. What is published is a wealth of material on marketing in general and several very inspiring texts on how architects themselves should market their firms. These include Bruce and Cooper (1983), Coxe (1983), Haupt and Kubitza (2002), Koren (2005), and Linton Clary et al. (2005). These are all full of useful advice, but none of them attempt a survey of the marketing activities of architectural firms. The researchers therefore felt that it was high time for an attempt to determine just what architectural firms were doing to promote themselves. The study focuses on Dutch architects, and will conclude with some remarks about the possible generalization of the results to architects elsewhere.

The research was carried out in late 2008 and early 2009 as part of the first author’s masters thesis (Roberti, 2009) when effects of the credit crunch were beginning to be felt.

2. Method

The research was carried out as an explorative research project as described by Baarda & De Goede (2001). The method for this research was constructed from three techniques: a survey, a series of interviews of clients, project management firms and marketing consultants, and a series of brief case studies. The survey of architectural firms provided a general picture of how Dutch architects promote themselves. The survey was sent out to the membership of the Royal Institute of Dutch Architects (BNA). 235 architectural firms responded, approximately 8% of the membership of the BNA. Of these 71% were firms of 10 FTE or fewer. Where results have been correlated to firm characteristics this has been done with a significance of $\alpha=5\%$ and therefore of a 95% certainty.

Interviews of clients, including individuals (2), housing corporations (2), a developer (1), and project managers (3) provided insight into which promotion instruments are perceived to play a role in their architect selection process. Public clients were excluded as the European Tendering process excludes the direct influence of most promotion techniques. Interviews with the two consultants shed light on the generally accepted understanding of promotion for architectural firms. The interviews were semi-structured interviews based on a list of open questions. The interviews were recorded and transcribed. They were then coded and analysed using Atlas.ti.

The case studies of four firms served to add depth and specificity to this picture. For each case descriptions of the firm organization, of how the firm obtains work, of how the firm promotes itself were collected, of which promotion instruments were used, and of the role of promotion internal to the firm. The cases were chosen to span a range of firms, in terms of both age and size. The cases were based on interviews with principal architects, and an examination of promotion materials...
produced by the firms. These interviews were also based on a list of open questions, recorded, transcribed, coded and analysed in Atlas.ti.

The research was structured around two fundamental marketing concepts: strategy and promotion mix.

Kotler (Kotler and Armstrong 2004) states that it is important for a business adopt a long-term view and develop corporate vision, a strategy, and an identity. The identity is the picture of itself the corporation seeks to convey to its target audience. A corporate image, on the other hand, is the picture of the corporation as it is perceived by its audience. This audience may be seen as the sum of clients or customers, competitors, colleagues and suppliers, or these audiences may be defined and addressed separately.

As architects’ clients are most often other businesses, they are primarily interested in industrial or business to business marketing and not in mass consumer marketing. Business to business marketing is distinguished from consumer marketing through the importance of relationship building and personal contact. This is particularly true of architecture as we are concerned with large multi-year projects with high uncertainty and in which there is a desire for a great amount of information. Rather than selling a product, architects are selling their expertise and experience. Clients must believe that their architect can quickly understand their problem and find a solution in the form of a feasible design. They seek above all confidence and certainty in what are perceived as highly risky projects.

The total promotion mix consists of a specific combination of five promotion tools with which a business uses to convey its promotional message: Advertising, Public relations, Sales promotion, Personal selling, and Direct marketing (Kotler and Armstrong 2004). Advertising is any non-personal presentation of ideas products or services associated with and paid for by a specific company. Public relations is the construction of a good public image through obtaining favourable publicity. Sales promotions are short-term incentives to purchase a product or service. Personal selling is the use of a designated sales staff to personally approach customers to makes sales and build relationships. Direct marketing is customised communication to specific selected customers to make sales and build lasting relationships. However, it should be kept in mind that clients do not make any distinction between the messages received through different promotion tools, rather the various messages merge into an image of the business.

2.1 Case Study Firms

The four firms selected for case studies were Maria Teresa de Matos Matilde Architect, Cepezed, Fokkema Architecten, and Hootsmans Architectuurbureau.

Maria Teresa de Matos Matilde is a sole practitioner, working primarily for developers, and often in collaboration with other architects. Her clients come to her through word of mouth. Although she has not developed an image for her firm, she has developed a consistent minimalist graphic style for her firm which clients generally appreciate. She has done little promotion and has experienced difficulty
acquiring new projects, however she had recently followed a course in acquisition at the BNA (Royal Dutch Architectural Institute), and plans to apply several of the recommended tools in the near future.

Hootsmans Architectuurbureau <www.hootsmans.com> had been established only two years before they were interviewed. Rob Hootsmans founded the office after nine years service in the Government Buildings Agency. Hootsmans work at the GBA was primarily in the role of client, and he has developed a sensitivity to the needs of clients. Their strategy, therefore, has been to provide a high quality of service and client orientation. At the time of the interview they had about 15 employees. As they have plenty of work, promotion has a low priority. However, they are attempting to move from primarily public buildings to housing (where the market seems to have declined less after the credit crunch). They are signalling this to the industry through participation in competitions. The firm has a website. They have had a number of projects published, and occasionally send out a portfolio, but little effort is made for active acquisition. Rather the firm hopes to attract new work through providing a high quality of service.

Fokkema Architecten <www.fokkema-partners.nl> is a medium sized service oriented firm with 30-35 employees. Founded 12 years ago, the have grown steadily, and have a steady stream of work. The office is specialized in office projects, both buildings and interiors. One partner is assigned to direct promotion with the assistance of one or two of the general design staff. Their promotion is directed at two markets, potential clients (to attract new projects), and young architects (to attract new staff). Their projects are regularly published in the architectural press. They have regular office drinks parties, a quarterly newsletter, and an extensive website. Potential clients are invited to the firm’s offices and given presentations of their work. These presentations are always tailored to foreground projects in sectors similar to the visitor’s. The firm as recently adopted a new house style, and redesigned their website to go with it. Most new projects come through repeat business and personal networking.

Cepezed1 <www.cepezed.nl> is a well-established medium sized firm with 30-35 employees including a designated PR officer. They have a well-known signature style strongly associated with a pre-fabricated approach to construction. Their work is regularly published in the Dutch architectural press and they have brought out several monographs, including The Work of Cepezed (2007) which won an RIBA International Book Award. They take on a wide variety of projects, in both size and type, and have a steady stream of work. Cepezed regularly applies for public sector work through the EU tendering procedure. They have also built a large network of contacts over their 35 year existence through which projects regularly come into the firm. As the firm often develops innovative applications of materials, they collaborate on promotion with suppliers. The firm does not maintain a mailing list, but does have an extensive website.

What follows is a discussion of marketing strategy and promotion mix as observed in the survey interviews and case study. Strategy and each of the promotion tools will be discussed in turn. For

1 Cepezed was also selected as a case by Kioussi and Smyth in their study of brand management in design-led firms (Kioussi and Smyth, 2009)
brevity of presentation the results from the different research methods are presented together, beginning with the literature and the interviews with the consultants, then the survey, and following with the client interviews and case studies.

3. Strategy

The literature commonly recommends that firms must have a long-term vision and strategy around which to structure their promotion efforts. Successful acquisition is based on a systematic approach (Haupt and Kubitza, 2002). Architects should, it is held, analyze the current market, formulate goals, develop a general strategy and then specific acquisition and communication strategies. Coxe (1983) concurs and goes so far as to recommend doing market surveys. This analysis should lead to a well defined identity or philosophy that can be clearly communicated to potential clients. There should be clarity in the services offered and in the working approach taken by the firm. The literature (Coxe, 1983; Haupt and Kubitza, 2002; Koren, 2005) also commonly recommends collaboration with clients and occasionally other parties in communicating the firm’s message. Such collaboration can provide access to communication channels not otherwise affordable. The literature also recommends that there be specific partners and staff within the firm assigned to promotion, when possible these should include specialists.

The consultants both said that architects often do not have well developed strategies. Only a few large specialized firms have a proper strategy. Further they asserted that architects often have little idea of their identity or image or the similarity between the two. The importance of the coincidence of image (in the minds of the potential clients) and identity (in the minds of the architects) was reinforced by the fact that reputation plays an important part in the selection of architects, and that it is common for project managers and clients to enquire among their colleagues about previous experience working with different firms. The consultants emphasized that good service is a prerequisite for a good reputation. Thus project wind-up meetings with clients can serve to resolve any outstanding issues while consolidating the impression of quality service and therefore one’s reputation. One consultant stated that architects must have a clear idea of what types of commissions they want to acquire, and must direct their promotional message towards these commissions. Clients are not interested in the details of an architect’s firm, they are interested in their vision.

The survey of Dutch architects indicated that 40% claim to have a clear long-term vision and strategy, while 43% considered their strategy. Approximately half the architects claiming to have a long term plan also have a promotion plan. Fully 90% of the respondents strive to maintain a specific image or reputation. While half claim to know the image their clients have of them. 25% indicated that they work regularly with their clients to promote their firm, and 61% does this occasionally. Only 6% of firms have a marketing professional on staff. Approximately half of the architects polled indicated that they seek commissions in building types or with clients outside their normal practice, while a fifth seek commissions outside their geographic area.

All four case study firms have considered a long term vision. The three larger firms have shaped their promotional strategy around their vision. Fokkema Architecten and Cepezed have a clear promotional
plan in place. Hootsmans Architectuurbureau plans relatively little promotional activity, choosing to concentrate on their quality of service. De Matos Matilde is currently considering how to translate her office strategy into a concrete promotional plan.

Two of the firms claimed to have a good idea of the image potential clients have of them. Hootsmans indicated that their firm is known for the specialism of their principal architect Rob Hootsmans, and Cepezed is known for a specific signature that attracts some clients while discouraging others. Fokkema and Cepezed both have staff assigned to promoting the firms. None of the four case study firms collaborated with clients to promote their firm.

Two of the firms have made attempts to obtain commissions in new building types, through competition and advertising in trade publications. Neither have made a concerted effort as of the time of the interviews they both had sufficient work in house.

The clients stated that experience with their building type was an important factor in architect selection. They were unimpressed with unbuilt projects, and looked to an established track record in a building type for confidence in the architect's service quality. The backgrounds of individual designers assigned to the project were also important, especially where these had had experience with the building type in other firms. This said, several of the clients indicated that they were willing, once in a while, to take on a less experienced firm for the sake of a fresh look at their building type. One project manager indicated that for him it was not per se the experience of the architect that was crucial, but the combined experience of the architect and client.

4. Advertising

Koren (2005) discourages architects from making any use of paid advertising. It is expensive and fails to lead to any increase in market share. It may be useful for large or leading firms in order to remind potential clients of their position. Coxe finds that advertising can be useful, but only if the target group is clear and there are appropriate media available to reach them. They note, however, that advertising requires a great deal of preparation, and is not a good tool for the short term.

The consultants stated that advertising does not encourage trust in clients. A good name and a reputation for reliability are much more important.

The survey indicated that other than placing a sign at a building site little use is made of advertising by Dutch architects. What little advertising there is was placed by large firms, and is incidental. Although these firms report that they use advertising to increase name recognition, fewer than ¼th of them had a promotion strategy in place. Both expense and ineffectiveness were given as reasons for not using advertising.

Two of the case study firms make no use of advertising. One uses signboards on building sites. One placed a banner in a popular website for architects. However, this was intended to attract perspective employees rather than clients.
The clients were similarly disinterested in advertising. They claimed already to be in possession of information regarding a sufficient number of architectural firms to choose from. Again, reputation is more important.

5. Public relations

In general publicity is the result of success rather than a cause of it, however, Haupt and Kubitza (2002) see publicity as a way of increasing a firms visibility. Koren suggests that for firms other than the most well known media relations are more important than public relations. The press is as important an element of an architect’s network as clients or contractors. Both publications and brochures have a role to play. Coxe (1983) sees brochures as short-term instruments. These are more often scanned than read. The firms experience, expertise and reliability must therefore stand out. Two versions are required, one brochure for general inquires and custom made brochures for individual clients addressing their particular concerns.

The consultants recommended promoting the architect’s vision rather than the firm itself. They suggested that this is the best way to encourage third parties to express in interest in the firm and to mention the firm in conversation. Brochures must stand out. Websites too, as most are too similar to each other, too dull, and not professionally designed. Placing finishes in design competitions can be a useful way to draw attention to a firm. However, competitions require a large investment, and provide no certainty of the result. Further, smaller firms will generally find it hard to compete with larger more noted firms.

Fewer than half the firms surveyed had a publication or newsletter in the last two years. One third of the firms have 1-5 publications, and 11% had more than 5 publications over the same period. The majority of firms have a website and a portfolio. 71% of firms participate in competitions and 25% do at least three per year.

Fokkema and Cepezed actively pursue publications and maintain contact with the press. Both firms are frequently published. The other two firms take no initiative for publications are much less well published. In addition to articles, Cepezed has brought out several monographs. The other three firms make use of portfolios and firm booklets. All four case study firms have a website, but only Cepezed is satisfied with theirs. Hootsmans and Fokkema want to make their websites more professional, while De Matos Matilda’s website is still under development.

The clients make use of architectural publications primarily to keep abreast of trends in the field. Unless the project is very unusual, they rarely contact architects on the basis of a publication. However, name familiarity does play a role in architect selection. Once client stated that flyers and brochures were seen to have little value. They are mostly filed in the bookcase. While another complained that architects prefer only to show beautiful pictures. He made a plea for architects to present the results of their project in terms of the clients brief and the way they fulfilled it.
Where there is publicity attached, the clients saw competitions as a useful way for architects to promote themselves. They noticed that winners of competitions for young architects such as Archiprix and Europan often turned up later as leaders of good firms.

6. Sales promotion

In general sales promotion plays little role in the architectural sector. Kotler (2005) warns that most sales promotions have a negative impact on image. Sales promotions suggest inferior quality and are inappropriate to a sector based on expertise and reliability.

None of the case study firms reported making any use of sales promotions.

The clients interpreted this category in terms of price discounts. Although price was seen as an important factor, it was generally seen in terms of a price/quality ratio. Further price negotiations occur after architect selection not before. The clients reported that they had had no experience of architects offering discounts as a means of acquiring a project.

7. Personal selling

Identifying and analyzing the target group is the key to strategic promotion (Haupt and Kubitza, 2002). Because architects supply a service it is important to create confidence among potential clients. This confidence can be fostered by making clear to a perspective client exactly what services and performance a firm can offer them. Claiming to be able to design anything rarely instils confidence in a potential client.

Maintaining contact with the firm’s network including but not limited to potential clients is of great importance. However, according to one consultant, this does not come naturally to architects. When meeting a client for the first time, he suggests seducing them so that they ask the architect questions rather than coming out with a prepared sales pitch. It is about creating a relationship, rather than transmitting bureau statistics. And in creating this relationship it is better to let the client do most of the talking. Architects far too often try to sell their ability as generalists: “We build everything.” However, the consultants believed that clients find this claim disingenuous. It is better to choose a target group that matches the abilities and track record of the firm.

Three quarters of the architects actively seek and approach potential clients. Of these two thirds gather information about the client to be used in their approach. On average, Dutch architects have contact with former clients once a year. This is primarily in the form of personal contact, in visits, or by telephone.

The cases provide a contrasting impression. At the time of the interviews, Hootsmans and Fokkema did not actively seek commissions, as both had enough work in house. Neither did, De Matos Matilde, as she relied on coincidental approaches from clients. Cepezed pursues mainly public
commissions through European Tendering processes, where the initiative lies with the architect. Commercial commissions come into Cepezed mainly through the partners’ networks. All four firms indicated that personal contract was an important factor.

Clients are primarily interested in the specific services and performance an architect can offer them. They are less interested in the architects ‘storey’. Reputation and the experiences of colleagues are important in considering new architects. Email, newsletters and brochures are less important. Personal contact is also important on the client side. It is essential to know exactly who, which designers, one will be working with. Even within one office they felt that architects differ in quality and working methods.

Clients only seek out architects when they have a project going. This applies as well to approaches by architects to clients. It is a question of timing. When they do not have a project at the appropriate stage they are not interested in contact with architects seeking work.

8. Direct marketing

Coxe (1983) recommends the mailing list as a good means of contacting potential clients as the sender has control over exactly what is received and to some extent by whom. It is the most cost effective method of maintaining contact. They also find that regular mailings to potential clients can facilitate better recognition and confidence when the time comes to start a new project. Both Coxe (1983) and Koren (2005) state that personally targeted newsletters are best. Both in order to avoid being seen as ‘spam’, and in shaping the message to the services each particular client would be likely to need.

Most of the firms surveyed maintained a client file or mailing list. E-mail is the most popular means of reaching clients, although new editions of firm brochures are most often sent by post. These mailings were not seen as aimed at achieving an immediate response. And fewer than half the respondents distinguished between different target groups in designing their mailings. In two thirds of the firms, mailings were addressed only to business or individuals with which the firm already had a relationship. Only a very few firms allow one to subscribe to their mailings.

Only 12% of firms have no form of brochure or information package. Most firms offer a generalised bundle of information about the office and their projects. Fewer than half target their brochures towards specific sectors, and only a quarter target specific types of clients.

Among the case study firms only Fokkema uses a mailing list to send out newsletters. Hootsmans and Cepezed do not send out regular mailings as they do not want to annoy potential clients with unsolicited mail.

The clients indicated that they valued the occasional newsletter from architects. It is important that this be short and concrete, but it is frequently not the case. However, clients do not react to newsletters, approaching architects only when they have a commission to award. One client remarked that few architects sent out newsletters.
9. Conclusions

From the study it would seem that at least Dutch architects are more actively promoting their firms than either the literature (which admittedly was not based on research in the Netherlands) or the consultants would suggest. Websites, newsletters are very common. Cold calls are also commonly used. And half of architects have some regular exposure in the press. Most architects strive to maintain a specific image among their client base. Unsurprisingly, the most active firms are the largest. And these also make use of the widest range of promotion tools. For all firms relationship marketing was a very important tool. These findings support and expand upon those of Kioussi and Smyth (2009) where it was found that among design-led firms in the design-construction-development relationship marketing was the primary means of promotion, and that a greater consideration to brand development.

Where there may be weaknesses is in the development of a promotion strategy and in the tailoring of the message to specific target groups or clients. Only 40% of the respondents reported having a promotion strategy, while 43% had only thought about it. Further, in most cases newsletters and brochures were produced for a generalized audience, and not tailored to the sectors or building types of the clients receiving them. It appears that while many architects are actively promoting their firms, they have not considered how their promotion activities correlate to overall firm strategy, to the market they are active in, or to the needs of their clients.

The reliance of potential clients on reputation and on the reported experience of other clients and project managers with particular architects represents a challenge to architects trying to build or maintain a specific image. Naturally, providing services, quality and performances consistent with the desired image is important, but if the word does not get out, this will do little to advance the firm’s cause with new clients. In this respect one client’s plea for promotional materials to focus on the match between client’s expectations and the architect’s quality of service in the presentation of completed projects may indicate a useful approach. Further, a greater use may be made of client statements of satisfaction, and of collaborative promotion may help to put across the views of satisfied clients.

Perhaps the greatest problem facing architects is how to sell into a building type or sector where they have not yet been active. Here the strong preference among clients for experience in a given building type represents a significant barrier to firms trying to enter a new sector. Architects will need to try out ways of describing their previous experience and expertise in terms relevant to the new building type.

The case studies show some of the range of development of marketing behaviour of Dutch architecture firms. As was suggested in the survey data, the degree of development of the marketing approach seems to follow the degree to which the firm has developed a clear idea of its own image. Interestingly the two larger firms follow different approaches. Fokkema’s approach is relatively closely aimed at their clients, reflecting perhaps the high degree of specialisation in the firm’s portfolio. Cepexed, on the other hand, promotes primarily through architectural publications, which are not specifically addresses to potential clients. While it is difficult to attribute success to any
particular promotional approach, all of the case study firms seem to depend a great deal on passive and word of mouth approaches to bring clients to them.

In summary it can be said that for Dutch architects at least promotion is part of normal business practice. What remains is the need to improve the design and implementation of promotional strategies to more closely match the desires of their clients.

References


Design Management Methodology to Strengthen Firm and Industry Competitiveness in the Construction Design Services Export sector

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Abstract

The aim of this research was to investigate strategies deployed by successful construction design-related firms towards achieving high levels of firm competitiveness in international markets. A reflexive capability model, developed through a critical analysis of related internationalisation literature, is composed of three key areas; internationalisation process, market knowledge and design management. Firm reflexive capability is explored through the management of social, cultural and intellectual capital. The concept of reflexivity is borrowed from sociology. Reflexivity is reinterpreted as the ‘firm’s’ ability to be aware, responsive and adaptable to self, market and project needs assessment. A cross case analysis explored the barriers and success factors through three constructs; internationalisation process, design management and market knowledge of three firms. This paper demonstrates that international firm competitiveness is dependent upon the strategic inter-relational management of social, cultural and intellectual capital for maximum advantage of the utilisation and leverage of one form of capital to gain another. This leads to the development of increasing reflexive capability to support internationalisation. An outcome of this research is the identification of the central relation between a level of reflexive capability within the firm and the firm’s level of success in international markets. This research is part of an ongoing program of research on international collaborative practice. A Reflexive Capability Matrix was developed from the findings of one research project and then validated through a second research project (only the capability matrix is presented in this paper though). The reflexive capability approach is appropriate to all firms but what is speculated upon is that the reflexive capability is particularly intrinsic to small to medium sized construction design firms who work globally. A reflexive capability is a characteristic of successful and innovative firms internationalising and working within global models of practice.

Keywords: reflexivity, internationalisation, case studies, design management
1. Background

Firms in the construction industry have demonstrated an increasing involvement in international markets, however, there is still significant opportunity for further growth in the export of these particular services (London, 2008). Notwithstanding assistance provided for firms through international trade missions, export firm support networks and information packages by government agencies, evidence suggests that there are still perceived barriers to market entry and long term economic sustainability for firms. Furthermore, exporting firms are generally not as well known as the local firms in international markets and thus there is an increased need to gain access into client networks through adaptability and flexibility. Firms who achieve competitive advantage in international markets and thus long term sustainability are constantly adapting their business practices to achieve client satisfaction by a combination of self, market and project needs assessment (London and Chen, 2007). The need for flexibility, adaptability and continual reassessment is enhanced as the market evolves in various localities. This paper reports the empirical results and findings of a study which aimed to assess the strategies used by three Australian firms who work internationally and were involved in design management. This study has opened new research territory by developing through detailed case study investigation and analysis a qualitative methodology specifically related to design management which relies upon the concept of reflexivity and social, cultural and intellectual capital. The general research question addressed in this research project was: “How do construction sector design firms internationalise and develop sustainable business models?” The paper outline is a) Brief overview of the proposed conceptual model, b) Description of the research methodology employed c) Discussion of results and findings and d) Description of concluding remarks and outline of the Reflexive Capability Matrix. The theory underpinning the conceptual model has been reported elsewhere (London, 2010).

1.1 Conceptual model

The concept of capital has been extensively researched based on empirical evidence by Bourdieu (1991) from sociology research and has been applied in many different fields. The types of capital that have been adopted for this study include financial, social, cultural and intellectual capital and these are now discussed. Social capital is the creation of personal relationships and networks based on trust built over time. Working in a network helps spread risks and marketing costs and has relevance for project team networks and firm and client networks. According to Cohen and Prusak (2001, p4), ‘Social capital consists of the stock of active connections among people: the trust, mutual understanding, and shared values and behaviours that bind the members of human networks and communities and make cooperative action possible’. Skaates et al (2002) further defined social capital as recognition by other actors within the construction industry that the firm is a member of ‘their inner circle due to one’s dispositions…or one’s way of working and ‘tacit knowledge’. Cultural capital entails physical ‘dispositions’ such as ‘building visible buildings, winning design competitions, or obtaining important tenders’ (Skaates et al, 2002). These concepts are premised on the reputation of the firm, in that the success of marketing architectural services ‘depends upon the firm’s ability to sell and deliver a credible promise’ (Lowendahl, 2000). It differs from social capital in that it is the high
profile of a firm’s projects that marks the firm as having acquired a level of cultural capital. Therefore, cultural capital is the firm’s highly regarded past achievements that create trust and credibility; which is different from trust that is formed through relationships or networks. A firm acquires cultural capital through building successful buildings, thus creating a presence in the foreign market. More and more clients are relying on instantaneous recognition when selecting suitable design firms and such recognition is gained through the creation of reputation. A firm’s reputation is earned through a high level of cultural capital. Intellectual capital is a firm’s collective skills, experience, competences and knowledge and is critical to the sustainability of firms, particularly in international markets. According to Stewart (1998), the strength of a firm lies within its intangible assets, where he proposes that intellectual capital of a firm is ‘the talents of its people, the efficacy of its management systems and the character of its relationships to its customers’. A firm can acquire its intellectual capital through establishing skills and niche expertise by employing specific skilled staff members, which would enable the firm to respond to client’s requirements more efficiently. A firm’s skill specialisation which is accumulated through its involvement in previous projects and employment can contribute to winning further projects as clients typically value a firm’s expertise to deliver satisfying results. Whilst the internationalisation process is often viewed as one of which necessitates extensive country-specific knowledge and significant financial resources (Eriksson et al, 1997), long-term perspective afforded by the capital acquisition approach may provide advantages to firms attempting to internationalise into foreign markets. It is suggested that the dynamics of capital acquisition allows for a firm to build upon initial resources to achieve sustainability in foreign markets and to understand and contextualise the value of various forms of capital to a firm’s internationalisation strategy. This is of particular importance to SME’s who have fewer resources available. An example of how a firm strategically manages its capital acquisition is the firm’s conscious decision to penetrate a foreign market through heavy financial investments into that market without immediate return. Such investments may not lead to immediate financial success but may initiate the firm’s acquisition of social, cultural and intellectual capital. As such the firm may build up its acquisition of capital by creating networks, gaining reputation and developing skills. This would in turn translate to financial success in the long term. This poses problems for firms but it highlights two key questions, that if ‘softer’ capital is key to long-term sustainability then to what extent they are and through this understanding can develop greater clarity on strategies to manage social, cultural and intellectual capital? And is there any inter-relationship between social, cultural and intellectual capital that underpins such strategies? The notion that “economic capital is at the root of all other types of capital” and that these other types are in fact “transformed, disguised and forms of economic capital” is not a new concept at all (Bourdieu, 1991). For example, economic capital makes possible the investment in cultural capital by making possible the investment of time needed to accumulate cultural capital. The relationships between cultural, social and intellectual capital are complex (Bourdieu, 1992). Capital exists in a variety of forms or states. Bourdieu (1992) suggested that these primary relationships are guided by an understanding of three concepts; investment, exchange and accumulation of capital. The investment of a particular type of capital can be aimed at the exchange of capital in order to accumulate capital (London et al, 2005b). Alternatively the accumulation of a particular type of capital may be so that an exchange of another type of capital can take place. The other important concept underpinning this research is that of reflexivity. Reflexivity has its derivation in sociological research (Giddens, 1991). According to Giddens (1991), “modernity’s reflexivity refers to the susceptibility of most aspects of social activity, and material relations with nature, to
chronic revision in the light of new information and knowledge” (Giddens, 1991, p20). To be able to chronicly revise means a continual responsiveness to change by participants in the system. Participants need to have some sense of self-awareness about what practices they are embedded within and be conscious of that constantly changing environment. Participants not only need this openness to change but also the skills and culture or mechanisms that allow change.

2. Methodology

The case study approach was chosen for this study because of the desire to understand cases of firms who had developed sustainable business models by virtue of being successful in market entry and then by a degree of longevity in particular market(s). Three instrumental case study firms were selected to provide insights into ideas about business sustainability and the role of cultural, social and intellectual capital in relation to firm sustainability in international markets. The main method for data collection was in-depth interviews conducted across three firms between one and three hours duration (refer to Table 2). Two interview instruments were developed; one was developed for Senior Managers and one for Design Team Staff. The major topic areas and some example questions are included in the following Table 1. The analytical methodology was drawn from the perspective of grounded theory (Strauss and Corbin, 1990). Grounded theory was used as a means of data organisation and theory generation, particularly useful in its capacity to provide structured guidelines for conceptual relationships and explanatory frameworks. Each case study was analysed as an independent unit of analysis and subjected to two stages of analysis. Open coding: involved the loose association of themes and concepts revealed by individual transcripts. At this stage, theory was considered as a general outline that served to organise the indicators that emerged from the data. Axial coding: involved the arrangement of data according to dominant themes that emerged. At this stage a comparative analysis was conducted to ascertain common themes and irregularities and to enhance the potential for generalisation of resultant theory.

Table 1: Interview Schedule

<table>
<thead>
<tr>
<th>Part 1: Participants role.</th>
<th>What is your role in the organisation? What is your role in relation to international work?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2: Policies, procedures and performance management (Senior Managers)</td>
<td>Is internationalisation a part of the organisation’s objective? Can you tell me which countries you work in and how you came to work in those countries? How is the brief developed? How are consultants managed?</td>
</tr>
<tr>
<td>Part 2: Project processes (Design Team Staff)</td>
<td>Of the projects you have been involved in do you know how they came about? How were you assigned to the projects and did you receive any training? Have you been involved in any project performance reviews?</td>
</tr>
<tr>
<td>Part 3: Successful strategies and inhibitors to success</td>
<td>What do you think has worked well in the past? Why do you think you don’t do as well in some markets as others?</td>
</tr>
</tbody>
</table>

Table 2: Case study firm/participant overview

<table>
<thead>
<tr>
<th>Firm</th>
<th>Firm type</th>
<th>Markets, longevity &amp; organisational structure</th>
<th>Interview participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Architectural</td>
<td>China; 10 years; 1 office in Aust capital city</td>
<td>7; 4 Senior staff, 3</td>
</tr>
</tbody>
</table>
3. Results and discussion

The first stage of analysis identified the firms’ internationalisation and project processes including market entry strategies and factors influencing choice of entry mode, motivations for internationalising, design management policy and practices and level of market knowledge as well as barriers to internationalisation but it is not the intention of this paper to present this part of the results in detail. However, a brief description of the key barriers serves to provide some context to the discussion which follows in relation to the successful strategies used by firms to develop sustainable business models in international markets. Despite quite different entry modes and organisational strategies, analysis revealed a high level of comparison between the three firms in relation to what they defined as being barriers to internationalisation. Predominantly these can be grouped under three categories, which were barriers relating to financial issues, market knowledge, and cross-cultural communication. Barriers relating to cross-cultural communication was seen as by far the most influential barrier facing design firms in international contexts. Somewhat surprisingly, there was a reticence to identify purely financial issues as the primary barriers. This is not to say that firms did not discuss financial considerations, but rather they were not discussed in terms of being the dominant barrier. This demonstrates that financial impacts are the product of barriers that have their underlying causes in more subtle and complex factors. Significantly the firms generally considered financial barriers to be a product of a lack of market knowledge and the barriers concerned access at the level of informational knowledge and the formalisation and utilisation of experiential knowledge as a resource for the firm. Therefore, underlying both these groups of barriers to understanding is the theme of communication between cultures. Cross cultural communication was identified as the primary barrier by the firms and also as the underlying cause of many of the surface level manifestations of barriers. Results demonstrated the field of cross-cultural communication to be a much more complex site than previously addressed in the literature. Barriers in cross cultural communication are usually seen as revolving around translation between languages and personal interpretations of meanings, and this is certainly an important element. Yet, gaps in cultural understanding can also often be the product of differentiated cultural values, and of limits in conceptual continuity and compatibility between niche areas of expertise. Whilst issues of cross-cultural communication appear to be obvious, there is a relative lack of understanding of the complexities related to such difficulties. There is also a relative absence of explicit measures such as policies, processes and procedures formally designed to manage these potential problems. This study has identified that communication between cultures occurs in three different contexts; (a) between national cultures (language differences, cultural understandings and social customs), (b) between corporate business cultures (management styles, processes and procedures), and (c) between project
cultures (fields of expertise, niche specialisation and conceptual compatibility). These three contexts regularly overlap and interpenetrate to create the complex field that is cross-cultural communication. The interpenetration of the three contexts produces certain dynamics that must be negotiated and managed strategically. The predominant cross-cultural communication dynamics outlined by the firms were geographic and cultural distance from the host country, the interrelation of project and business cultures impacting the way a firm does internal business and its relations with external businesses, and the dissociation from local contexts that especially impacts the function of design teams. Accordingly, the means through which the firms managed cross-cultural communication issues largely determined the extent of their successful business practices. There was an overwhelming correlation between the extent to which firms utilised social, cultural and intellectual capital to overcome cross cultural communication challenges and what firms identified as the predominant success factors in their internationalisation experiences. As we proceeded to the next stage of analysis, key themes were identified in relation to how the firms utilised each type of non-economic capital to develop sustainable business models in different international markets, which in turn lead to the firms’ increased flexibility and adaptivity in those markets (London et al., 2005; London & Chen, 2007). There was a high level of comparison between the three firms in relation to what they defined as being success factors to internationalisation and export of design. Predominantly these can be grouped under three categories, which were success factors relating to a) social capital in relation to creating social networks, development of informal interaction, management of internal organizational trust and overcoming dislocation from local contexts; b) cultural capital in relation to development of firm reputation and also cultural understanding and c) intellectual capital in relation to niche specialization and cultural understanding and bilingual capacity and development of ‘deep’ cultural understanding. The following discussion draws together many of the key themes that demonstrate the central relationship between the firms’ strategic management of social, cultural and intellectual capital and its level of reflexive capability. In order to illuminate what is meant by reflexive capability the discussion centres on three themes. Firstly; the need to understand at a detailed level the social, cultural and intellectual requirements of any given role in a firm’s organisational practice. Secondly; the development of an understanding that a firms’ procedures are adaptable, enabled through the increased levels of social, cultural and intellectual capital. Thirdly, reflexive capability occurs in response to information, and thus the depth of information that the firm can utilise is of great importance. The importance of social, cultural and intellectual capital at this level lies in their ability to increase the amount of accessible information and to provide a more accurate grounding for its interpretation.

3.1 Client contact and the flow of information

This section highlights the importance of internal and external flows of information to enable effective delivery of services to clients. Furthermore it highlights the value in firms having an in-depth understanding of the interrelating forms of social, cultural and intellectual capital required in any given position within a firm’s design management practice. Significant findings were that those individuals with client contact were responsible for delivering a brief to the design staff that would facilitate project delivery. On occasion this was made difficult by the skills of the individual responsible for meaningful interaction with both client and design team. The efficacy of each firm’s design management practice is largely dependent on the establishment of effective flows of
information. The accumulation of intellectual capital and increasing niche specialisation of individuals within firms reinforces structural differentiations between the management level of the firm and design staff. It is primarily senior managers who have the initial contact with clients, and usually senior niche-specialised individuals who maintain that contact. Design staff are predominantly disassociated from direct client contact. There were two distinct information flows recognisable within all three firms analysed: the external, which links the firm to clients, partners, third parties and other institutions of the market, consisting of information moving into the firm. Alongside this, and within the firm, the internal flow dictates the efficiency with which information is made available and accessible.

Analysis revealed that the primary points of relation between these otherwise separate circuits of information flow are through the briefing process and feedback gathering procedures. The individual who has the contact with clients occupies a central position as the linking interface between design team networks and clients. Such a position has a great amount of responsibility in regard to managing the briefing process and ensuring that design teams are accurately apprised of client’s requirements. At the end of the day, sustainable business practice is determined by the design team’s ability to produce design solutions that meet or exceed client’s expectations. In turn, this is dependent on the accuracy and amount of detail delivered to design staff via the internal flow of information. Individual firm’s organisational structure influences the manner in which information is conveyed, and the form in which it is transmitted. A common theme emerged where all three firms described the information flows experienced as ‘difficult’ (firm 1), ‘tricky’ (firm 2) and ‘a challenge’ (firm 3). The reliance on one staff member to be the key client contact as well as to act as the conduit for internal flows of information was felt to be a difficulty because an individual’s interpretations were ‘slightly different’ with ‘slightly different nuances’, and were affected by both personal interpretation and linguistic limits. The fact that only one person had ‘been over there and liaised with the client’ makes the briefing process potentially more difficult because culturally specific values and interpretations are the textures that give language its richness and determine the level of detail supplied to the design staff. While it is to be expected that client contact is considered a crucially important niche specialisation requiring a particular set of skills, it appears that it was less often taken into account that the same individual would be the primary source of information concerning the brief for the design staff. The ability to interact efficiently with clients and to overcome cross cultural difficulties is not a guarantee of the capacity to transmit relevant information within the briefing process, and in some cases could even work against it. This is particularly so if the niche expertise that makes the individual suitable for that role is a high degree of familiarity with a foreign language as a product of extensive education. The implication is that the more narrowly focused the individuals expertise is on a particular area, the more likely to adequately fulfil the needs of that role yet also more likely to be less than adequate in filling other niches. Design as a niche expertise comprises a unique terminology and a specific set of concepts that are not immediately transparent to an outsider – to an extent communication between a non-designer and design teams is a cross-cultural scenario. A disparity can occur between accessing the details of the brief from the client and transmitting those details to the design team:
Some people aren’t as good conveying the client’s requests as much as others. Some people pick it up really well and they’re able to convey it and other people don’t pick it up that well and therefore can’t convey it to the people who are going to work on the project (Design Staff – case 1).

The two elements of this process are thus made clear as firstly ‘picking it up’ and secondly ‘conveying it’, which require different areas of skill. Also, between client contact and design team briefing is a third element to the process – interpretation – that brings the individual staff member’s personal perception into play. In international contexts, interpretation potentially involves translation between languages, but certainly the translation of client information into relevant detail for design staff. Cultural understanding is a valuable resource in providing the capacity for ‘deep’ rather than simply ‘surface’ level communication through awareness of culturally specific nuance and subtlety. A lack of cultural understanding can create a situation that can ‘end up in disaster’ (Senior manager firm 1). While this is readily acknowledged in regard to client interaction, it is less often perceived as a potential problem regarding transmission of detail to design staff. Designers identified the combination of dissociation from clients and project sites coupled with a poor level of available detail as exerting influence on their ability to design:

> It was so abstract. I had no idea where it was. It was very disjointed...it was very fast. It was a lake with all the surrounding areas were going to be different styles of housing and landscaping...it was constant that they wanted a lot of detail & not much information was coming from them (Design Staff – Case 1)

> We had another project and that was a lot better. We knew where that was on a map and our director went over a couple of times... to look at the site. So we had a lot more information and photographs and personal involvement. There was a lot clearer direction in that one, we knew what we had to produce and it wasn’t so abstract. That was mainly because the briefing was better. (Design Staff – case 1)

Although clearly identifying the singular nature of the source of information, the second quote highlights the correlation between the level of design-relevant detail and the degree of ‘personal involvement’ as opposed to dislocation experienced from a project perceived as ‘abstract’. It also serves to reinforce the uniqueness of design projects and that different forms of management approaches are required in response to individual projects. This high level of interactivity and need for responsiveness to changed circumstances is rarely found in other sectors and rarely appreciated by other researchers who are associated with international business environments in long run manufacturing and non-project based industries. Therefore, the reflexive capability model is perhaps more suited to sectors that are project based and where changes to work processes and client requirements occur on a weekly if not daily basis. This analysis has demonstrated the level of awareness that is necessary regarding the different positions within the firm’s information flows and processes. However, each position within the firm has a similar array of needs and requirements, albeit a different set of functions requiring a precise combination of forms of social, cultural and intellectual capital. The extent to which these forms of capital can be efficiently and strategically managed is a primary indicator of a firm’s potential for a reflexive capability and this is now discussed.
3.2 Developing reflexive capability

All firms demonstrated an implicit understanding in relation to the value of reflexive capability. Alongside an understanding of social, cultural and intellectual capital, the firms discussed terms such as ‘versatility’ and ‘adaptability’ as being highly valued qualities of staff. The following discussion identifies the interest that firms have in fostering reflexive capability:

*The most important thing for the business...is the project being established and set-up properly. It’s a process of staffing correctly, getting the brief from the client correctly. Then at the end of the project giving the client feedback ... and then giving those results back into the system so you can maybe do things better next time. So it’s a whole continuous improvement by the end. (Senior Manager – case2)*

Clients frequently hold a privileged position regarding what was done particularly well and what could be improved. Accessing this source of information about the firm’s performance is a central aspect of reflexive capability. However, the above quote also highlights an aspect of the predominant perception of ‘feedback’ and performance improvement in that it states that such phases can only occur at the end of a project. Thus a central premise of reflexive capability is that the ‘continuous improvement’ system can be maximised so that benefits are felt within the life of a project. The rigid nature of linear development based on the premise of improving processes in response to lessons learned from past projects is a useful tool of reflection and we are not advocating the elimination of project reviews, however, strict reliance on this process alone can prevent the maximisation of reflexive capability. For many years the research and industry communities alike have emphatically advocated the advantages of feedback systems from project to project. The post occupancy evaluation literature is well documented and has a long tradition in academia and facilities management. However, it remains a largely ad-hoc approach to project, process and design evaluation despite this heritage – and is considered a luxury by most. It is possible that a reason for this is the ‘after the fact’ nature of any insights gained from such evaluations, and the inherent difficulty in applying lessons learned at the end of one unique project to another. It is suggested that a more immediate approach to appraisal would be likely to be followed more readily and benefits accrued in relation to immediate financial considerations rather than future situations. The advantages of this approach should be obvious, and to a degree this is the model practiced by successful firms on this study. The reflexive capability model implies that lessons learned from each project are applied within that project to immediately adjust the functional parameters. Furthermore, lessons learned – as effective responses to a specific problem encountered – are collected as resources to be used in future projects according to the situational need. A process is *constructed* for the specific project in question that fulfils its requirements, and as new requirements come to light the potential exists for the process to be altered to accommodate new needs. The material for constructing adequate processes are individuals with particular forms of social, cultural and intellectual capital, placed in certain relationships with one another. These individuals and relationships are organised according to the desire to maximise interactive information flows. Adjustments to processes and procedures as projects develop occur through individuals recognising change and adapting their roles accordingly. Therefore, the reflexive response by individuals within processes enables more effective project delivery. The firms demonstrated differing degrees of concern with fostering a reflexive capability at an individual level.
The most explicit in this desire was firm 3 who by virtue of its size, had the least formulaic procedures:

*We try and train our guys to think outside the square. If there is a problem on site before coming back to me they must try and think about how they can solve that. If the way it was supposed to be done wasn’t done, if that path doesn’t work well what do you do? You’ve got to think laterally…you’ve got to be versatile, every jobs different and you know it’s not text book stuff*. (Design Manager – case 3)

This quote highlights the value placed on a ‘lateral’ problem solving ability and also illustrates two important points regarding reflexive capability. First, it is considered a form of intellectual capital – a set of skills, or a particular way of perceiving problems, that can be learnt, ‘we try and *train* our guys to think outside the square’. The importance of this is that this form of training is entrenched as part of the firm’s business culture and thus goes a long way to ensuring another of the central parameters of reflexive capability: a culture that adopts a positive interpretation of the value of change. The second point of interest is the capability of individuals to make decisions without referring to a higher authority thus creating a laterally organised firm where individuals are empowered to make decisions rather than a hierarchically constructed firm where decisions are made centrally. Interestingly, the senior partner in firm 3 has a similar disdain for formalised procedures such as quality assurance manuals which encourage staff members to think only about fulfilling a ‘checklist’ rather than the totality of jobs that need to be addressed within a project:

***[senior manager] does not believe in a quality assurance manual. The reason being is that ***[senior manager]’s worse fear is that it stops people thinking. You get the quality assurance manual and tick the boxes, have you done this have you done that and people think yes – so the jobs perfect. It’s not the case. You’ve got to think, to read between the lines and what is not on the list gets missed and you can’t checklist the amount of things on a building. (Design Manager – case 3)

Projects continually undergo change and this change needs to be accepted as an inevitable outcome of design practice and embraced rather than merely limited through control of the situation. Perceiving that the same procedures will produce equally positive outcomes in all situations is problematic because ‘every job is different’. The need to ‘read between the lines’ can be understood as vernacular for understanding that positive outcomes are dependent on meeting the needs of the *situation*, not a concern with ‘ticking the boxes’ which implies meeting the particulars of a given *procedure* that may not be relevant to the situation at hand. To maximise reflexive capability participants need self-awareness about what practices they are embedded within and to be conscious of constantly changing environments. Elements of the process are considered as components of a malleable system that are evaluated according to their function and on the basis of their contribution to the overall efficiency of the process. The extent to which experiential knowledge is accumulated, formalised and disseminated plays a role in the management of social, cultural and intellectual capital and the development of reflexive capability. Thus the importance of developing in staff a capacity for seeing the issues related to projects and a willingness to change behaviours in order to achieve a more positive outcome. Another important example to illustrate reflexivity is the discussion where *firms* readily acknowledged face-to-face interaction as the preferred form of information transfer. While it is accepted that this form of interaction is potentially difficult to achieve in the context of
internationalisation this discussion attempts to make clear what is meant by the term interactive two-way information flow and how this can increase a firm’s reflexive capability. Both senior and design staff placed great emphasis on face-to-face communication as the preferred means of attaining and delivering accurate and detailed information. This is the case whether dealing with the client group (external information flow) or dealing with other individuals and departments within the firm (internal information flow), or in the case of firm 2, offices of the firm’s global group. There are two sides to the preference for face-to-face communication. One concerns the advantages for the briefing process, the other the barriers created by infrequent communication. The two levels of senior and design staff have different perceptions of the advantages and disadvantages involved determined by their position in the structures of information flows. For firm 2, the global model means that both these flows of information are international, and therefore potentially involve elements of cross-cultural communication that must be managed. The preference for face-to-face communication is identified through discussions by both senior management and design staff of idealised briefing process scenarios. For the senior staff, this ideal relates to briefing processes on ‘traditional’ (non-international) projects, whilst for the design team member it is an imagined solution to many of the difficulties that arise from briefing processes in international cross-cultural projects.

‘On a traditional project done here...down the street, our consultancy team would meet once a week, the client would more than likely be involved in those consultancy meetings, we’d sit around a table like this & pull out a roll of drawings and everyone would go through everyone’s role every week & sort through the issues...It’s a face-to-face discussion & there’s nothing quite like a face-to-face discussion’ (Senior Staff – case 2).

‘If I could do it again I’d like to pick up the team & go there & spend two- three weeks solid with the client group, what happens then is the whole team has a sense of ownership on the project, there’s a level of importance of going over, getting an environmental understanding of the place, getting an acknowledgement of the client & then coming back & then we could do teleconferences after that, but I think there ideally would be nice to have a timeframe where you actually dealt with the client face to face. (Design Staff– case2)

For senior staff with the responsibility of client interaction, the problem is not a complete lack of face-to-face communication, but rather its sporadic nature. This pattern of client interaction in ‘concentrated spurts’ means the workload within these periods of face-to-face contact is intensely demanding with a high degree of information passing between the two parties. Outside of this period of face-to-face contact, communication is mediated by information technology, response time is elongated and the capacity to ensure ideas are being conveyed accurately is diminished.

‘It’s very difficult working with a client when you actually only communicate relatively infrequently. We don’t have weekly hook-ups with the client group, they expect when we have contact with them it is very concentrated, you know workshop three or four days face to face grinding out the issues. We’ve always communicated on very concentrated spurts and then you know there might be a month that goes past before we actually communicate with them again on a face-to-face basis. (Senior Staff – case 2).
For design staff, who are perpetually communicating with the client group through mediated situations, both IT communications such as email or web-cam and traditional ones such as teleconferencing, there are technical difficulties. The disparity between levels and system types of information technology between the client group and firm were discussed, and the impact on the briefing process in terms of gaining a connection should be obvious. However, certain challenges also arise simply through the mediated nature of the communications, where the IT mediated situation implies the lack of face-to-face communication. The problem lies in the comparative amounts of information conveyed through the spoken word as compared to non-verbal aspects of communication. Meanings between cultures vary substantially even though those meanings may be signified by the same verbalised word-sound. This is the difference between ‘surface’ level communication, and a ‘deeper’ culturally informed understanding of meanings supplied by appropriate types of cultural capital. Designers are dealing with complex ideas, and the non-verbal elements of communication such as facial expression, body language and gesture, as well as the use of props, drawings and demonstrations may be vital in getting ideas across accurately. These methods of communicating are absent in the mediated communication, and are the reason why face-to-face contact is the preferred mode. These problems are made even more acute in the cross-cultural communication context, even when the client groups speak reasonable English. These are issues encountered by all three firms:

‘The whole technical implications, getting echoes and all that, and people, they’ve got accents and sometimes you can’t pick up from the accents what people are saying. You know South African, English, Pakistan...all these different accents and over a phone it’s harder sometimes...you miss a few words and you miss the essence of the whole sentence It’s very, very difficult to deal with people when you don’t understand the subliminal messages that are coming back or the body language or just how they’re likely to interpret things’ (Design Staff– case 2).

You can’t just send the graphic and trust someone else to explain it. It’s a lot more difficult. Even in the age of technology and internet and all that sort of stuff, you’ve got to have a face, you have got to have a presence. (Design staff – case 1)

...since email came in it has probably increased the amount of discussion we have by two, and then phone calls are just on important issues or initial introductions. But I’ve been on two and a half hour phone calls with our Australian design manager, our Chinese translator, our Chinese project manager and us trying to convince them that we know what we’ve done. It’s different; it’s very difficult because through Chinese language there must be a fair bit of presence of the person. (Design Staff – case 3)

The dependence on IT is ever more important in internationalisation. Geographic distance and cross-cultural communication difficulties are unavoidable elements of doing business in international markets. The issue is the lack of reflexive capability in the communication process. At its simplest manifestation this concerns the inability to ask for, or give, clarification on a point of issue – whether it is a client’s requirement, or a greater explanation of some element of design. At a more complex level, it concerns the capacity of staff to adapt procedure or behaviour in order to more efficiently meet the needs of the situation because the needs of the situation are partially concealed by a reduced level of communicative interaction. This raises an important area of future research which is the way in which IT with its non verbal and visual cues can support reflexivity.
4. Reflexive capability tool & concluding remarks

The reflexive capability maturity assessment tool is the product of research into the barriers and success factors encountered by design firm’s when internationalising (London et al, 2005). It was developed out of insights gained into the underlying causes behind prominent barriers, and the themes common to the successful approaches used by firm’s to overcome those barriers. The reflexive capability tool is at present specific to the management of international design projects and will need to be adapted for application in other contexts. It is a conceptual device for the measurement and management of a firm’s levels of reflexive capability within any specific firm practice or activity. For example, these may include; market entry strategies, training practices, design management practices, knowledge management practices, communication practices, client management, briefing practices, feedback gathering processes, etc. The tool has been developed to allow firms the means to gain a more detailed understanding and appreciation of an activity, practice or process within the firm. By providing a tool for self-management rather than a series of recommendations, it is anticipated that a greater and more useful level of reflective practice can be achieved by the firms. An overview of the reflexive capability tool in terms of its key elements and how it can be used is now provided including a set of qualitative dimensions and levels relating to the primary characteristics of reflexive capability:

Awareness:

- of the need to create, use and maintain social, cultural and intellectual capital for internationalisation practices and processes
- of key strategies needed to create, use and maintain social, cultural and intellectual capital to support internationalisation practices/processes
- of key strategies as changeable depending on project scenarios or market requirements

Responsiveness:

- Staff members within a firm, both individually and collectively openness to change in the firm’s international practices and processes
- Staff equipped with adequate skills and capacity and empowered to make changes and supported by firm business culture

Adaptability

- Defining core principles to be maintained and adapt accordingly practices and procedures based on firm values and staff members skills
- Change strategies clearly and consistently communicated within the firm
The continuum of reflexive capability is designed to demonstrate the relationship between increasing levels of reflexive capability and a movement towards embeddedness of the principles of reflexive capability within the firm. The movement is from the implicit to the explicit; from practices which are often uncritically examined through procedural mechanisms for establishing new ways of thinking and efficient ways of doing things, to explicit definition of these values as central to reflexive capability formalised in firm policies and strategic objectives. Ideally practices are formalised and enshrined in policy to provide clear direction and purpose, which are clearly communicated to staff members. Individual staff members should therefore be clearly aware of both the nature of the firm’s internationalisation process and their own role in the process. Such an understanding implies the ability to perceive that any given position in the internationalisation practice requires a specific yet interrelating mix of various forms of social, cultural and intellectual capital. Staff members should be aware of the various strategies needed to create, use and maintain social, intellectual and cultural capital for internationalisation practices and processes and that the strategies are changeable depending on project scenarios and market requirements. It has been a central theme of this research study, and therefore the reflexive capability maturity assessment tool, that change is dynamic and takes place along a continuum rather than a series of linear categories. This is aimed at a clear representation of firm practices in terms of its level of maturity compared to the ideal scenarios for reflexive capability. Firms can identify the different areas that require improvement in international contexts for maximum success. The matrix was developed for three themes; market entry, knowledge management and design management and the Table 2 is the market entry matrix. The analysis revealed that the strategies used to manage difficulties in international contexts revolved around the strategic management of social, cultural and intellectual capital. Key themes were identified in relation to how firms utilised each of these capital to achieve sustainability in different markets, which in turn lead to increased adaptivity in those markets. This paper has highlighted the variety and density of information moving along internal and external information flows and the high degree of interpretation required in international design practice. It is this need to remain constantly open to emerging information, to be continually processing and evaluating information from a variety of different sources, which enables firms to adjust firm procedures and processes accordingly. Through reflexive capability it is possible to become consciously aware of changes in market conditions and client requirements to absorb those changes in a manner that facilitates the firms’ strategic objectives. Analysis across all three cases identified that barriers are primarily the result of a low degree of reflexive capability and that success factors are the product of increasing reflexive capability. Reflexivity is based in a positive interpretation of change and a continual responsiveness to change by participants in the system. The outcomes of reflexive capability in the firm’s internationalisation process concern the notion that improvements in system function and individual performance can occur within the lifecycle of a project not simply between projects. Reflexive capability can be considered a conglomerate indicator of a firm’s potential for international success.

References


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Abstract

1- How authenticity criteria contributes for the conservation of historic buildings.

2- The author, based on relevant research and theories used case studies from historic buildings to understand the best practices in Europe in order to define "a set of authenticity criteria in conservation".

Taking in consideration the different interdisciplinary views in Conservation, this research aims for a consensus about the concept of "authenticity criteria" and as a way to improve the practice on Conservation of Historic Buildings. For this reason a focus group of experts agreed in the definition and finally the consensus about the set of authenticity criteria for Conservation of Historic Buildings.

3- The results shows that "authenticity criteria" as similar to “sustainable development” and it is different and related to common geographical and cultural areas of the Globe.

4- According to the study it is possible to define authenticity criteria for Conservation of Historic Buildings based on different levels of importance for the World Heritage Value. (International, National, Regional and Local)

Keywords: historic buildings, conservation, authenticity
1. Introduction

This study is about a set of authenticity criteria for the conservation of historic buildings in Western Europe, although the definition of authenticity for conservation today is very controversial all over the world.

This paper describes the phases that the study went through in order to achieve a consensus about a set of authenticity criteria for the conservation of historic buildings and also to demonstrate its contribution to the management of UNESCO World Heritage.

2. Background

Following the Nara Conference on Authenticity in Japan in 1994 experts from ICOMOS have published many articles in scientific magazines on this subject but they have not reached a consensus in the area of historic buildings.

According to Stovel (1994) the word "authenticity" appears in the preamble to the Venice Charter (1964) without a definition because most of those involved in the writing of the Charter shared similar backgrounds and therefore broad assumptions about the nature of an appropriate response to conservation problems.

The word "authenticity" gained a measure of formal authority within the World Heritage Committee in the late 1970s, when the Committee included the "test of authenticity" in its Operational Guidelines as a measure of the essential truth of the values established in looking at the cultural criteria (Stovel, 1994). Since then, the problem has been "what are the authenticity criteria in effective conservation decision making?". This is particularly important today in historic areas in Western Europe, given the growing number of individuals and groups working on conservation of areas expressing considerable unease about the state of doctrinal texts in the field.

3. Aims of the Study

According to the philosophy of the Venice Charter on the Conservation of monuments (1964) and the monitoring of a number of case studies, this research has the following:

Scope - Authenticity for the conservation of historic buildings.

Focus - The development of a set of criteria to assess authenticity in conservation of historic buildings.
Purpose to define a set of authenticity criteria to facilitate the conservation of historic buildings in Western Europe.

4. Scope

What is Authenticity in the Conservation of Historic Buildings?

According to the review of relevant research and theories, presented at the Nara Conference (1994), "Authenticity" can be defined as something that sustains and proves itself, as well as having credit and authority from itself. Authenticity refers to something creative, an authorship, something having a deep identity in form and substance. It means something specific and unique, and is different from "identical" which refers to universal, representing a class, reproduction, replica, copy, or reconstruction. While in many cases “authenticity “can relate to the “original creative source “, it is also a relative concept, and, according to modern value judgements, it can relate to historical - continuity in the “life” of the heritage resource. This includes interventions in different periods of time, and the way that these have been integrated in the context of the whole. The relative significance of each period in the whole should be established through a historical-critical process, in order to form the basis for treatments. Authenticity can be understood as a condition of the heritage resource, and can be defined in the artistic, historical and cultural dimensions of this resource. These dimensions can be seen in relation to the aesthetic, structural and functional form of the object or site, in relation to its material and technology, as well as in relation to its physical and socio-cultural context (Jokilehto, 1994).

According to Jokilehto (1994) at the Nara Conference, “the existence of authenticity in a heritage resource and its context will be the basis for the measurement of relevant cultural values, on the other hand, the identification of parameters for the specification of pertinent authenticity will also depend on these values. Considering today’s society, its character and the problems it faces in relation to its own identity and authenticity, it will be most important to take great care to maintain the authenticity of existing heritage resources from the past. They will form a reference for future memory, and will therefore need to be conserved with due respect for relevant issues. The dynamic conservation management of the built environment and the approach to authentic living traditions requires an appropriate process. Such traditions are becoming rare in the present-day world, and although they should themselves provide the required knowledge and skills for their continuation, they will also need support in general planning and management in order to make it feasible for them to keep their authentic creative capacity”.

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5. Propositions

The research question is “what are the parameters of authenticity criteria for conservation of historic buildings?” As stated by Stovel (1994) the best definition for Conservation is Feilden (1993) quotation: "Conservation seeks to prolong the life of cultural property and if possible to clarify the historic and artistic message without loss of authenticity."

According to Jokilehto’s definition of authenticity (1994) referred on 1.4 the research was based on the following propositions from the USA National Parks Service which constitute the basic parameters to assess authenticity in historic places. The following propositions parameters are used in the four case studies in West Europe in order to built theory:

1. **Location**, is the place where the significant activities that shaped a property took place;

2. **Design**, is *the composition of natural and cultural elements comprising the form, plan, and spatial organisation of a property*;

3. **Setting**, is *the physical environment within and surrounding a property*;

4. **Materials**, *within a property include the construction materials of the building, immediate surrounding area of the building itself, highways, fences and other structures*;

5. **Workmanship**, is *displayed in the way people have fashioned their environment for functional and decorative purposes*;

6. **Feeling**, although intangible, *is evoked by the presence of physical characteristics that reflect the historic scene*;

7. **Association** is *the link between a property and the important events or persons that have shaped it*

6. The objectives of the research

In the last twenty years much has been written about authenticity in monuments and nowadays the concept of “monument” includes not only the isolated building with historical value, but also all the buildings and areas that due to their exceptional character, represent some significant period in the evolution of human beings.

This notion has been enlarged in the recent concept of "cultural landscape" as defined by UNESCO (1997).

Bearing in mind the philosophy of International Charters and Conventions on the preservation process of historic places proposed by UNESCO and ratified by most European countries, this study reflects
on a set of criteria as a way to assess authenticity for the conservation of historic places based on the assumptions from the Venice Charter on Restoration, in 1964.

Thirty years later, in 1994, the ICOMOS (Stovel, 1994) reflected upon the evolution of the use and the concept of authenticity for World Cultural Heritage in many meetings with the aim to achieve some consensus at the Nara Conference (1994).

Since then, and to date, much has been written about "authenticity" in historic buildings and sites. On its importance, Linstrum (1996) makes the following remark: “Authenticity is fashionable; we think it is important, otherwise we would not be spending three days discussing it”.

Both the theoretical debates about monumental buildings and the studies of practical urban areas carried out in European historical cities (Cohen 1999), show the need to define a set of authenticity criteria as a means to elect priorities and to have a real intervention in each respective historic area.

To sum up the presence of this very real problem in the preservation of historic areas in Western Europe, theoretical and practically oriented research work has been developed based on a literature review of the material available on this subject and by using a selection of case studies of historic centres in European cities which serve to support this issue.

The authenticity criteria, referred to throughout this study, is the indicators that the scientific community describes not only in their theoretical development work but also in their practical judgements selected for the classification process of national historic areas (USA) or of the World Heritage areas of UNESCO (ICOMOS). The set of four criteria that are being used for the classification of the World Heritage areas of UNESCO (Jokilehto, 1993) were compared with the seven criteria of property evaluation from the USA Parks Service, which are designed to be used as an analytical tool for the preservation of the authenticity of historic places. The criteria used by the US Parks Service has the following parameters: Location, Design, Setting, Materials, Workmanship, Feeling and Association.

According to Jokilehto’s (1994) definition of authenticity that had the support of “the sounding board of experts”, and the latest research and theories, seven criteria were elected and applied on four case studies in Western Europe. These initial seven authenticity criteria were defined and applied to the historic centres of Lisbon (Bairro Alto), Bruges, Chester and Athens (Plaka).

A cross-case analysis was used in each of these case studies for the refinement of these criteria in order to create the model of research. The result was a set of authenticity criteria defined by five parameters as follows:

<table>
<thead>
<tr>
<th>1-Material / Substance</th>
<th>The physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form, an historic property.</th>
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<tr>
<td>2-Design</td>
<td>Combination of elements that create the form, plan, space, structure, and style of a property.</td>
</tr>
</tbody>
</table>
3-Workmanship | The physical evidence of the crafts of a particular culture or people during any given period in history or prehistory.
4-Function / Use | The degree of continuity of original or significant uses in a property.
5-Setting | The physical environment of a historic property.

This set of criteria was tested and validated by a “panel of specialists” through the application of the Delphi Method made up by an “expert group” of different European countries and organisations.

7. Research outline

In order to establish a “set of criteria on authenticity for the conservation of historic buildings “the research design is shown in figure 1.1.

First, the initial literature survey based on the Venice Charter (1964), The Nara Conference Proceedings (1994), The San Francisco conference (1996) and other important charters and conventions (ICOMOS Scientific Magazine) provided the researcher with strengths and weaknesses which pointed out the importance of this research subject. The scope of the research in which authenticity is based are the principles and the agreement about this concept in Venice Charter (1964) for the conservation of monuments and sites.

Based on relevant research and theories, and the views of the “sounding board of experts”, the four case studies in Europe constitute the practical material for the criteria. These case studies used as examples to built theory. Having the theoretical framework and relating it to the practical experience in some case studies, a set of authenticity criteria is defined and creates the model of the research. The model of the research defined is a set of authenticity criteria composed by five parameters. These five parameters are the aspects to assess authenticity for conservation of historic buildings. The five aspects proposed to assess authenticity are:

1. Materials (USA Parks)
2. Design (USA Parks)
3. Workmanship (USA Parks)
4. Function (Jokilehto and Stovel)
5. Setting (USA Parks)
Figure 1.1
In order to test and validate the model- “a set of criteria” defined it was used the Delphi Process in order to reach a consensus on authenticity criteria for conservation of historic places of Western Europe:

The Delphi process is developed in three rounds as follows:

- First Round was based on the criteria achieved with case studies. The researcher allocated the criteria according to the hierarchy of importance and sent to twenty panellists in order to achieve consensus about the allocations.

- Second Round reconsidered the allocations of the first round and weighting the reasons for the hierarchy proposed and definitions of authenticity criteria.

- Third round summarized the new allocations and gained consensus for the final allocation and definition.

The Delphi results, with the final criteria were validated and illustrated by a case study in Bath in order to know the possibilities of generalization of the final authenticity criteria for conservation of other historic places of West Europe.

8. Conclusion

The final criteria achieved with this research (table1.1) reveals the emerging importance of function and use in historic buildings for the future. This research achieved the following five authenticity criteria:
| A. Design | Is the combination of elements that create the form, plan, space, structure, and style of a property. It results from conscious decisions made during the original conception and planning of a property (or its significant alteration) and applies to activities as diverse as community planning, engineering, architecture, and landscape architecture. Design includes such elements as organization of space, proportion, scale, technology, ornamentation, and materials |
| B. Material | Are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property. The choice and combination of materials reveal the preferences of those who created the property and indicate the availability of particular types of materials and technologies. Indigenous materials are often the focus of regional building traditions and thereby help define an area's sense of time and place. |
| C. Workmanship | Is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory. It is the evidence of artisans' labor and skill in constructing or altering a building, structure, object, or site. Workmanship can apply to the property as a whole or to its individual components. It can be expressed in vernacular methods of construction and plain finishes or in highly sophisticated configurations and ornamental detailing. It can be based on common traditions or innovative period techniques. |
| D. Setting | Is the physical environment of a historic property. Whereas location refers to the specific place where a property was built or an event occurred, setting refers to the character of the place in which the property played its historical role. It involves how, not just where, the property is situated and its relationship to surrounding features and open space |
| E. Function/Use | Is the degree of continuity of original or significant uses in a property. An historic area and its surroundings form a coherent whole including associated human activities and constructions; continuation of original or compatible uses minimizes negative impact on authenticity |

Due to the fact that the sounding board of research and Delphi members were made up of experts with different background, ranging from Academia, Architecture, Construction, Industry of Culture, NGOs (Non Governmental Organizations) and other built heritage organizations (UNESCO, ICCROM, ICOMOS, Europa Nostra and Council of Europe) the final set of criteria to assess authenticity for conservation of historic places in Western Europe has an holistic point of view.
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Conventions and Recommendations of UNESCO concerning the protection of the cultural heritage. UNESCO. 1985


ICOMOS,(1964).International Charter for the Conservation and restoration of Monuments and Sites


The aim of this research was to investigate strategies deployed by successful construction design-related firms towards achieving high levels of firm competitiveness in international markets. A reflexive capability model, developed through a critical analysis of related internationalisation literature, is composed of three key areas; internationalisation process, market knowledge and design management. Firm reflexive capability is explored through the management of social, cultural and intellectual capital. The concept of reflexivity is borrowed from sociology the philosophers, Bourdieu and Giddens. Reflexivity is reinterpreted as the ‘firm’s’ ability to be aware, responsive and adaptable to self, market and project needs assessment. This research is part of an ongoing program of research on international collaborative practice. A Reflexive Capability Matrix is proposed. The reflexive capability approach is appropriate to all firms but what is speculated upon is that the reflexive capability is particularly applicable to small to medium sized construction design firms who work globally. A reflexive capability is a characteristic of successful and innovative firms internationalising and working within global models of practice. This paper is the theoretical development to support the paper in this congress “Design Management Methodology to Strengthen Firm and Industry Competitiveness in the Construction Design Services Export sector” where the methodology and results of a cross case analysis of three construction design firms are presented.

Keywords: reflexivity, human capital, internationalisation, design management
1. Background

The current global economic crisis is heralding a new era for the construction industry. As domestic markets shrink, Architecture, Engineering and Construction (AEC) firms are increasingly seeking opportunities to work internationally (Lizerralde et al, 2008; Preece and Shi, 2009). Exporting firms are able to relocate their competitive position to be less susceptible to downturns in local markets (El-Higzi, 2003) and are provided the opportunity to increase their market share by diversifying their products and/or services in international markets. Firms in the construction industry have demonstrated an increasing involvement in international markets, however, there is still significant opportunity for further growth in the export of these particular services (London, 2008). Notwithstanding assistance provided for firms through international trade missions, export firm support networks and information packages by government agencies, evidence suggests that there are still perceived barriers to market entry and long term economic sustainability for firms. The international context of construction is characterised by a high degree of volatility, complexity and risk (Lizerralde, 2008). Firms working in international markets not only need to be strategic in their selection of markets and entry mode – they also need to have extensive knowledge of the market in question. This involves having considerable understanding of the market’s regulations, project organisational structures, development processes and political issues. Furthermore, exporting firms are generally not as well known as the local firms in international markets and thus there is an increased need to gain access into client networks through adaptability and flexibility. Firms who achieve competitive advantage in international markets and thus long term sustainability are constantly adapting their business practices to achieve client satisfaction by a combination of self, market and project needs assessment (London and Chen, 2007). All successful firms ultimately achieve this in local markets but what is intensified in the international market is the complexity of barriers grounded in cross-cultural contexts. Therefore the need for flexibility, adaptability and continual reassessment is enhanced as the market evolves in various localities.

Some attention worldwide has been directed towards understanding the design and procurement of construction projects in the international context (London et al, 2005; Demers, 2008; Abdul-Aziz et al, 2008; London, 2008; London and Siva, 2009). Studies on the international construction business environment have been typically limited to exploratory case studies (Pietroforte, 1997; London, 2001) which only sought to describe market entry strategies used by firms. Various innovative strategies exist for architectural, engineering and construction firms to enter markets (Doherty, 1999; Buckley and Ghauri, 1994, El-Higzi, 2002) but less is known about the internal firm management strategies to support long term economic sustainability. This paper explores the justification and development of a theoretical model for design management within firms. In acknowledging that firms typically develop their own highly sophisticated financial measures, they however have only an implicit understanding of other less tangible factors that impact upon sustainability. This study has opened new research territory by developing a qualitative measurement model specifically related to design management which relies upon the development of a qualitative indicator methodology focussed upon social, cultural and intellectual capital. The general research question addressed in this research project was: “How do construction sector design firms internationalise and develop sustainable business models?”
Although there have been numerous international business empirical studies there is little theory related specifically to design management and internationalisation. International construction literature has tended to focus on investigations of broad trends and dominant patterns of change (Bon and Crosthwaite, 2000; Mawhinney, 2001), levels of competitiveness (Ofori, 1998, 2003; Oz, 2001) and broad principles, frameworks and approaches for international construction practice (Mawhinney, 2001; Howes and Tah, 2003). Less attention has been paid to the critical aspect of international design management particularly in relation to the ‘softer’ and less tangible elements of social, cultural and intellectual capital for internationalisation. The literature on design firm internationalisation has implicitly indicated that social, cultural and intellectual capital are all key factors related to successful market entry and long term sustainability; however, it has not been previously investigated to the extent where explicitly rich descriptions of the phenomena can be attained. A theoretical framework specifically designed for the analysis of organisations entering new markets and aiming to achieve sustainability was developed to guide data collection and theory generation in order to encompass an adaptive aspect to internationalisation business practices. The conceptual framework relied upon the three key areas of internationalisation process, market knowledge and design management. Underpinning the development of the adaptive performance framework for a sustainable business model is the assumption that these factors and their various components interact and impact upon each other.

2. Theoretical framework

A sustainable business model for construction design firms would typically rely upon individual project success and a key part of how this is achieved is through project and strategic design management. The factors affecting project management differ from country to country and project to project (Draganich, 1998; Loosemoore, 2001). Similarly, design management may be affected by country and project type. Therefore the continuous adaptation of the export enterprise part of a firm to changing market conditions and the new knowledge generated from each project is fundamental to the model. Three key areas which provided insight into the research problem of developing a sustainable business model for design firm internationalisation were considered; internationalisation process, market knowledge and design management, which are now briefly discussed.

2.1 Internationalisation process

The internationalisation process has been well established within the research literature. A research gap exists, however, through emphasis having been given to large firms, and in particular those within manufacturing. Consequently there is less known regarding the internationalisation of SMEs, especially those that provide a service such as design firms. The importance of this research gap is reinforced through the differences between SMEs and larger firms as well as those between services and products. This is problematic because SMEs are one of the principal driving forces in economic development (UN/ECE Secretariat, 2008) and the majority of construction firms are SMEs (London, 2008). The internationalisation process has four key factors including market selection, decision to enter, entry modes and factors affecting entry modes and the literature is quite detailed in discussing
Internationalisation can be perceived as a part of the ongoing strategy process of most business firms (Melin, 1992). The main differences between internationalisation and other types of strategy processes include:

- firms transfer products, services or resources across national boundaries, implying that firms have to select in which country (or countries) the transactions should be performed
- firms have to select the international exchange transaction modality, that is, a foreign market entry strategy.

These two dimensions – international market selection and choice of entry mode – represent key strategic decisions in relation to a firm’s internationalisation (Bradley and Gannon, 2000) and are both related to addressing client’s requirements. International market selection is a pivotal aspect of international business and a number of factors contribute to market selection including: business factors, chance and psychic distance. After reaching the decision to enter a particular market, a firm needs to determine a mode of entry. Mode of entry has been described as utilizing an institutional arrangement for organizing and conducting international business transactions (Erramilli and Rao, 1993; Root, 1987). There are two types of foreign market entry situations among service firms:

- market seeking (MS): a proactive approach, which is determined by a firm’s organisational goals of looking to expand its businesses or
- client following (CF): a reactive approach, which is to achieve client satisfaction as a firm is asked by a client to export its services

A large number of service firms enter foreign markets primarily to serve the foreign subsidiaries of their domestic clients (Terpstra and Yu, 1988). For example, Australian architectural firms designing high rise office buildings could follow their financial institution clients to international markets. This phenomenon of client following while not unheard of in the manufacturing sector, is a unique characteristic of service firms in terms of its occurrence and importance. A firm can be expected to be more knowledgeable about its market when it goes abroad to serve its current domestic clients (CF), than when it enters a foreign market to serve foreign customers (MS). This means firms using MS entries can be expected to perceive relatively higher levels of uncertainty and risk. Therefore relative to firms using CF entries they would be more inclined to scale back their resource commitment and show a greater willingness to collaborate with external entities during foreign market entry. It is useful to conceptualise firms as seeking entry modes that allow them to exercise maximum possible control over their foreign operations. Entry modes differ in the amount of control they provide the firm (Erramilli and Rao, 1990; Root, 1987). Typically the amount of control increases as a firm's resource commitment and level of involvement increase. Firms preferring to maintain control over their foreign operations may have to choose entry modes with high involvement levels. When faced with unacceptable levels of uncertainty and risk (Mascarenhas, 1982) decision-makers try to reduce their involvement by cutting back on the amount of resources and/or by teaming up with outside agents, distributors, and partners, especially in the host market. Construction firms are not well regarded as having high levels of in house financial resourcing and are typically risk averse (London, 2008).
2.2 Design management: Cross cultural communication

In many markets the delivery of a design service to clients has often been problematic as it is characterised by a high level of uncertainty whereby client’s requirements are negotiated, defined and challenged. Such an uncertain and creative environment requires a high level of communication. Communication in the design process has long been considered a complex issue where the gap between expectations and realisation is central to the problem (Brown, 2001; Emmit, 1999). Design management in the international context is fundamentally impacted by cross-cultural communication. The added difficulty of communicating across international boundaries further compounds the problem of capturing the client’s requirements (Howes and Tah, 2003). Cross-cultural business communication is an important part of how a firm manages the design service and is regularly identified as a significant barrier encountered in the internationalisation of design firms (Draganich, 1998). However, Pietroforte (1997) following a study on construction alliances between an Italian contractor and an American architectural firm cites the possibility of achieving client satisfaction through the implementation of several cooperative strategies in international markets by forming international alliances. International alliances may offer firms a range of advantages including risk sharing, technology transfer and market access (Badger and Milligan, 1995; Mohamed, 2003). Perhaps though there are a variety of ways for firms to achieve international success. Ultimately the challenge for firms is to manage both their firm and the projects to provide a service that responds to their client’s brief. The management of design firms and design by firms is an interdependent process (Emmit, 1999; 2007; Allinson, 1997) and therefore cross-cultural communication becomes an important part of achieving and sustaining success in the international environment. There are various strategies undertaken by firms to manage design at both project and organisational levels. Within the context of design management, effective cross cultural business communication becomes an important part of the firm’s ability to develop knowledge to export, enter new international markets and to then maintain a strategic position within various markets. A study exploring the collaborative practices of an international design team on a complex building project in Brazil identified that international design teams intensify traditional communication problems as a result of differences in language, managerial style, organisational and individual culture, lack of personal contacts and poor adoption of communication technologies (Grilo et al, 2007). Knowledge sharing between individuals with different cultures, backgrounds, perspectives and motivations is a critical step in facilitating collaboration on international projects (Grisham and Walker, 2006; Dulaimi, 2007). Information internalisation and the effective translation of information into relevant knowledge and firm resource have been identified as an important part of the internationalisation process of firms (Morgan et al, 2003, Knight and Liesch, 2002; Dulaimi, 2007).

2.3 Knowledge: market and experiential

Market knowledge within a firm includes both informational and experiential knowledge (Morgan et al, 2003). To undertake international contracts an understanding of fundamental and basic informational knowledge is required; which is concerned with the various legal, economic, institutional frameworks – all information that is often accessible and transferable by government trade agencies and/or management consulting firms specialising in providing assistance to exporting
firms. Such information is often generic though not always and is very critical. Informational knowledge often seems critical at market entry and is tangible, can be made explicit and can be static. *Experiential knowledge* typically arises from individual experiences with particular markets, clients and projects. Within a firm a project can be considered an *export venture* and for sustainability it should be considered as a strategic business unit in that it represents the individual export market efforts of the firm and comprises a unique design service exported to a specific foreign market. The export venture’s knowledge base of experiential knowledge can include both an individual and the venture’s experience. The venture includes all the people within the firm and the accumulation of tacit knowledge in relation to working on international projects. Experiential knowledge is really nothing if it is not matched to the venture’s organisational capabilities. The venture’s organisational capabilities involve the marketing, planning and implementation capabilities; which refer to the way in which those involved in the particular venture apply the knowledge to the venture. The adoption to changing market conditions of the export venture is key to maintenance, performance and success of the firm. The alignment of the venture’s objectives to the firm’s strategic organisational objectives underpins the ultimate success of the venture.

This concept was tested using small to medium sized exporting manufacturing firms from China and the United Kingdom and the results indicate positive relationships between a firm’s collective and individual’s knowledge of markets. Perhaps most interesting to this study on design firms is the relationship that knowledge has to adaptive performance as well as the relationship that knowledge has to initial market entry strategies. Maintenance of existing relationships with clients is critical to future project contracts that clients may offer and to the reputation that the firm will have in the region. Adaptive performance is critical to design firms in the construction sector as they internationalise, as their ability to win new projects relies upon the success of the immediate past contract – their firm’s credibility and reputation.

### 3. Conceptual model

There is no need to look too far for theory to assist the development of a model for sustainable business performance in relation to capital. The concept of capital is one that has been extensively researched based on empirical evidence by Bourdieu (1991) from sociology research. The types of capital that have been adopted for this study include financial, social, cultural and intellectual capital and these are now discussed.

#### 3.1 Social, cultural and intellectual capital

Social capital is the creation of personal relationships and networks based on trust built over time. Working in a network helps spread risks and marketing costs and has relevance for project team networks and firm and client networks. According to Cohen and Prusak (2001, p4), ‘Social capital consists of the stock of active connections among people: the trust, mutual understanding, and shared values and behaviours that bind the members of human networks and communities and make cooperative action possible’. In a study on the internationalisation of Danish architectural firms
Skaates et al (2002) saw national construction industries as milieus or groups characterised by geographical areas which had a network of actors with a set of ‘rules and norms regulating the interactions between these actors’ (Cova and Ghauri, 1996). Skaates et al (2002) further defined social capital as recognition by other actors within the construction industry that the firm is a member of ‘their inner circle due to one’s dispositions…or one’s way of working and ‘tacit knowledge’. Cultural capital entails physical ‘dispositions’ such as ‘building visible buildings, winning design competitions, or obtaining important tenders’ (Skaates et al, 2002). These concepts are premised on the reputation of the firm in that the success of marketing architectural services ‘depends upon the firm’s ability to sell and deliver a credible promise’ (Lowendahl, 2000). It differs from social capital in that it is the high profile of a firm’s projects that marks the firm as having acquired a level of cultural capital. Therefore, cultural capital is the firm’s highly regarded past achievements that create trust and credibility; which is different from trust that is formed through relationships or networks. A firm acquires cultural capital through building successful buildings, thus creating a presence in the foreign market. It can be likened to achieving a foothold in a market, where success often breeds further success. More and more clients are relying on instantaneous recognition when selecting suitable design firms and such recognition is gained through the creation of reputation. A firm’s reputation is earned through a high level of cultural capital. Intellectual capital is a firm’s collective skills, experience, competences and knowledge and is critical to the sustainability of firms, particularly in international markets. According to Stewart (1998), the strength of a firm lies within its intangible assets, where he proposes that intellectual capital of a firm is ‘the talents of its people, the efficacy of its management systems and the character of its relationships to its customers’. A firm can acquire its intellectual capital through establishing skills and niche expertise by employing skilled staff members, enabling the firm to respond to client’s requirements more efficiently. A firm’s skill specialisation which is accumulated through its involvement in past projects and employment can contribute to winning further projects as clients typically value a firm’s expertise to deliver satisfying results.

3.2 Strategic indicators for internationalisation

Whilst the internationalisation process is often viewed as one of which necessitates extensive country-specific knowledge and significant financial resources (Eriksson et al, 1997), long-term perspective afforded by the capital acquisition approach may provide advantages to firms attempting to internationalise. Scarce resources means one firm cannot supply all the necessary skills, knowledge and expertise for the process (Porter and Fuller, 1986). However, the dynamics of capital acquisition allows for firms to build on initial resources to achieve sustainability in foreign markets and to understand and contextualise the value of various forms of capital to a firm’s internationalisation strategy. This is of particular importance to SME’s who have fewer resources available. An example of how a firm strategically manages its capital acquisition is the firm’s conscious decision to penetrate a foreign market through heavy financial investments into that market without immediate return. Such investments may not lead to immediate financial success but may initiate the firm’s acquisition of social, cultural and intellectual capital. As such the firm may build up its acquisition of capital by creating networks, gaining reputation and developing skills. This would in turn translate to financial success in the long term. This poses problems for firms but it highlights two key questions:
• is ‘softer’ capital [social, cultural and intellectual] key to long-term sustainability and if so to what extent?
• is there any inter-relationship between social, cultural and intellectual capital that underpin such strategies?

Financial capital is significant to all three types of non-economic capital as ultimately all three types are aimed at creating financial capital for the firm. The notion that “economic capital is at the root of all other types of capital” and that these other types are in fact “transformed, disguised and forms of economic capital” is not a new concept at all (Bourdieu, 1991). For example, economic capital makes possible the investment in cultural capital by making possible the investment of time needed to accumulate cultural capital. The relationships between cultural, social and intellectual capital are complex (Bourdieu, 1992). Capital exists in a variety of forms or states. Bourdieu (1992) suggested that these primary relationships are guided by an understanding of three concepts; investment, exchange and accumulation of capital. The investment of a particular type of capital can be aimed at the exchange of capital in order to accumulate capital (London et al, 2005b). Alternatively the accumulation of a particular type of capital may be so that an exchange of another type of capital can take place.

3.3 Reflexive capability and future research

Reflexivity has its derivation in sociological research (Giddens, 1991). According to Giddens (1991), “modernity’s reflexivity refers to the susceptibility of most aspects of social activity, and material relations with nature, to chronic revision in the light of new information and knowledge” (Giddens, 1991, p20). To clarify some terms common to sociological thought yet perhaps less well known in other academic fields; modernity is the underlying conditions and modes of thought correlating to ‘modern society’. The underlying premise is that the natural and social world can be understood, and through this understanding can be brought into the realm of human intervention. Material relations with nature encompasses the interactions between the social system and natural world, including modes of production through which material (natural) resources are transformed into products and commodities, and systems of thought that dictate such processes. To be able to chronically revise means a continual responsiveness to change by participants in the system. Participants need to have some sense of self-awareness about what practices they are embedded within and be conscious of that constantly changing environment. Participants not only need this openness to change but also the skills and culture or mechanisms that allow change. To allow for change does not necessarily mean that everything is in a state of flux – there is a suggestion here that there is no need for prior learning of knowledge and that past experience does not contribute to our current practices. Therefore there are core principles that are not subject to change and boundaries should be placed around elements that are considered unchangeable. A reflexivity capability maturity assessment framework is proposed. The framework is at present specific to the management of design projects in the context of international markets and will need to be adapted for application in other settings/contexts. It is a conceptual device for the measurement and management of a firm’s levels of reflexive capability. For example, these may include; market entry strategies, training practices, design management practices, knowledge management practices, communication practices, client management, briefing practices, feedback gathering practices, etc. The framework has been developed to allow firms the means to gain a more detailed understanding and appreciation of an activity, practice or process within the firm. As a
framework for self-management rather than a series of recommendations, it is anticipated that a
greater and more useful level of reflective practice can be achieved by the firms. An overview of the
framework in terms of its key elements and how it can be used is now provided including a set of
qualitative dimensions and levels relating to the primary characteristics of reflexive capability:

Awareness
- Awareness of the need to create, use and maintain social, cultural and intellectual capital for
  internationalisation practices and processes
- Awareness of key strategies needed to create, use and maintain social, cultural and intellectual
  capital to support internationalisation practices/processes
- Awareness of key strategies as changeable depending on project scenarios or market
  requirements

Responsiveness
- Staff members within a firm, both individually and collectively openness to change in the
  firm’s international practices and processes
- Staff equipped with adequate skills and capacity and empowered to make changes and
  supported by firm business culture

Adaptability
- Defining core principles to be maintained and adapt accordingly practices and procedures
  based on firm values and staff members skills
- Change strategies clearly and consistently communicated within the firm

Reflexive capability is considered to be on a continuum and designed to demonstrate the relationship
between increasing levels of reflexive capability and a movement towards central embeddedness of
the principles of reflexive capability within the firm. The movement is from the implicit to the
explicit; from practices which are often uncritically examined through procedural mechanisms for
establishing new ways of thinking and efficient ways of doing things, to explicit definition of these
values as central to reflexive capability formalised in firm policies and strategic objectives. Ideally
practices are formalised and enshrined in policy to provide clear direction and purpose, which are
clearly communicated to staff members. Individual staff members should therefore be clearly aware
of both the nature of the firm’s internationalisation process and their own role in the process. Such an
understanding implies the ability to perceive that any given position in the internationalisation
practice requires a specific yet interrelating mix of various forms of social, cultural and intellectual
capital. Staff members should be clearly aware of the various strategies needed to create, use and
maintain social, intellectual and cultural capital for internationalisation practices and processes and
that the strategies are changeable depending on project scenarios and market requirements. The
following Table 1 summarises key attributes of the framework. It has been a central theme of this
research study, and therefore the reflexive capability maturity assessment tool, that change is dynamic
and takes place along a continuum rather than a series of linear categories. This is aimed at a clear
representation of firm practices in terms of its level of maturity compared to the ideal scenarios for
reflexive capability. Through this representation firms can identify the different areas that require
improvement if the firms success in international contexts is to be maximised. The advantage of
understanding reflexive capability as a dynamic continuum lies in the realisation that influencing any
particular component of a practice can also impact upon some other firm practice indicating the
interdependency between the various forms of capital and how it may be utilised to a firm’s advantage. The matrix has been developed for three themes; market entry, knowledge management and design management and Table 2 is an example for the market entry matrix. It is proposed that a reflexive capability to the internationalisation process by design firms is needed; and the ensuing manner in which they strategically manage social, cultural and intellectual capital is highly appropriate to the complex environment of international projects. Furthermore, reflexive capability of the collective firm and its institutionalised culture is the ideal is a characteristic of successful exporting firms. The reflexive capability approach is appropriate to all design processes but what is speculated upon is that reflexive capability is particularly applicable to design firms working globally and who are successful in that process. The future research involves a cross case analysis of three construction design firms to explore the further development and refinement of the proposed conceptual model of reflexivity capability as a construct applicable to successful firms who have been involved in international projects for a long period of time[approximately 15 years or more]. This future research is published at this World Congress in the paper entitled “Design Management Methodology to Strengthen Firm and Industry Competitiveness in the Construction Design Services Export sector.
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<th>Table 1 Reflexive capability maturity assessment for market entry</th>
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<td><strong>Awareness</strong></td>
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<td>Awareness of the need to create, use and maintain SCI capital for market entry</td>
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<td>Firm support to be responsive in the creation, use and maintenance of SCI capital for market entry at project level</td>
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<td><strong>Explicit</strong></td>
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Abstract

Current sustainable buildings in reality are not sustainable. The sustainability concept has been transformed in a stereotype language about a theme which is more than designing bioclimatic architecture and saving energy. The aim of this work is to identify, in a critical way, the aspects related with the unsustainability of the architecture developed nowadays. Many architects have a focus only on energy efficiency in the operation phase of the building's lifecycle and forget the other issues related to the sustainable architecture. In this way, the necessary energy for the electrical devices used every day comes from the non-renewable sources. These buildings are reducing the natural resources and continuously contaminating the environment. All the buildings consume around 40% of total raw material available and produce large amounts of waste during extraction, transformation, construction and demolition. The energy savings achieved in these buildings are admirable, mostly in skyscrapers. Nevertheless, this does not mean anything in terms of architecture that respects the environment because most of the energy supply comes from non-renewable sources. Furthermore, the building materials used on these buildings are often extracted in a destructive manner and a small quantity of it is reused or recycled. The buildings are design to be built, but not designed to be deconstructed. These and other factors contribute to reduce the energy and natural resources and to increase the amount of waste. From the development of this paper it can be noticed that the actual architecture can not be characterized as sustainable, because there are many issues that must be solved until it becomes a truly sustainable architecture.

Keywords: sustainability, waste, building, resources
1. Introduction

Currently, it is widely know that non-renewable resources are limited. There are many by-products that are treated as waste and that cause environmental pollution. The climate change implies an ecological, political and social awareness. In addition, it calls for a change in how to think the new buildings and how the architects should design it. The sustainable architecture must take into account the close-loop life cycle of materials, that is, reduce, reuse and recycle the available resources. The utilization of virgin materials which are resources with low entropy should be avoided in order to preserve these resources because waste is not limited in the building material itself, but in all the production chain of a material or a component. Natural resources are inside the earth, that is, no one can see them. However, waste is a surface phenomenon; it is produced at all phases of a material's life cycle and no one can ignore it. In this sense, the efficiency in the construction material's processes must be increased, in order to produce more construction materials with minimum resources and search alternatives that are truly sustainable.

Recently, many “sustainable” buildings, mainly skyscrapers, were presented in an event called World Architecture Festival, held in Barcelona in 2008. All skyscrapers had a focus on the building's energy efficiency during their utilisation phase. The buildings presented at least use renewable energy to supply their operation phase. All skyscraper projects use double glazed skin façade with aluminium structure but no one demonstrated that these structures were made with recycled metal. Hardly any architect demonstrated interest in the close-loop of building materials. The criticism is not about energy efficiency concerns on the operation phase of a building, but rather, is the concept of sustainability applied in the architecture. A building only can be sustainable if, for instance, uses rainwater, treats organic waste generated by people in the building, there is a close loop of materials, uses renewable energy and materials are reused or recycled among other factors. In the following sections it will be explained on the critical way the points that why the architecture produced nowadays is not be considered as sustainable.

The Bruntland report (1987) defines sustainable development as “development that meets the needs of the present without compromising the ability of the future generations to meet their own needs” pp 43. The ecological footprint is a “tool that enables us to estimate the resources consumption and waste assimilation requirements of a defined human population or economy in terms of a corresponding productive land area (pp 9)” (Wackernagel and Rees (1996). The ecological footprint is estimated in hectares and is related to the amount of productive land to meet the necessities of a defined population in a sustainable way, like the water consumption, forests, and agricultural land. In 1900, the ecological footprint for developed countries was 1 hectare per capita and in 1995 was between 3 to 5 hectares per person, (Wackernagel y Rees, 1996). These definitions have the aim to prevent large amounts of waste, pollution, lack of equity and the destruction of nature. In other words, a sustainable concept must focus on a fractal with ecology, economy and equity on the vertices of the triangle (Braungart and McDonough, 2008). The following sections will discuss the aspects related with the unsustainability of the architecture developed nowadays.
2. Characteristics of building unsustainability

2.1 Complex societies

Unsustainability is an old phenomenon. The resources shortage can lead to a collapse of a society. It was happened with the population of Eastern Island due to some factors like superpopulation and deforestation. Rees (2002) argues that colonization of Eastern Island started in the 5th century. After one thousand years of growth, the population of the island was estimated between 7,000 to 10,000 people and then the collapse started. Intensive deforestation, loss of pollinating birds and the increase of rat population were some of the causes to the decline of this society. In this sense, people did not have wood to make canoes and to maintain their needs of fish. Rats eaten the seeds, and shellfishes and chickens did not provide minimum conditions of calories for people island. In this manner, the population starts to decrease. The first European that arrived at the island in 1722, encountered people living in terrible conditions in shelters or in caves and the land was totally devastated. Malthus (1798) states in his book that population grows at geometric scale and food grows at arithmetic scale. As humans need food to live, the two sides of the equation have to be equal. Human population does not grow indefinitely, but there are growth limits that must be respectes, like food growth. Saura (2003) argues that grow of any species begin by a exponential curve and then drops when some limits, for instance, food, space or other type of resources, appear. Afterwards, this reduction stabilizes by the growth limits.

Rees (2002) still argues that technology is not the only way to solve society problems. In fact, Tainter (1995) states that there are more expenditure of resources in more complex societies to maintain them. Furthermore, the author argues that industrial societies are an anomaly. This is because human species has been living for 99% of their existence in small villages. The reasons for this are the high costs involved in large and complex societies. It is more difficult to solve problems when the complexity increases and significant results require more resources. Tainter (1995, p. 401) says that “there are, reasons to suspect that science is becoming less productive overall (…) because it has become increasingly specialized and expensive”. The reason is that for every advance in science much more resources are needed and the evolution of problem solving is smaller. One example is the US health care system in which the productivity of the system declined 60% between 1930 and 1982. First studies about diseases lead to penicillin which did not cost more than 20,000 dollars. From this point the costs necessary to cure other diseases rise too much. Furthermore, when complexity of diseases increases, costs rises too, nevertheless, the increment in life expectancy is smaller, Tainter (1995).

2.2 Problems of the economic system

The current economic system is based on pendulum like motion (cycles). If there is any decrease on demand or a crack, the economic process always returns to the previous condition, that is, in economy everything is reversible. According to this principle, the basic sequence is always a constant flow among production and consumption without taking into account external factors (Georgescu-Roegen, 1976). If this economic model degrades the nature by itself, the globalization has permitted
the acceleration of degradation. Jimenez (2008) emphasizes that globalization “looks for increase productivity and competitive advantages which give better mass consumption conditions, but does not focus precisely in meeting the real needs (…) and does not insure integrity of the natural system and its autoregeneration” (p 48). These competitive advantages are a result of a complex transport and fabrication logistics.

The capitalism makes the nature have a market value. In other words, nature can be purchased and the owner can do what he wants with the natural goods available on his territory. As people persecute profit, in theory, higher money quantity would represents higher satisfaction of individual needs. For instance, United States has a quarter of the world’s cars and today there are more particular cars then driving licenses (World Watch Institute, 2004). Wealth generates more consumption, which leads to higher materials production to supply the “needs” of people and it is necessary to extract natural goods from nature. Now, we are consuming high quantities of natural capital and nature is not capable to regenerate these natural goods to keep step with our current consumption and superpopulation. Marketing contributes to high consumption and says to consumers to satisfy their needs with new products which they often do not need. All this consumption increases the ecological footprint, which according to Latouche (2008 p. 41) “the planet already does not enough to all of us, it would be necessary to have 3 to 6 more planets to sustain our occidental way of life”.

2.3 Exploitation and material resources shortage

Construction industry is the sector which consumes more energy and material resources and the demand for these types of resources increases more and more (figure 1). The quantity of raw materials consumed in the United States only decreases when some crisis occurs. One of the 20th century crises was the First World War. Next, there was an increasing period of use of construction materials and then other crisis. At this time it was the America’s Great Depression in 1929. After this crisis, the consumption starts to increase and is decreased by the Second World War. Long time will pass until the oil crisis and recession in the United States come back to drop the consumption. What can be seen is that economy always operates in cycles with moments of high and low consumption. Nevertheless, after the Second World War, the materials consumption increased at rate of 3-4 times in 25 years, before the oil crisis.

The effects of globalization help to accelerate resources depletion. The global market has expanded 3 times in the last 20 years, while population has increased 30% at the same period. The carbon dioxide levels rise up to 30% during the industrial era and these are the highest levels in the last 160,000 years (IPCC, 2005). The economic activity nowadays does not help sustainability, because the market model promotes individualism opposite to collective values and equitable distribution. Globalization is a product of countries that have deficit in their ecological footprint, and need more cultivated earth from other countries to meet their necessities. These resources are extracted, manufactured and transported most of the time by multinationals and transformed in many parts of the planet with the aim of cost saving. For this reason developed countries adopt the neoliberal economy (Ress, 2002).
The scarcity of some metals reflects the high rates of extraction which leads to higher mining costs. So it is necessary to explore new mining sites but the mining operation can cause serious damage in the local environment, such as deforestation and contamination with toxic elements. Metal prices reflect well the mineral resources available nowadays. The availability of iron ore is high and therefore its sale price by tonnage is low. However, the less a material is available in concentrated rates, the higher is its price due to more investments necessary to extract a determined material. It occurs in a progressive scale with alumina, aluminium, copper, nickel and cobalt. As the mineral ore become rarer, its price tends to rise as well as the building costs. The closed-loop of materials will help to decrease the extraction levels of mineral ores, as well as to decrease the environmental impact of forests which are devastated by extraction.

As well as ferrous and non ferrous metals, cement and gypsum extractions are large too. Cement industry produces around 1.6 million metric tons of material, according to Cement Sustainable Initiative data (2008), which belongs to World Business Council for Sustainable Development. In the last year, almost 200 million metric tons of cement was produced only by Holcim (2008). Torgal and Jalali (2007), argue that Europe uses more raw materials in the construction industry than whatever other economic activity. The authors also state that more durable materials have higher useful life and consequently have lower environmental impact. Other issue is to treat the waste produced in some industrial activity as raw material for another type of industry. Cork is an example and, according to Eires et al (2007), it is a waste that is converted into raw material to produce wallboards with no structural applications.

2.4 Production of residues

Building construction generates a large quantity of waste. Larson (2007) argues that “pollution is a function of design”. This is because all contamination made by humanity is a result of much planning e.g. nuclear and other toxic wastes which can cause serious health problems. People need to be re-educated to avoid consumerism and the industries must change their products production processes. Wastes are produced constantly and with higher rates due to the increase of industrial era production and especially after the Second World War. The U.S. Environmental protection Agency (EPA) estimates that of all waste produced by construction industry, 92% is related to demolitions and
refurbishments (Franklin Associates, 1998). However, waste production in buildings begins in the
design process in which architects use mistaken concepts.

Mistaken concepts in the design of buildings can lead to utilize materials that are not necessary, such
as use a low emissivity coating made of metallic oxides on the glass curtain wall “to protect” the
interior of the building from infrared energy. Using transparent glass in smaller windows with
appropriated orientation can provide light and the same time reducing the heat gain or loss. Many
building materials are actually compound materials bounded together with resins or adhesives. This
compound materials are very difficult to separate and this do not help in the close-loop circle.
Braungart and McDonough (2008) state that these materials are manufactured following cradle-to-
grave principle where materials are discarded to landfills after complete their life-cycle. Moreover, the
authors argue that materials should be designed with cradle-to-cradle principle, i.e. treated as technical
nutrients for other building materials or biological nutrients for nature. The change is in designing
products thinking that products have some life expectancy and they will not exist forever. Nature is
the example of recycling. Architects must know that the artificial products must be recycled anyway.
It is a programmed mortality with conscious and maximum utilization of reclaimed or recycled
materials.

Many sustainable buildings use materials containing toxic elements, such as PVC, paints or
components with lead or cadmium. Mineral ore extraction and transformation into metal elements
release large quantity of hazardous substances into the air, water and land (Sarkar, 2002). These
elements can create poor indoor air quality into the building and can be potentially toxic for human
health (Calkins, 2009). Transport of building materials consists in another waste, i.e. carbon dioxide.
This residue results from the combustion of non-renewable energy resources and oxygen. Carbon
dioxide is one of the responsible for green-house effect that began in 1850 with the Industrial
Revolution and it has increased in the last years.

Other issue that contributes to the unsustainability in architecture is the demolition of a part or even
the entire building (Shaurette, 2006). Building demolition requires less time and less labour cost than
deconstruction. On the other hand, valuable materials are lost in the demolition process because
materials are all mixed. Deconstruction process can salve large quantity of materials and energy due
to carefully work in separating and salvaging the products. Designing buildings to incorporate
reclaimed components is the best way to reduce dramatically the environmental impact, but reclaimed
products have disadvantages too, such as: they are more labour intensive in identifying the source; no
equivalent market exists and design detailing can only commence after the purchase of the reclaimed
components (Addis, 2006). In this sense, the Design for disassembly (DfD) gives a way to anticipate
possible residues and to decrease then.

### 2.5 Energy saving

Reuse and recycling of materials permit to save energy. Building materials have already passed
though transformation processes requiring a lot of energy. Reuse and recycling materials contribute to
decrease embodied energy of materials with subsequent utilizations. In fact, the energy that is
necessary to reuse some material is very low, because a product does not need any additional
transformation, but only a suitable work before its reuse on site. Recycling has more complex
procedures, depending on recycling methods utilized. Nevertheless, the energy quantity necessary to
produce recycling materials is lower, respect to produce the same products with virgin materials.
Same as energy, reuse and recycling permit to reduce carbon dioxide emissions if compared to
manufacture processes with virgin materials.

Metals are a family of materials which have one of the highest recycling potentials. These materials
require much energy for its transformation since mineral ore to metal. But, when recycling factor is
included, the embodied energy of metal and carbon dioxide emissions are small comparing to a
conventional fabrication process (Berge, 2009). Another material, like glass follows similar recycling
rules, too. The difference is with laminated glasses, because there is a thin film of Polyvinyl butyral
(PVB) which is a resin used to join two panes of glass. PVB has to be taken from glass and than glass
can be melted again. Drywall panels are recyclable too, but paper must be taken out previously from
drywall (CIWMB, 2001). However, concrete can be downcycled into aggregates for new concretes.
Many studies have focused on concrete recycling because more than a half part of the building mass is
made of concrete (Hansen, 1992). Bricks can be reused (Martin, 2007). The brick separation methods
for reuse are manual and very laborious. Recycled bricks are used mainly as aggregate for new
concrete mixture. All of these and more options are alternatives to save energy and reduce carbon
dioxide emissions, furthermore, to contribute to the preservation of virgin materials.

2.6 Limited reuse and recycling standards

A difficulty that impedes the increase in reuse and recycling rates is the lack of politics and standards
favouring reutilization and recycling of building materials which continuously go to the landfills. The
European Union has a general standard related to residues since 1975. From then on, each European
Union Member State defines its own standards, as it can be seen in the first considerations of the last
approved standard related to residues 2006/12/EC. In the United States, some States are more
advanced than others, in relation to standards about reuse and recycling of construction and
demolition materials (Martin 2007).

Spain has a directive about residues of construction and demolition since the year 2008. One of the
characteristics of this directive is to difficult the disposal of construction and demolition wastes into
the landfill without previous treatment by increasing the landfill taxes. The directive establishes
producer responsibility obligations of the construction and demolition wastes which is intended as the
building client. The holder of mentioned wastes is the agent who generates and controls these
residues. The producer of the waste is responsible for “the inclusion of a management study of
construction and demolition waste that will be produced on site” (pp7724). This directive establishes
general conditions for waste managers and the correct sorting and assessment of waste. It also shows
the minimum amounts of waste which are necessary to sorting - 80 mt for concrete, 40 mt for
masonry, and ceramic tiles, 2 mt for metals, 1 mt for wood products, 1 mt for glass, 0.5 mt for plastics
and another 0.5 mt for cardboard. The sorting applications of this directive are valid from 2010.
Europe and United States have standards that provide guidance rather than specific criteria of how to recycle these materials. It does not make much sense sorting a specific type of waste if there is no facility to treat such residue. For instance, the plastic recycling facilities in Catalonia, Spain do not accept any building construction and demolition post-consumer waste. The reason pointed out by the recyclers is that the post-consumer waste comes with a lot of contaminants and with many different formulas. The International Organization for Standardization (ISO) has standards related to the environmental labelling, but there are few products that already have such label in comparison with the total number of building materials available in the marketplace. The ISO 14020 standards are limited related to the reuse and recycling contents because many products can have the eco-label without having any recycling content in the product itself.

### 2.7 The problem of new housing

Housing has the main function to serve as a shelter, to protect from the environment and to meet the basic family needs. Housing can be seen as an income alternative and investment. However, housing must respond to demographic demand and economic value has influence in the number of housing units built. Earth’s population is growing constantly. Up to the year 2000, almost 116 million houses in United States were built (U.S. Census Bureau, 2000). Figure 2 shows the evolution of houses built in The United States between 1968 and 2007. Only to have an idea of houses built, almost 2 million houses were completed in the year 2006.

It is interesting to note that the cycles of rise and fall of number of built houses coincide with the crises periods. These crises periods are shown in figure 1 which are related to the raw materials consumed in The United States. In de 1970’s there is a drop proportioned by the oil crisis, which affected a lot the construction industry. The 1980’s and at the beginning of the 1990’s coincide with the recession in The United States. At this point the number of houses built increases each year, with a significant drop in 2007 possible due to the financial crisis. It can be seen too that single family houses dominates the total numbers of built area.

![Figure 2](image.png)  
Figure 2 – Relation of total houses built and total of single family and multifamily houses completed in The United States among 1968-2007. (U.S. Census Bureau, 2008).
Even though the number of built buildings dropped in the last years; the number of apartments per building has increased as well as the apartment area. For instance, in 2007, 284,000 multifamily buildings were built. The average number of apartments was 32 and the average area was 109 m² (U.S. HUD, 2008), which results in 993 million square meters of housing for multifamily buildings. On the other hand, the great number of single family houses multiplied by average area of each house corresponds to 267 millions square meters, which represents 27% of total built area. The total area of houses built in 2007 was 1,260 million square meters. It can be imagine the environmental impact that will be produced by the consumption of energy and materials resources and the production of large amounts of residues for new housing construction.

Other aspect is the housing deficit and the worst levels are in developing countries. According to the Ministry of Cities of Brazil, it was necessary about 8 million of new houses to supply the demand until 2008. This value does not count with the future population. According to Brazilian Institute of Statistics, IBGE (2008), Brazil has more than 56 million houses built. The sum of Brazilian houses among 2001 to 2007 is 11.5 million houses. The sum of United States houses in the same period was 12.1 million units. In other words, Brazil builds almost the same amounts of houses as United States.

According to the Ministry of Housing of Spain, this country has 24.5 million houses built until 2007 and reaches the maximum amount of houses built in 2006 with 650 thousand units. The average area of these houses in Spain is 76 to 90 square meters (INE, 2002). The total area built passed from 59 million square meters in 2001 to more than 84 million square meters in 2005 (The Second National Plan of Construction and Demolition Wastes of Spain - PNRCD, 2006). This represents an increase of 50% of total area built in Spain only by houses. Nevertheless, there was no significant increase respect to the average area of homes. In fact, there was a decrease of area of multifamily houses.

The Federal Ministry of Transport, Building and Urban Affair of Germany (BMVBS) estimates that Russia will have to build 25 million houses until 2025 to supply the demand of that country. The amounts of houses built in United States, Brazil y Spain annually summed can be estimated as been 3.9 million per year. All this quantity of new construction houses in only 3 countries. All houses that will be built will create a large amount of residues. Furthermore, the population growth will increase the demand for new houses and consequently for energy and materials resources.

3. Final considerations

From the previously exposed it can be observed that energy and material resources are currently exploited at higher rate. Aggregates are material resource of major use in building construction and are easily encountered; however, metals are more concentrated. Extraction and manufacture of these products produce waste, as well as the transport which releases carbon dioxide and can contaminate the air, water and soil. The Earth is a finite system, in turn, the economic system is based on continuous growth within a finite system. More standards and policies are necessary to diminish the environmental impact of construction industry. A few of them has been made until now in standard issue that effectively help to decrease the energy and material resources consumption. Apart from this, the existent standards are conservative.
Materials reuse and recycling is a way of preserving material resources and decreasing the amount of waste. The best option is to reuse old materials, because of energy that is saved and because it prolongs the materials' life-cycle. Recycling requires much more energy than reuse, since recycling utilizes industrial processes to transform old materials into new ones. However, materials like concrete or masonry do not have recycles but rather have downcycles, because these products can not be remanufactured in the again like metals. This same principle is valid for compound materials due to the difficulty to maintain the high quality in the separated layers. These materials neither serve as industrial nutrients nor as biological nutrients.

Populations will growth in the coming years and the demand for housing, energy and materials will increase too. So, the demand for resources will rise if the today’s parameters are maintained. The majority of the so called sustainable buildings use virgin materials and almost the same materials as a conventional building. Therefore, the architecture made today is far from being considered sustainable. The enormous resources used and waste created are witnesses of unsustainability.

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Programming Practices of Large-Scale Public Building Projects by Construction Professionals and Clients in China

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Abstract

To better understand the characteristics of event-led large-scale public building projects (LSPBPs) and affiliated challenges at the initiation stage, the current trends in programming practices of both conventional and eventized LSPBPs need to be explored. For this purpose, a questionnaire survey was conducted, whose conceptualization coincided with the release of two LSPBPs-related official documents jointly issued by five Chinese state ministries in 2007 and 2008. Aiming at identifying the achievements and drawbacks in programming practices of LSPBPs from the perspective of construction professionals and their clients, the survey is by far the first of its kind in Mainland China, and also constitutes a key component of the ongoing case studies of the “Big4” LSPBPs initiated by Expo 2010 Shanghai China.

In-depth findings of 57 respondents actively involved in the “Big4” Expo projects and other LSPBPs are analyzed in full details. Especially documented is detailed information on a total number of 90 LSPBPs in which respondents had hands-on inputs in various scopes and standpoints during the programming stage. Starting mainly from 2000 to early 2009, these cases offer a miniature of the dynamic market of LSPBPs. The survey results in general reveal the significant gaps between the real performance by the practitioners and the best practice prescribed in the two government documents. Among others, the finding that a majority of the programming services were not separately billed corresponds to the respondents’ feedback regarding the current market trends. It is concluded that the concentrated problems identified in the survey are closely related to the public clients who have profound impacts on LSPBPs at the initiation stage.

Keywords: programming practice, LSPBP, the initiation stage, client impact, questionnaire survey
1. Background and latest development

Since the 1990s, fixed-asset investment in Mainland China has consistently maintained around 38% of GDP - a much higher figure than the world’s average (Li, 2002). A significant portion of the amount is devoted to large-scale public building projects (LSPBPs) whose initiation issues always high on the agenda of all concerned parities, which forms the broad context of the questionnaire survey on the programming practices of LSPBPs on which this paper centers.

1.1. Joint-issuance

Despite the great magnitude, LSPBPs have never been officially defined until the release of Several opinions on strengthening the administration of large-scale public building project construction ("Several opinions") (Ministry of Construction, et al., 2007). As a milestone in the construction industry, this long-waited document was jointly issued in early 2007 by five state agencies, aiming to impose tougher controls over the development of LSPBPs. A year later, Ministry of Housing and Urban-Rural Development (MOHURD)1 (2008) issued an updated version of The provisions of schematic design bidding for construction projects ("The provisions"). What is worth thinking is why the development of LSPBPs triggered such an unusual coordinated effort among the nation’s top regulators.

1.2. Beneath the definition

According to Several opinions (2007) and The provisions (2008), LSPBPs are termed as office, commercial, tourist, science, education, cultural, health, communications and transportation buildings with a threshold floor area of 20,000 sq.m. Mostly funded by the public sector including government agencies, state-owned enterprises or the combination, the development of LSPBPs is characterized by a higher level of government involvement than that of most other buildings developed by non-public clients. This high-profile government element largely explains the drive behind the joint-issuance with this scope and on this scale. It conveys a clear message to the industry that the development of LSPBPs cuts across a wide range of domains and therefore demands for coordinated cross-agency supervision.

1.3. Content highlights

While Several Opinions (2007) aim to review the past performances of LSPBPs, identify concentrated problems, and make recommendations for improvement, The provisions (2008) revolves around institutionalizing the bidding activities and enhancing the design quality. In Several Opinions (2007), pressing issues commonly found in government-funded LSPBPs concentrate on ‘image building’ mania, resulting in an undue emphasis on building appearance, a deliberate ignorance of cost issues and other key factors in play, and a lack of appreciation of the local historic and traditional features. In view of this, it stipulates that the number, scale and construction standards of LSPBPs

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1 Ministry of Housing and Urban-Rural Development is previously known as Ministry of Construction.
shall be subjected to national and regional economic constraints. Moreover, a whole range of corrective actions are to be taken, with a special emphasis on the strategic decision-making process in the initiation stage. As these issues are also closely tied to competition architecture out of international design competitions, MHURD began to keep a tighter rein over the operational procedures of design competitions through the issuance of *The provisions* (2008). Major prescriptions include the supplementation of a series of specific reports on functional performance, energy-efficiency, construction and operational costs to the design bidding documents, the introduction of a balanced pool of interdisciplinary experts into the design review jury, an increase in bidding transparency through public consultation, and a restriction control over unnecessary international design competitions.

### 2. Questionnaire survey

#### 2.1. Significance and objective

Through the content analysis, the significance of the initiation stage manifests itself. As a crucial part in this stage, programming is to identify project opportunities and constraints, investigate and communicate project requirements among all stakeholders, and develop a well-thought-through program statement as the guidance of a proper design solution and as a constant yardstick against the built product. As discussed in a preceding paper (Deng & Poon, 2009), event-initiated LSPBPs are characterized by un-ambiguousness in deadlines, sophistication in systems, dualism in programs, temporariness of organizations, poor knowledge management and lack of institutionalization. All these challenging issues drastically increase the difficulties in the programming processes. Although some challenges are exclusive for event projects, others are global, which leads to a need to depict a broader picture of the current programming practices of LSPBPs in both conventional and eventized scenarios.

To this end, questionnaire survey is employed for its extensive use in programming studies outside Mainland China, e.g. Preiser (1993), Bowen (1997), Brown (2001), Kelly et al. (2005) and Shen and Chung (2006). However, a major drawback in the ‘broadcast’ survey approach lies in its oversimplification of the client organization (Cherns & Bryant, 1984), resulting in an underestimation of the client leadership and influence. To overcome such deficiency, this questionnaire survey stays focused on a representative of highly-relevant respondents to guarantee its pinpoint accuracy. As the first of its kind in Mainland China so far, it was conceptualized to triangulate the case studies on the Big4 LSPBPs initiated by Expo 2010 Shanghai China, and coincided with the release of the aforementioned government documents. In order to address those highlighted issues, it is necessary to identify the discrepancies between the best practice and the real-life performance. Hence, the survey’s main objective is to investigate, from both sides of the industry - construction professionals and their clients, the current achievements and drawbacks in programming practices of LSPBPs.

#### 2.2. Data sources

With a clear objective in mind, the next step is to locate the right survey base and respondent group. Major projects often come along with major cities. In 2009, investment in the planned 86 major
construction projects would reach CNY155 billion (USD22 billion), which justifies Shanghai as an ideal place to offer a wide ranges of choices in projects. In 2006 as the beginning year of China’s 11th-Five Year Plan, Expo projects became the central priority of all municipal-level major construction projects (Shanghai Urban Construction & Communications, 2006). Therefore, it is convenient to make direct contact with intended respondents in the city as the meeting ground for domestic and overseas construction professionals and their clients involved in both Expo projects and many other significantly comparable developments.

For a sampling survey, four major issues still concern respondent selection. (1) The design procurement process of LSPBPs is highly selective. The contractor-winners usually belong to a limited number of large and interdisciplinary practices experienced in handling sophisticated design tasks. It is therefore rational to seek respondents from these veteran players to ensure survey validity. (2) As frequent orchestrators for government-funded LSPBPs, public-sector clients are influential in the formative stage. Given this, unlike some previous surveys aiming unilaterally at construction professionals, this survey will also listen to the story from their clients. Key client members in the Expo project system will also form an indispensable part of the respondents. (3) Senior staff members usually have a better chance to establish early contacts with their counterparts, thus getting a better understanding of the whole scene than their junior colleagues who only come in place subsequently and have to rely at least partially on second-hand information for implementation. As the driving forces at the initiation stage, respondents with decision-making authorities and hands-on experience will make a predominant presence. (4) As Chinese is the sole official language for most project documentations and prevails in bilingual versions for international competitions, overseas firms usually count on in-house Chinese colleagues for project information and communication. In view of this, Chinese staffs are preferred respondents from intended overseas firms.

Based on the above criteria, there exist a limited number of qualified respondents, which in turn justifies the use of representative sampling. In January 2009, the questionnaires in Chinese and English versions were distributed to 100 staff in 11 large agencies involved in both Expo-led and other conventional LSPBPs. By the end of March, 65 samples were returned with 57 valid ones. Among the three public clients, one is from the government sector and the other two from the business sector, all of which are pillars of the Expo projects as well as powerful players in the development of other major LSPBPs. Among the eight large design practices, five are domestic institutes listed on *The Top 60 Chinese Design Firms for 2008* (ENR, 2009), with one ranked in the top five and two in top 20. The three overseas firms are also ranked among *The Top 500 US-based Design Firms for 2008*.

### 2.3. Major findings

The framework of the questionnaire is presented in Table 1. Data was collected by the use of structured questions. Among the 26 enquiries, 14 (54%) are close-end, 10 (38%) semi close-ended and the rest two (8%) open-ended. Summary of major findings are presented in the rest of this sector.
Table 1 Questionnaire framework

<table>
<thead>
<tr>
<th>Composition</th>
<th>Scope of enquiry</th>
<th>Purpose of enquiry</th>
</tr>
</thead>
</table>
| **Part 1** (Q1-7) | **Respondent profile**  
- Length of job experience  
- Diversity of job experience  
- Recent involvement in LSPBPs (number)  
- Programming learning channels | **To validate the respondents’ relevance to LSPBPs** |
| **Part 2** (Q8-14) | **Overview of programming**  
- Professional performance  
- Academic supply  
- Educational provision | **To identify the performance gaps** |
| **Part 3** (Q15-18) | **Perceptions of programming practices**  
- Value  
- Status  
- Fee | **To investigate the attitudinal aspects of programming practices** |
| **Part 4** (Q19-20) | **Design competitions and its programs**  
- Determinants for competition results  
- Typical syndrome of program deficiency | **To identify the most significant problem areas** |
| **Part 5** (Q21-25) | **Formation of program**  
- Method in use  
- Benefit (short-term, long-term)  
- Attitude (seeking response to a typical dilemma) | **To identify communication gaps between the design team and the client organization in the programming process of LSPBPs** |
| **Part 6** (Q26) | **Programming cases**  
- Project profile (location, type, scale, attribute)  
- (regular or event-led), length of formation period)  
- Client profile (ownership, proficiency, organization)  
- Competition format (scope, stage)  
- Frequency of significant program changes  
- Communication method  
- Fee issue of programming services | **To indentify the current trends in programming practices of LSPBPs** |

### 2.3.1. Part 1 – profile of respondents

As the way people handle projects is largely determined by their background and experience (Usmani & Winch, 1993), respondents’ profiles were investigated in four major dimensions as specified in Table 1.

![Distribution of respondents by position](image)

Figure 1: Distribution of respondents by position

Results show that each respondent was at least involved in one LSPBP between 2003 and 2008. Fig. 1 shows that most (74%) held senior positions at the time of the survey. Noticeably, six (11%) claimed to have been involved in 50 to over 100 LSPBPs, which is well above the range from one to 20. Fig. 2 indicates the diversity of respondents’ job experiences. No “pure” programmer was
found as the three respondents who ticked this job title also chose others. Fig. 3 demonstrates that 66% respondents received programming education or training, while 34% never did. Specifically, 16% received such knowledge from school education and 23% from vocational training. Other channels include project experience, brain-storming events, external consultation, public lectures, training programs, literature research and self-teaching.

Fig. 2 (left): Respondent distribution by job title (person-time)

Fig. 3 (right): Distribution of programming learning channel (person-time)

2.3.2. Part 2 - programming performance

In the second part, a general picture of the current programming performance of LSPBPs is sketched out in terms of professional service, academic supply and educational provision. Most respondents (89%) considered that the current market for programming is “on the rise”. The same high rate supported the view that the future market looks promising; while over half of the respondents (58%) casted doubts on the sufficiency of the current professional supply. In marked contrast, respondents predominantly (95% and 96% respectively) took a very dismal view of the current provision of literature and education. These findings are further corroborated by three facts. The first concerns the scarcity, if not a total absence, of academic contributions on programming from Chinese researcher community. The second is the paucity of available overseas publications (in both original and translated versions), as compared to an enriched literature pool outside Mainland China. The third is the lack of the appropriate guidance from the government regulators or professional institutions.
To better understand the impacts of programming beyond the initiation stage, respondents were then asked to rank five given after-effects which may backtrack to the problematic early-stage programming process. Fig. 4 ranks them by number of votes each ‘syndrome’ received, with “major design revision” in the first place, followed by “outstanding cost overrun”, “serious operational problem”, “serious cooperation problems” and “serious construction delay”.

### 2.3.3. Part 3 – value, status and fee of programming

To investigate the attitudinal receptiveness of programming among industrial insiders, opinions were sought regarding the value, status and fee of programming. Four statements were given for evaluation, (1) “Programming should be added as a link between planning and design”; (2) “Programming is critical along the project cycle”; (3) “Programming has not yet gained enough attention it deserves”; and (4) “An additional fee for the programming service shall be charged”. Fig. 5 shows a one-sided result as an average 87% favored for all four statements.

### 2.3.4. Part 4 – design competition and its program

Respondents were asked to rank by order of priority six potential determinants affecting the outcome of design competition. The first-choice ranking according to the number of votes is: 1st-“Program quality”; 2nd-“Project/client prestige”; 3rd-“Jury composition and design review process”; 4th-“Remuneration/prize reward”; and 5th-“Bidding time”. Respondents were also required to grade, according to their own experience, in descending order the applicable problems in competition programs - the primary vehicle for design competitions and the fundamental criteria for design review. Eight most recurring problems are typified to be ranked by frequency of occurrence from high to low. The result by order of the first-place ranking is listed below.

1. Too generic or too trivial in project requirements.
2. Lack of priority, clarity or consistency in the occupancy requirements.
3. Lack of site suitability or adequacy.
4. Ignorant of, or in conflict with regulatory planning requirements.
5. Only a space list, lack of the client’s idiographic values and objectives.
6. Unachievable budget or inadequate cost estimation.
7. Insufficient required gross floor area (GFA) resulted from miscalculation or inconsideration of net-to-gross area ratios of different building types.
8. Unachievable project schedule.

2.3.5. Part 5 – formation of program

An overwhelming majority (91%) supported that the professionals should help their clients in the process of programming. Among the three given choices of justifications, 81% respondents agreed that by doing so, it can realize the short-term objective to “better determine the client’s requirements to assure design efficiency and quality”; while 53% considered the benefits can also be long-lasting as to “build up a long-term reciprocal relationship with the client through the process” and to “help win the trust and respect from the client, thus having greater say in the process of design decision making”. Regarding programming methods in use, the ranking of six given choices by order of popularity is shown in Fig. 6, with “study visit” in first and “literature search” in last. However, the gap between each adjacent standing is insignificant, ranging only from three to six votes, which indicates a proportionate balance among a range of methods. About 2% of the responses belonged to “other” category, including external consultations of governmental or professional agencies; market analysis; multiple-scheme comparison and selection.

![Fig. 6: Frequency of programming methods in use](image)

To identify communication gaps between the design team and the client organization, respondents were asked to provide answers to a chicken-and-egg situation: when some project requirements are in need of immediate clarification for the design team but cannot be easily confirmed by the client organization, from their own position (i.e. either as a client or as a designer). The outcome turned out to be unexpectedly and interestingly insightful. Among the 63 pieces of advice received, 20 were from the client perspective and 43 the designer perspective. Worth noting is that advice from the client perspective is NOT necessarily from a client respondent, and vice versa. Significantly, 16 respondents replied in the other party’s “shoes” and 16 provided solutions from both perspectives.

2.3.6. Part 6 – programming cases

To identify the pressing challenges in current practices, information of LSPBPs were sought from respondents with their own inputs. Data of 90 projects were collected in multiple dimensions as listed in Table 1. Mostly developed from 2000 to early 2009, these LSPBPs were located in 25 mega- to medium-cities, 65% of which came from the four municipalities - Beijing, Tianjin, Shanghai
and Chongqing. New constructions accounted for 79%, while 12% belonged to adaptation/renovation and 9% extension development. Most (74%) occupied a gross floor area of 50,000 sq.m or above. About one third were initiated by events and the rest were regular developments. More than half (56%) of the 16 documented types were mixed-use ranging from two to four combinations of the basic types in the official definition of LSPBPs.

Client profiles are investigated in terms of ownership, proficiency and organization. Government and corporation clients had an absolute presence of 97%. Fig. 7 shows that 47% clients were either experienced or regular/repeated, and the rest 50% first-timers. As for organizational structure, 81% clients were single-headed and 19% multiple-headed. Among the 90 LSPBPs, 88 (98%) went through design competitions of which 64% were in invited format, leaving only two through no-bid contracts. As shown in Fig. 8, international and domestic competitions almost equalled each other in the 88 LSPBPs, which confirmed the concerns over the proliferation of international competitions in the two government documents.

Fig. 7: Distribution of 90 projects by client experience

Fig. 8: Distribution of 88 projects by design competition format

Fig. 9: Distribution of 90 projects by billing format of programming service
The result of the billing issues remains similar to Preiser’s finding (1993, p. 12) that respondents exhibited a tendency not to be bill for programming separately. In this survey, only 30% programming services were billed, either as part of the design service or as a separate consulting service, as shown in Fig. 9. This figure (30%) is in sharp contract with the feedback that 82% respondents supported the institutionalization of billing the programming service separately, thus strengthening the argument that programming is still seriously undervalued by the market. In terms of the composition of the programming team, Fig. 10 reflects the ranking of its members by presence frequency. Results show that “Client representative” (78%) came in the first place, while “Architect” (76%) scored much higher than other professionals such as Urban planner, Building economist and Engineer. Worth noting is that “User representative” maintained fairly low ranking at merely 14% presence rate in the programming team.

3. Concluding remarks

Table 2: Comparison between the best practice and the real performance

<table>
<thead>
<tr>
<th>Project Initiation Stage</th>
<th>Key Performance Interface</th>
<th>Area of Deficiency /Potential risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Appraisal Feasibility</td>
<td>What the client should do?</td>
<td>The top two ranked problems in competition programs:</td>
</tr>
<tr>
<td></td>
<td>• Seeking experts’ advice</td>
<td>• Too generic or too trivial in project requirements</td>
</tr>
<tr>
<td></td>
<td>• Clarify project requirements</td>
<td>• Lack of priority, clarity or consistency in the occupancy requirements.</td>
</tr>
<tr>
<td></td>
<td>• Determine critical technical and economic parameters</td>
<td>Ambiguity in requirements indicates a deficiency in feasibility study.</td>
</tr>
<tr>
<td>Planning Control</td>
<td>What the architectural design should conform to?</td>
<td>The 3rd and 4th ranked problems of competition programs:</td>
</tr>
<tr>
<td></td>
<td>• Approved master plan</td>
<td>• Lack of site suitability/ adequacy.</td>
</tr>
<tr>
<td></td>
<td>• Detailed regulatory plan of the specific site</td>
<td>• Ignorant of, or in conflict with regulatory planning requirements.</td>
</tr>
<tr>
<td></td>
<td>• Urban design of the site</td>
<td>A gap between the planning and design may give rise to a later zigzagging rework.</td>
</tr>
<tr>
<td>Design Competition Competition</td>
<td>• Which format to adopt?</td>
<td>Actual ratio between international and domestic competitions:</td>
</tr>
<tr>
<td></td>
<td>Domestic rather than international design competitions are encouraged and shall be the first choice when possible.</td>
<td>48%: 51% (Almost each other, with highest profile design competitions always in invited format and of international reach).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>One of the major catalysts for ‘image projects’ craze.</td>
</tr>
<tr>
<td>Design review:</td>
<td>Which actions to take?</td>
<td>Problems revealed by respondents:</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td></td>
<td>• Prioritize weighting and specify requirements.</td>
<td>• Lack of a clear-described review procedure and evaluation criteria.</td>
</tr>
<tr>
<td></td>
<td>• Setting up transparent mechanisms for jury review.</td>
<td>• Ambiguous requirements for the final deliverables.</td>
</tr>
<tr>
<td></td>
<td>• Clarify the requirements and accountability of jury.</td>
<td></td>
</tr>
</tbody>
</table>

As the first of its kind in Mainland China, the questionnaire survey offers a miniature of the current programming practices of LSPBPs by construction professionals and their clients. Accordingly, a series of significant gaps are identified between the real performances by the practitioners and the best practice expected from the regulators. To clarify, a point-to-point comparison is made in Table 2 between key issues highlighted in the two guidance documents and the pressing problems revealed in the survey outcomes. How to narrow these gaps deserves much deeper thoughts and wiser strategies. Despite the high-profile issuance and clear-cut determination, the two government provisions have yet to offer any substantially detailed operational approach. How all lofty objectives can be incorporated into everyday practices remains a priority enquiry for researchers, practitioners and public clients.

There are both similar and contradictory results regarding programming methods used by respondents in this and previous surveys. Interestingly, “literature search” was ranked the last in both this survey and Preiser’s (1993). In this case, the paucity of literature and the unsatisfactory quality in education helps explain why practitioners preferred NOT to act by book, as well as why only 16% of respondents gained the knowledge of programming from school education. Although research findings continue to show a strong correlation between early-stage performances and building sustainability, the inputs at the very beginning are still scarce, evidenced by the intuitive and unstructured programming practices over years in many different countries. This seriously challenges the effectiveness of the existing academic contributions, which in turn deserves much attention of the research community worldwide.

By contrast, “study visit to similar projects” was ranked the least preferable in Preiser’s survey (1993), but the most popular in this one. A possible explanation is that in Mainland China, such visits are oftentimes arranged separately by the clients and the designers before the awarding of the design contracts; and co-arranged by both parties during the early-stage of the post-contract period when project requirements become more clarified and may therefore result in significant changes. Aside from its effectiveness, it indicates the significance of building up client-designer relationship through various communication channels at the early stage.

Regarding how to solve the dilemma in clarifying the client requirements during the early stage, the unexpected high volume of comments from the opposite side exposes potential differences in perception and suggests room for improvement on both sides. As almost any exchange of the client requirements needs to pass through the interface of programming (Brown, 2001), both sides should make best of this communication platform by looking for more effective approaches to enhancing mutual understanding in “resolving the problems of interdependent decisions” (Crichton, 1966).
The issue of additional fee for programming service comes in the spotlight again in this survey as 70% of the programming services remained unpaid. While most respondents acknowledged the significance of programming, the irony lies in that much fewer clients in reality were willing to pay the bill, despite the insignificance of the amount. Although perceived as a growth area by most respondents from both sides, services provided do not necessarily attract monetary rewards, which will certainly dampen the motivation for enhancing the service quality. This puts the designers into a dilemma between responsibility and profitability, thus strengthening the conventional wisdom that the design portion is a natural profit center while the pre-design portion merely a cost center.

As for the programming team, the client organization not only takes the lead in presence rate, but largely determines its structure and membership, which is no easy job if the scope of the project and the complexity of the its own organization are taken into consideration. There has been much criticism to ‘government official choice’ or ‘sponsor choice’ in major project decision-making. However, it should not be forgotten that intensive client involvement in establishing a good program is in proportion to the standard of service provided (Barrett, 1992). How to make this client impact a positive driving force in the project initiation stage is worth more serious investigation. As noted by Sir Latham, “implementation begins with clients” (Latham, 1994, p. vii), it is up to the public clients who initiate the LSPBPs to take the initiative in narrowing the gaps between ideas and reality in a high-profiled manner.

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Adaptive Management in the Building Sector: The Curious Case of Traditional Buddhist Temples

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Abstract

Adaptive management (AM) has been successfully used for the management of natural resources and environmental initiatives. Even though AM has had an important impact on various fields such as landscape, geography and ecology, its influence in the management of construction projects remains limited. AM is an iterative process of optimal decision making in the face of uncertainty, aiming at reducing it over time via system monitoring. It seeks to improve decision-making processes and management methods by learning from the outcomes of decisions previously taken within the same project. It is based on “learning by doing” and it usually includes increased strategic flexibility, adaptation to uncertainty and avoidance of irreversible decisions. It also helps to avoid some of the problems traditionally associated with the standardized practices of project management framed and supported by professional associations, which we identify here as Professional Project Management (PPM). Wysocki (2003) has found that the PPM works best when both the goal and the solution are clearly defined, but it is less appropriate when the goal is clearly defined but how to reach that goal or the solution - is not. Instead, AM is particularly useful for situations of increased uncertainty.

This ongoing research project seeks to identify the characteristics, the advantages and the limits of AM, and to examine its use in construction projects. The empirical study is conducted in locations where professional project management has had little influence over rooted practices of project development based on AM. This article presents the preliminary research results based on the detailed examination of two construction projects of Buddhist temples in Buryatia. The preliminary results highlight the advantages of AM in complex construction interventions and illustrate how adaptive management incorporates the process of learning into the management approach, and how this learning is used on following iterations to significantly reduce project risks and conflicts.

Keywords: adaptive management; project management; iterative decision-making; project performance
1. Introduction

The objective of this article is to identify the characteristics, the advantages and the limits of Adaptive management (AM), and to examine its use in construction projects. The study includes the differences between AM and the standardised practices of project management, as identified (among others) by Williams (2005), who refers to them as “conventional PM”. Because these practices are often framed and supported by professional associations, we prefer to use the term Professional Project Management (PPM). In the first section of the article, we explain that AM includes a number of organizational principles, such as iterative development and avoidance of irreversible decisions, which are less stressed by the PPM approach, notably by the approach described by the PMBOK (PMI, 2008). In the second section, we explain the empirical methods used for the study. The third section explains the preliminary research results, particularly the two case studies conducted in Buryatia. The last section discusses the results and “opens the door” to further areas of research.

1.1. Comparing PPM and AM

According to Williams (2005), PPM identifies a sequence of stages in the project life cycle. These stages often include: i) project initiation, ii) project planning, iii) project execution, and iv) project completion (PMI, 2008). The process includes complex control systems based on standardised practices of monitoring and risk management (Susilo, 2007; PMI, 2008). While the terms may differ from industry to industry, the actual stages typically follow the common steps to problem solving: defining the problem, weighing options, choosing a path, implementing the solution and evaluating the outcomes. The implicit goals of PPM are to try to eliminate uncertainty, identify risks, predict impacts and aim for a stable-state system varying as little from baseline conditions as possible (Noble, 2000). Lawson and al. (2003), Mitchell (1997) and Noble (2000) show that this approach works well for well defined projects, but often fails in projects of ambiguous nature. While the PMBOK (PMI, 2008) proposes high levels of standardization in organization and project management, AM offers less standardized procedures to cope with project uncertainty. Table 1 summarises some of the differences between PPM and AM, as they have been discussed and presented by previous authors.

Originally developed by ecologists in the 1970s as “Adaptive Environmental Assessment and Management” (AEAM), AM has become a powerful tool for project management. AM is defined as “a collection of concepts, techniques, and procedures intended for the design of creative resource management and policy alternatives” (Noble, 2000, p.98). It was initially a response to Environment Canada’s intention to examine the potential use of systems modelling for environmental management. In fact, resource management and management of environmental systems have high levels of uncertainty, and often the most carefully crafted plans and policies are inappropriate (Mitchell, 1997). AM was then proposed by a group of ecologists who introduced the idea of adaptive resource management and “learning by doing” (Holling, 1978; Walters, 1986). However, while simulation modelling was the principal focus of this investigation, the scope quickly became much broader (Jones, 1985) and project managers in other fields (information technology, product design, organizational management) started to take advantage of the adaptive approach (Chiva-Gomez, 2004;
Palmberg, 2009; Susilo, 2007). We discuss below some of the most important characteristics of AM, notably its approach to change, uncertainty, failure and the project organization.

**Approach to change:** AM is based on the notion that planning and management benefit from adjustments to changing events, decisions, and circumstances (Mitchell, 1997). Conceptualizing interventions and expecting to modify them based on knowledge gained from changing events is the basis of this approach. AM encourages planners and managers to make decisions with the expectation that they may be incorrect, but that the experience and lessons gained from lesser successes can allow them to benefit and improve existing and future policies and practices (Mitchell, 1997).

Table 1: A comparison of APM and PPM core-values:

<table>
<thead>
<tr>
<th>Variables</th>
<th>APM</th>
<th>PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most important fields of development:</td>
<td>Environmental management, ecology, landscape (Kato, 2008; Mitchell, 1997; Rammel, 2007)</td>
<td>Information Technology (IT), construction, health care, etc. (Moore, 2002; Saunders, 1992)</td>
</tr>
<tr>
<td>Important guides and publications:</td>
<td>Adaptive environmental assessment and management (Holling, 1978); Panarchy: understanding transformations in human and natural systems (Gunderson, 2002); Adaptive management of renewable resources (Walters, 1986)</td>
<td>Project Management Body of Knowledge (PMI, 2008); Project Management Body of Knowledge (APM, 2006); Code of practice for project management for construction and development (Chartered Institute of Building, 2002)</td>
</tr>
<tr>
<td>Approach to uncertainty:</td>
<td>Adaptation and change (Palmberg, 2009)</td>
<td>Standardisation of procedures and methods (Moore, 2002)</td>
</tr>
<tr>
<td>Ultimate focus:</td>
<td>Client-focused (Wysocki, 2003)</td>
<td>Project-focused (Walker, 2007)</td>
</tr>
<tr>
<td>Decisions in the time scale of the project:</td>
<td>Based on incremental results early and often (Virine, 2008)</td>
<td>Policy decisions through short and long-term empirical studies (Kerzner, 2003)</td>
</tr>
<tr>
<td>Approach to the problem:</td>
<td>Proactive approach: supported by continuous questioning and introspection (Virine, 2008)</td>
<td>Often based on reactive approaches: controlled failures are not accepted (Naoum, 2001)</td>
</tr>
<tr>
<td>Approach towards change:</td>
<td>Changes are regarded as a progress to a better solution (Lawson, 2003)</td>
<td>Little changes, inflexible implementation (Bennett, 1983)</td>
</tr>
<tr>
<td>Life cycle:</td>
<td>Mostly iterative (Berman, 1980)</td>
<td>Mostly linear and sequential (in construction activities) with some iterative processes of design and planning (Moore, 2002)</td>
</tr>
<tr>
<td>Reference of performance:</td>
<td>Correct previous mistakes and adapt to new changes (Noble, 2000)</td>
<td>Respect of Quality, Schedule and Budget (Saunders, 1992)</td>
</tr>
<tr>
<td>Approach to decision making:</td>
<td>Making decisions that will have to be adjusted and corrected (Mitchell, 1997)</td>
<td>Making appropriate decisions (Kerzner, 2003)</td>
</tr>
<tr>
<td>Process of learning:</td>
<td>Trial and error (Holling, 1978), learning by doing</td>
<td>Learning based on Knowledge Management (Williams, 2005) and performance assessments</td>
</tr>
</tbody>
</table>
Approach to control: Based on monitoring change (Kato, 2008) Based on controlling Schedule, Budget and Quality (Williams, 1999)

Approach to uncertainty: According to Holling (1978), the traditional way of dealing with the unknown has been trial and error. The need for innovative solutions to complex and dynamic problems requires the use of ‘natural’ trial and error approaches. The principle is not to develop approaches that eliminate uncertainty, but to develop interactive processes that manage problems within uncertainty and also benefit from it (Holling, 1978). This leads to developing resilient assessment and management approaches (based on a dynamic systems approach) that are able to benefit from change. AM makes more sense in dynamic complex systems, particularly when there is uncertainty of data, management, predictions, and policy. AM accepts that eliminating the uncertain is not possible; thus, the implicit goal of AM is resilience in the face of surprise (Mitchell, 1997). In AM, the assessment of a problem and the implementation of a plan are facilitated through an approach that allows adjustments to changing circumstances, events, and decisions (Mitchell, 1997).

Approach to failure: An adaptive approach encourages generalizations, or even vagueness, at the start of project development and implementation (Noble, 2000). Vagueness and ambiguity provide scope to custom-design implementation to suit differing and dynamic conditions. Vague goals and generalizations, however, should not lead to misunderstandings or conflict of values, as this can leave project managers without sufficient direction and guidance (Berman, 1980). According to Noble (2000), the establishment of a reachable end requires the development of a flexible means. The key is to recognize that failure is not always a manifestation of lack of skill, and both success and failure can be instructive if there is a willingness to learn from them. AM is recommended for conducting impact assessments, especially when complexity, uncertainty, and risk are associated with management options. From the initial stages of policy planning, through preliminary and formal assessments, to post-approval monitoring and regulation, AM provides a set of tools to facilitate problem identification, communication, and explicit impact prediction (Jones, 1985).

Approach to the project organization: An important way to minimize risks is to engage stakeholders throughout the planning process (Wysocki, 2003). According to Naoum (2001), organic organizations, imply less formalized definitions of jobs, increased flexibility and a communication approach based more on consultation than command. Contrary to the PPM, which is more likely to be found in a bureaucracy management structure (Mintzberg, 1998), AM approaches are often found in organic structures.

2. Research methods

Construction projects are known for their high levels of uncertainty (Walker, 2007) and can therefore benefit from some of the principles of AM. This is the general hypothesis of this study, which specific objectives are: i) to compare the professional project management approach with AM; and ii) to identify the characteristics, advantages and limits of the adoption of AM in construction projects. The study highlights the relationships between project stakeholders and the project life cycle in AM.
Considering that PPM is largely applied in the building sector in Canada, United States and Europe, the methodological choice was to move away from familiar contexts, and to examine projects in a context where there is less influence of standardized forms of management. This method, largely used in research in anthropology, brings light to the understanding of a social phenomenon by studying in detail a society in which the phenomenon does not manifest in the same manner (Angrosino, 2002; Bernard, 2006; Laurier, 2008). We found that traditional forms of AM are used in Central Asia and South Siberia, particularly because: i) there is a strong influence of ancient cultural practices on both the lifestyle and the practices of intervention in the built environment; ii) there is a reduced influence of PPM theories and practices, compared to most western societies; and iii) there are culturally rooted approaches to the notions of time, performance and quality of projects that differ from the ones largely accepted in western societies.

There are hundreds of Buddhist religious sites in Central Asia. This gave us the possibility to study the use of AM in the development of religious sites (notably traditional Buddhist temples). Qualitative methods, and particularly case studies, were chosen for three reasons. First, they permit to examine a complex phenomenon (in this case, the management and organization of a construction project on a religious site) within its own environment. Second, Qualitative methods are the most appropriate to reveal the constraints of the organizational structures, interactions and communications between stakeholders (Mintzberg, 1998; Yin, 2003). Construction projects on religious sites require the presence of multiple consultants and other stakeholders, which apparently are not directly related with construction, such as religious leaders and communities of faith. In fact, Buddhist sites are known for developing complex social organizations associated with the development of the built environment (Serageldin, 2001). Third, case studies offer a holistic understanding of interrelated activities engaged in by the actors in a social situation (Halinen, 2005; Jaspers, 2007; Piekkari, 2009). The case study procedure was then adopted to satisfy the three tenets of qualitative methods: describing, understanding and explaining.

The area for conducting the study (the Republic of Buryatia, Russian Federation) was chosen because of the following reasons: i) it is a context of a newborn market economy where western practices of management and financing have not fully influenced traditional construction practices (Metzo, 2003); ii) the region has preserved traditional values and cultural heritage (Morokhoeva, 1995); iii) there is a strong influence of traditional religious practices on the society; iv) the society has a particular (and well documented) meaning of time, performance and quality (Morokhoeva, 1995). Initially, eleven different temples (and sites) were visited and observed. Finally, two of them were chosen for detailed analysis: the Ivolginski datsan and the Lisaya Gora datsan, both in the capital of Buryatia, Ulan-Ude. The two case studies were chosen because they responded to the following criteria: i) to be a functional religious site; ii) to have a construction project in development or recently finished; iii) to use a process of design and management based on adaptive methods; and (iv) to be accessible to the researcher (the main researcher is fluent the local language: Russian).

The first part of this ongoing study (which is reported in this article) proposes the following research question: *How does AM integrate the different notions of time, budget and quality to cope with uncertainty during the overall processes of initiation, planning, design and execution of the project?*
A long fieldwork of four months living on the site was conducted in summer 2009. During that period, the main researcher adopted participant observation methods which provided the following advantages: i) they made possible to collect all necessary data from local cultural and social characteristics, ii) they helped us to learn common knowledge shared among the people and to formulate effective questions; and iii) they helped us to develop intuitive understanding of the culture and the meanings of the data collected, so that we can draw reliable conclusions from the research (Angrosino, 2002; Bernard, 2006; Marshall, 1999; Robson, 2002).

The research method also included direct observations, which were reported in photos, notes and drawings. We conducted 16 semi-structured interviews with project stakeholders including architects, structural engineers, monastery wardens, lamas (monks), officers of municipal and federal services and construction volunteers. The interviewees were mostly chosen by their qualitative contribution to understanding the project, rather than by their statistic relevance. Each interview lasted for 45 to 60 minutes and included direct questions about the project development process and the context of the initiative. The interviews also allowed the participants to express their own subjects of interest; this complementary information proved to be very useful for understanding the religious and cultural context in which the projects take place. The study of printed documents (reports, charts, plans, drawings) related to the projects helped us validate the data obtained from the observations and interviews, particularly by applying the methods of triangulation proposed by Love and al. (2002) for case study and observation methods.

Two methods were used to analyze the data collected: i) the identification of patterns on both the structure and the behavior of the project team; and ii) the identification of patterns in the project process, notably in the project life cycle. To identify the first group of patterns, organizational diagrams were first prepared. These diagrams represent in a graphic manner all the project stakeholders and the relationships between them. They also highlight both formal and informal communication links between participants. The patterns found in the project process were identified by answering (using the data collected) a list of previously prepared questions and by drawing graphical representations of the project process. Finally, patterns previously identified by other authors (Alexander, 2002; Harkema, 2001; Naoum, 2001; Palmberg, 2009) were compared with the patterns found in the case studies in order to draw analytical generalizations (Yin, 2003).

3. Research results: the case studies

Case A, The Ivolginski datsan: After the Perestroika and the transition to new political and economic structures in the ex-USSR, many datsans (Buddhist monasteries) have been involved in new construction and renovation projects. The Ivolginski datsan is the largest Buddhist monastery in Russia (see Fig. 1), it is the residence of Pandito Hambo-Lama, the head of Buddhism in Russia. In 2002, a local man allegedly dreamed of a place nearby, and following his dream the monks from the Ivolginski datsan were able to dig out the mumified body of Pandito Hambo-Lama Itigilov, buried on the site for more than 75 years. The much-venerated body was transferred to the Ivolginski datsan and since then, the number of tourist, pilgrims and visitors as well as the number and size of
constructions on the site have remarkably increased. Presently, there are two new temples in construction as well as several renovations of existing buildings.

The construction project used for this case study is part of a long-term program, organized by the administration of the datsan, in order to respond to the needs of the Buddhist community, the lamas and khuvraks (students) living in the complex. The monastery complex consists of the main temple, four secondary temples, the palace of Pandito Hambo-Lama Itigilov, a Buddhist institute, a library, a hotel, a museum of Buddhist art, a tourist center and residences for lamas and khuvraks. The new building is a dugan (a type of Buddhist temple), devoted to one of the core principles of Buddhism. The project started in 2003, with a religious ceremony (bumba), held for the new construction on the site.

Fig. 1: Left: Location of Buryatia and the capital Ulan-Ude. Right: photo of the project

Acting as the project client, the lamas worked together with designers, managers and builders. They developed an organization structure based on previous construction projects in the monastery, following examples of other Buddhist monasteries in Buryatia and elsewhere. Building up on previous experiences, they have created a systematic program of financing, management and execution of projects. The following social aspects influenced the most important decisions in the project: (i) the management of time and the schedule of the project depend on moon phases, seasons and unexpected events in the nature (sometimes viewed as bad signs from the lamas); (ii) the client (the lamas) is involved in the entire design process, keeping a strong control over the functional program, the quality, the performance specifications, the schedule, etc.; (iii) construction norms and procedures are not defined by legal codes and industry standards but by religious and cultural values.

The lamas apply the following principles of AM to manage project uncertainty: (i) adjustment to changing events, for example the availability of people and equipment on the site; (ii) iterative development, for instance, group consultations with professionals and communities; and (iii) avoidance of irreversible decisions, which manifests in the following manner: there is not a preliminary plan and design of the process as how the project will develop. Instead, decisions are made spontaneously at the time of execution following the experience gained from the previous actions (see Table 2). The consequences of the use of the principles of AM are: (i) better cooperation between different community groups, lamas and other stakeholders involved in the process; (ii) decisions are made on the basis of consultations rather than imposed by professionals; (iii) better adaptation to the specific principles of Buddhism (particularly those that dictate relationships with
other people and the appropriateness of certain actions). The architect involved in the process stated that: “the interactions with lamas and religious community create an opportunity for constant learning not only for the project itself, but for our lives. It is something unique that happens in the process and no other project could give us that possibility”.

Increased uncertainty exists in the management of resources. The constructions are mostly erected by volunteers such as lamas from other monasteries in the republic and abroad (India, Mongolia, Nepal); local residents, visitors from Russia and abroad, and pilgrims. However, construction volunteers participate at different times and stay for different periods. This makes it difficult to synchronize and coordinate their work. Contractors therefore must guide the work of the lamas, khuvraks and volunteers on the construction site.

Considering that this project is of prime importance for the Buddhist community, officers of the local and federal governments, heritage services and the Municipality constantly communicate with the lamas and the professionals in order to follow the development of the project. Formal means of communication include reports, guidelines, summaries and letters. However, it is the appropriate management of informal communication between the stakeholders that assure the functioning of the bottom-up decision making process, which is considered to increase the overall performance of the project process and outcomes.

The Buddhist monks tend not to define the project schedule in the way PPM does. The rhythm of work follows the rhythm of life in the monastery as well as principles of astronomy and astrology – with different periods of high and low activities. The lamas believe that there is a dynamic energy in nature (called Chi) which influences man’s life and activities. Following the cycles of Chi permits to stay “in harmony” with nature. Fig. 2 shows, as a matter of example, the relation between the moon phases, and the intensity of work in the project.

Fig. 2: Correlation between moon phases and number of participants in the project

Risks are also managed with non-conventional tools dictated by intuition, prediction and astrology. There is no plan of risk management, neither there are insurances against possible risks. Instead,
Buddhist beliefs help to deal with the uncertain from a completely different point of view based on “causes and consequences” of human actions (karma).

**Case B, The Lisaya Gora datsan:** Contrary to the first site, which is an existing monastery, the second one is a new complex built on empty land. The datsan is located at the top of a hill on Lisaya Gora, and therefore has a privileged location and view over the city. The site was chosen by one of the closest followers of the Dalai Lama XIV (Lama Elo Rinpoche IV), for having a great amount of positive energy and thus, for being suitable for establishing a new religious community. The objective includes building a complex that includes a Buddhist institute for gathering disciples and followers of Buddhism. A Buddhist society (Rinpoche Bagsha) created by the Lama as a non for-profit organization is responsible for the construction projects on the site.

There was a small Buddhist stupa (monument) on the site at the beginning of the construction of the main temple at 2004. Since then, a hotel, a restaurant, a boutique and another various monuments have been added to the complex (see fig. 3).

![Figure 3: Pictures of a new Buddhist temple in construction on the site](image)

An Architectural studio was hired for designing and managing the entire project (including managing the structural and electrical engineers). Construction is conducted by a general contractor and many voluntary residents, local and international lamas (we identified volunteers from China, Ukraine, the United States and Germany). Their role is significant for the overall performance of the project. Some of them have even taken important roles in planning, designing and managing the project. The organization of the voluntary participants is often adapted to their availability of time. While hired workers (about 10 individuals) are mostly available from Monday to Friday, more than 40 volunteers and lamas work mostly during the week-ends. Of course, this requires increased adaptation of plans and schedules of work.

Sources of uncertainty in the project include: (i) the availability of resources (material, equipment and human) on the site, particularly due to non-planned activities; (ii) unclear prediction of outcomes based on lack of knowledge about the construction process; (iii) increased subjectivity in the decision making process, which is guided by intuitions and premonition based on astrology. However, the following principles of AM have been used to manage uncertainty: (i) monitoring and control early and often in the process, including daily meetings between at least one lama and the professionals; (ii)
client-focus, for this, professionals are required to keep constant consultations with the lamas; (iii) “Learning by doing”, for instance the first phase of the project tested the ability of the project team to work together, and showed that some adjustments were required for better organization (for example, the frequency of meetings, the type of communication, etc.); iv) approach to process performance, astrological charts and Buddhist principles are used as management tools to facilitate good relations between participants (see Table 2). The consequences of the use of these principles include: (i) that the initial process planning has been changed several times; (ii) mutual learning and training is often achieved; (iii) the coordination and planning process is time consuming; iv) increased satisfaction of stakeholders is often perceived. According to one of the lamas “the real heritage is the links between the community and the monks. Not the stones, nor the buildings, but the connections created during the services together. The building of a temple is the greatest possible service to God for both civil and religious communities”.

During the construction, the number of volunteers varied significantly. In fact, during a period of 90 days, the number of volunteers varied from 3 to 45. Some of them expected to be accommodated in the monastery and to take part in the construction process. Solutions for appropriate accommodation and the involvement of construction volunteers in the process were managed with adaptability. Besides, all decisions related to the project were made after reaching consensus between various professionals, lamas and members of the community. Regular meetings were thus held on a weekly basis to monitor budget, schedule, and quality. Although there was initially a fixed dateline for the project, its compulsory character was soon neglected by the stakeholders. In fact, there were important delays at the beginning of the work due to the inexperience of construction volunteers. The AM approach proved to be useful to cope with the flexible time schedule.

An important problem came from the design, which failed to include enough space for the five-meter high statue of Buddha. It became necessary to adjust the design of the building during the construction process in order to accommodate the statue, and especially to leave enough space for it in case “the Buddha stands up”, an event that followers literally expect will happen one day.

Table 2: Advantages of application of AM principles in project A and B

<table>
<thead>
<tr>
<th>Principles of AM used in case A</th>
<th>How the principles manifested in the development of the project</th>
<th>Advantages of the use of the principles of AM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustment to changing events</td>
<td>Variation of volunteers involved in the process</td>
<td>Optimization of the advantages of changes</td>
</tr>
<tr>
<td>Iterative development</td>
<td>Efficient and frequent consultations with different groups and communities</td>
<td>Satisfaction of a greater number of stakeholders</td>
</tr>
<tr>
<td>Avoidance of irreversible decisions</td>
<td>Frequent feedback and continuous introspection of the process</td>
<td>Appropriate and adaptive resource management</td>
</tr>
<tr>
<td>Client-driven</td>
<td>Intense informal communication</td>
<td>Effective team building</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Principles of AM used in case B</th>
<th>How the principles manifested in the process</th>
<th>Advantages of the use of the principles of AM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring and control early and often in the process</td>
<td>Availability of materials and people varied at different stages of</td>
<td>Continuing questioning and increased adaptation to the</td>
</tr>
</tbody>
</table>
the process | available resources
---|---
Client-focused | The lamas were presented in the process all the time | Efficient response to the client’s objectives
“Learning by doing” | Increased productivity of participants achieved through practice | Flexibility in the design and the construction process
Approach to performance | The religious servants apply and impose Buddhist principles | No conflicts among participants of the project team

4. Results and discussion

The objectives of this research were to compare the principles of PPM and AM and to identify how AM integrates the different notions of time, budget and quality to cope with uncertainty during the overall processes of initiation, planning, design and execution of the project. Results show that there is a great difference between the way time, budget and quality are perceived and managed in both approaches. The empirical study showed that the notion of time for the Buddhist monks is different then that of the other members of the project team. It was therefore observed that quality carries much more importance over time and budget in the development of the Buddhist temples. The management of time is based on adaptable calendars and decision-making is often based on religious values. The adoption of AM principles in these projects showed the following advantages: (i) the appropriate respect of priorities of time, quality and budget; (ii) the transfer of increased decision-making power to lamas and local communities; (iii) increased flexibility in the design and the construction process; (iv) continuous questioning of decisions and increased adaptation to the availability of resources; (v) innovation and proactive responses to uncertainty in the process.

In both sites, the performance of the overall process and the good relationships between participants are considered as important as the final product itself. Local communities believe that the building is erected not only for the current generation, but also for the future. Therefore, designs are elaborated and repetitively revised with special attention to details. The analysis of the case studies shows that, in Buddhist temples the use of AM allowed the project team to efficiently respond to the social and spiritual values of the monastic community. More research is still needed to identify the limits of this approach and its potential use in other contexts. The next step in this ongoing research project includes validating these results in other detailed case studies and following up the cases over a longer period of time.

References


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In Quest of Total Quality Management Principles in Architectural Design Services: Evidence from Turkey

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Abstract

Architectural design companies increasingly recognize that time spent on management is not at the expense of their production and there are always better ways to organize business. Although architects have long placed a traditional emphasis on quality, quality management is still a new concept for the majority of architectural design companies, which have to organize relatively more complicated operations nowadays to meet their clients’ expectations. This study aims to understand how architectural design companies define quality and explores the extent to which Total Quality Management (TQM) principles like continual improvement, employee involvement, customer satisfaction and others can be pertinent in these companies. Adopting a qualitative research strategy, the authors interviewed with the owner-managers of 10 widely-recognized architectural design companies of different size in Istanbul. The results from the content analysis of semi-structured interview data suggest that i) TQM principles cannot be directly applied in architectural design companies without an appropriate translation; ii) special characteristics of design services are important to explain quality-related perceptions of owner-managers; iii) the owner-managers feel the pressure from the changing internal and external environmental conditions, however few of them adopt a systematic and documented approach to quality management. Architectural design offices which aim to establish a quality management system can benefit from this study to understand potential problem areas on their road.

Keywords: architectural design, Total Quality Management, implementation
1 Introduction

As a consequence of either external pressure such as increasing quality demand of clients, or internal pressure such as organizational growth, architectural design offices seek ways to achieve higher quality targets in today’s competitive markets. This is why relatively new management approaches such as Total Quality Management (TQM) are likely to be the part of the agenda of architecture companies, which aim to achieve long-term success in competitive markets through the integration of various organizational functions. TQM is based on “…all members of an organization participating in improving processes, products, services and the culture in which they work” (ASQ, 2009) to achieve organizational objectives. Saarinen and Hobel (1990) argue that TQM constituents and principles have been part of daily routines in architectural offices, although they are not always systematically described and documented as ‘quality management’.

1.1 Research problem

Architectural design process is unique due to its nature and the designer’s subjective contribution and judgement. This asserts that applying TQM principles and implementations in the architectural services sector without appropriation may not yield successful consequences, considering that TQM has its roots in the manufacturing industries. Understanding the extent to which the implementations and approaches of these offices overlap with TQM, and to which they differ remains an interesting research topic. It is important to understand how architectural design companies interpret the notions like quality, institutionalization, teamwork, leadership, continuous improvement and client satisfaction to explore better ways to enhance their productivity and quality.

1.2 Aim and scope

This study aims to compare the pioneering architectural offices’ quality perceptions and to understand the principles and methods that they adopt to create high quality outputs. The assumption was that comparing observed principles with those of TQM would generate valuable information, which could be used as input to develop an effective quality management model and which fit in with the peculiar needs of architectural design offices. For this purpose, semi-structured interviews were conducted with the owner-managers 10 architectural design companies in Istanbul. The sample comprised pioneering companies that are well recognized in the domestic market and appreciated in different platforms for their high standard works.
1.3 Previous work

Mayon and Mabey (1993) argue that no clear definition exists for TQM in construction firms; the process basically proceeds through the phases of planning, preparation, implementation and sustaining; and the final phase is infinite. Pheng and Ke-Wei (1996) argue that the implementation of TQM in the construction sector is for the benefit of everyone involved in the process. Pheng and Teo (2004) explain the fallaciousness of expecting short term benefits through the necessity of cultural alternations. Arditi and Gunaydin (1997) argue that evaluating the quality on the basis of aesthetic features would give rise to controversies in consequence of subjective interpretations. Arditi and Gunaydin (1998) also underline that management participation, quality training, teamwork, customer/supplier relations and statistical methods are essential tools and elements for building projects.

Few empirical investigation exist that focus on TQM implementation in the design phase of the building production process. Majority of the studies on design and management come to the conclusion that the design process is a ‘black box’. Volker and Prins (2005) argue that “it is a cognitive process in the sense that the architect is problem-solving, creating, learning, exploring; it is a social process in the sense that the architect has contact with many participants or stakeholders in a variety of relationships; it is a cultural and technical phenomenon situated in a specific cultural context; and it is a process of dealing with uncertainty and establishing useful artifacts”. Sebastian (2004) highlights that all current design and project management methods have failed to penetrate the creative and subjective nature of architectural design practice, especially during the conceptual design phase. Table 1 below is a summary of TQM terminology.

<table>
<thead>
<tr>
<th>Table 1: Quality and TQM Terminology</th>
</tr>
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<tbody>
<tr>
<td>Quality</td>
</tr>
<tr>
<td>A subjective term for which each person or sector has its own definition. It may refer to the characteristics of a product or service that bear on its ability to satisfy stated or implied needs – ‘fitness for use’ and ‘conformance to requirements’; or a product or service that is free of deficiencies (ASQ, 2009).</td>
</tr>
<tr>
<td>Total Quality Management (TQM)</td>
</tr>
<tr>
<td>A management approach to achieve long-term success through customer satisfaction. TQM is based on all members of an organization participating in improving processes, products, services and the culture in which they work (ASQ, 2009).</td>
</tr>
<tr>
<td>TQM elements and principles</td>
</tr>
<tr>
<td>Teamwork and employee involvement</td>
</tr>
<tr>
<td>An organizational practice whereby employees regularly participate in making decisions on how their work areas operate, including suggestions for improvement, planning, goal setting and monitoring performance (ASQ, 2009).</td>
</tr>
<tr>
<td>Statistical methods</td>
</tr>
<tr>
<td>Provide teams with the tools to identify the causes of quality problems, to communicate in a precise language that can be understood by all team members, to verify, repeat, and reproduce measurements based on data, to determine the past, present, and to a lesser degree, the future status of a work process, and to make decisions on facts that are based on data rather than the opinions and preferences of individuals (Perisco, 1989).</td>
</tr>
<tr>
<td>Continuous</td>
</tr>
<tr>
<td>The ongoing improvement of products, services or processes through</td>
</tr>
<tr>
<td>Improvement</td>
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<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Training</td>
</tr>
<tr>
<td>Supplier involvement</td>
</tr>
<tr>
<td>Customer relations</td>
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<tr>
<td>Management commitment and leadership</td>
</tr>
</tbody>
</table>

### 1.4 Research design

A qualitative research strategy was adopted to understand the quality perception and quality-related attitudes and behaviors of pioneering architecture companies. As part of a multiple-case study, 10 in-depth interviews were conducted with the owner-managers of selected companies located in Istanbul. Most of the owners of these companies have won many prestigious international awards such as the AR Awards for Emerging Architecture, the Europe & African Property Awards, the Aga Khan Award for Architecture, the Cityscape Architectural Review Awards, and the ULI Award for Excellence and National Building Design Award. The sample consists of companies that have been appreciated for their ‘high quality’ products within the national and/or international architectural design community.

Data were collected through face-to-face interviews, which lasted for around an hour on average. A case study protocol was prepared prior to the data collection phase. Open-ended questions were tested and revised upon a pilot interview. Questions fell into three categories: quality perception, principles and methods adopted to achieve quality, and the company profile. Research goals were clearly explained to the interviewees and the interviews were digitally recorded with the consent of respondents. The researchers paid particular attention during the interviews, to be neutral, empathize with the interviewees, and changed the order of the questions in accordance with the flow of conversations. Including a pilot interview, ten in-depth interviews were conducted in total (see Table 2), however, the pilot interview data were excluded from the analysis. The interviews were transcribed to form an extensive case study database, from which data were then withdrawn for qualitative analysis.
Table 2: Summary of interviews

<table>
<thead>
<tr>
<th>Company</th>
<th>Interviewee</th>
<th>Total number of employees</th>
<th>Average number of projects per year</th>
<th>Annual Turnover (US Dollars)</th>
<th>Works: Type – Government/Private – National/International</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>owner</td>
<td>3</td>
<td>5</td>
<td>0 – 500,000</td>
<td>Mainly Residence and Invited Competitions – Private – National</td>
</tr>
<tr>
<td>B</td>
<td>owner</td>
<td>10</td>
<td>10</td>
<td>1,000,000 – 2,000,000</td>
<td>Mainly Residence and Education – Private – National</td>
</tr>
<tr>
<td>C</td>
<td>partner</td>
<td>65</td>
<td>30</td>
<td>10,000,000 +</td>
<td>All types – Private – National/International</td>
</tr>
<tr>
<td>D</td>
<td>owner</td>
<td>9</td>
<td>7</td>
<td>500,000 – 1,000,000</td>
<td>Mainly Residence – Private - Mainly National</td>
</tr>
<tr>
<td>E</td>
<td>partner</td>
<td>14</td>
<td>15</td>
<td>2,000,000 – 5,000,000</td>
<td>Mainly Commercial/Office Buildings – Private - National/International</td>
</tr>
<tr>
<td>F</td>
<td>partner</td>
<td>6</td>
<td>6</td>
<td>500,000 – 1,000,000</td>
<td>Mainly Office and Education – Private - National</td>
</tr>
<tr>
<td>G</td>
<td>partner</td>
<td>12</td>
<td>10</td>
<td>1,000,000 – 2,000,000</td>
<td>All types – Government/Private - National</td>
</tr>
<tr>
<td>H</td>
<td>owner</td>
<td>35</td>
<td>25</td>
<td>5,000,000 – 10,000,000</td>
<td>All types – Private – National/International</td>
</tr>
<tr>
<td>I</td>
<td>owner</td>
<td>11</td>
<td>20</td>
<td>2,000,000 – 5,000,000</td>
<td>All types – Private – National/International</td>
</tr>
</tbody>
</table>

2 Findings

2.1 Quality perception

Interviewees make a distinction between product and process quality and they argue that the quality of the production process does not guarantee the quality of end-product. Subjectivity, which originates from the cultural background of the designer, the relativity of quality perception, and the clients’ needs may change the quality of end-product even if all other processes are of high quality.

...there organized competitions, for instance. All participants are given the same topic. Most of the conditions and the data are the same. However, all come up with different outcomes. In my opinion, all groups achieving quality meet these conditions but they always have a plus which makes a difference. Because the way that they handle the situation is different...But we cannot argue that who puts on more wins because evaluation is subjective. A different jury might make a different decision.
Most interviewees agree on the definition of quality that it is not only ‘meeting client expectations, but going beyond those expectations in different and innovative ways’: by re-interpreting an element of the client’s life from a different angle, by intuitively understanding the clients’ problems and proposing rapidly the essential solutions or by noticing the missing elements of client’s demand with the help of his/her former experience and making new offers.

Quality includes more than expected. It is something that has never occurred to me, which is really impressive. If it provides me a solution even beyond my expectations, then it really captures me.

### 2.2 Teamwork and employee involvement

Teamwork is inevitable in architectural design practice as each project is unique and it requires the contribution of different disciplines to implement the project. Interview data suggest that rather than participating in project development directly, owner-managers with propensity to use their leadership skills assign tasks to employees to encourage their participation and to obtain effective consequences out of this participation. They expect all employees to freely render his/her opinions.

Can you imagine an architect who never tells her/his idea? This drives me crazy. Why she/he is here then?

Until quite recently, we used to work like that: we, the owners, were the two opinion generators, of the office...and the employees worked as technicians...As the number of the projects increased, this method lost its validity.

Wherever possible, my starting point is - “tell us how you would do this”.

The strategy is often to reach a common mind. As a leader, owner-manager draws the lines and interferes in to make the final decision. Whenever necessary, to prevent such a liberal atmosphere from turning into a chaos, the owner-manager finalizes the decision-making processes in relatively reasonable durations.

...Sometimes, I realize that I loose unnecessarily much time at an unnecessary point of the project waiting for the participation of the employees. Then I have to cut it off.

Interviewees have propensity to delegate their authority as much as possible, as they believe that authority delegation motivates the employees to exert themselves for success. Two approaches are noticeable in authority delegation. One of them is the use of authority delegation as a means of motivation. Employees can be delegated authority not only as an appreciation of good performance, but also as a stimulator to improve descending performance and encourage contribution. The other approach is the use of authority as reward, which means that owner-managers delegate authority to those who have already proven to be capable of using it and those with relevant competences. Interviewees try to figure out the amount of work that the employee could surmount and the fields that he could be the most effective.

Initiative is given to the ones who can take it, but they should prove having this capacity first. Nothing is taken for granted; they should earn it...
Another perspective on authority delegation is that enthusiasm is more valuable than competence since skills could be improved. Accordingly, concept design, preliminary project, as-built project, site inspections and the relationship with clients when possible are carried out by the same person or persons as much as possible. Unlike the former one, this approach suggests that efficiency could be achieved if the same employee keeps working on the subsequent steps. According to this group of interviewees, ‘having experience in each phase of the project’ is also an effective means of motivation.

...I sometimes fancy as if there are some other tiny offices inside ours...interrelated offices, almost like having an electrical or plant engineer in our projects. Performance of those tiny offices reflects on individuals, and the sum of individual performances reflects on the performance of the office...

However, not always it is not possible to delegate authority in all cases since the leader has also many subjective characteristics that are not easily transferable. This sometimes may even arouse a feeling of being neglected in the employee who strives to conceptualize the elements, the reasons of which she/he fails to comprehend.

This resembles to doctor-patient relationship. The client comes and indicates a problem, for example. This is the symptom, something apparent. Maybe, the solution he proposes is the pie in the sky. There comes in the intuitions. That’s why I cannot share these all with my team.

2.3 Use of statistical methods for performance measurement

The regular monitoring of employee performance is considered as a necessity by interviewees since individual performance is closely associated with collective performance. According to some owner-managers, this constitutes an impediment for increasing the number of employees in spite of the existing growth pressure. Although no statistical study could be mentioned, measurements accumulated in the database along with different means of expression are presented to management in periodical meetings.

...all our attempts are for making things measurable and keeping everything measurable.

...employees keep records of the project they work in, the topic they work on and the durations of works...We have a software which keeps record for each consumable material automatically...For instance, each print should be signed, so you can trace, itemize and list the print.

Owner-managers who have less than ten employees tend to carry out performance evaluation on the basis of individual experiences and intuitions without systematically using any performance measurement instruments.

...for this size of an office, I do not administer systematic measurement because I have control on them all...I get up in the morning and revise everything done starting from the beginning...
According to the owner-manager of company B, no reference can be made to ‘office performance,’ where a large number of people are employed. It is the performance of individuals what makes up the performance of the office in total and thus, it is sufficient to measure individual variables only.

Interview data suggest that performance measurement initiatives broadly fell into the following categories in the architecture companies:

*Cost measurements:* This type of measurement is carried out in all architectural offices to a certain extent in order to calculate deviations from project budgets and assess profit-loss situation. ‘Man-hour’ is the most frequently employed measurement unit. Another criterion might be the level of resource consumption (i.e., paper, cartridge, telephone calls).

*Process measurements:* Owner-managers compare the number of proposed projects and completed projects. Durations of the phases following the project proposal and the reasons for delays are also analyzed. Although relatively simple measures such as the ratio of proposed and completed projects are used in most offices, measurement of the phase durations is rare. Data on delays are considered important for continuous improvement.

*Individual performance:* Owner-managers measure employees’ performance in different phases of the projects to “find ways to improve poor performance while rewarding high performance”. Though being small in number, there are interviewees who emphasize the importance of the distinction between poor performance as a result of systemic failure and poor performance as a result of individual failure. Owner-managers agree that good performance should be awarded and they explore and use different methods for appreciation. They set various criteria “to be fair and hinder unnecessary competition between employees”. Some owner-managers tend to reward unexpectedly high performance, while in some cases company’s wage policy is associated with individual performance. In only one case, employees were systematically and regularly given feedback on their performance following an assessment. In other offices, employees were provided performance-related feedback only when there happened a negative incident, or it was in the form an unplanned feedback within the sincere atmosphere of meetings. According to some interviewees, there are some peculiar characteristics of architectural offices in terms of performance measurement. One of them is the variability resulting from the subjective nature of architectural design practice. Another one is the one-off nature of architectural design outputs. In case a project cannot be completed with budgeted costs, it is not easy to compensate this loss since the product is unique like its client/owner.

### 2.4 Continuous improvement

By the very nature of one-off products, each project requires different solutions. To develop tailor-made solutions in each project, companies mobilize all essential resources to adapt to the new design problem. All companies have project archives where they keep records of all information related to each project. Knowledge is constantly and cumulatively improved by putting on new information from different project environments, however, interviewees emphasize the traditional importance of oral transmission of knowledge in architectural companies.

> I believe that we own a library which is composed of orally transmitted information and which is busier than a physical library. We can handle it now, but I don’t think we could, if we were a larger-scale office.

According to interviewees, transforming project-level individual experience into organizational knowledge requires that turnover of experienced employees be kept at minimum. Owner-managers
agree that not all know-how related to design practices, however, is easily transferrable. Ability to understand clients’ needs and intuitive approaches to design are examples. Standardization of the methods of expression is relatively more easy:

...each piece of paper from this office should arise the same feeling in everyone. For this purpose, a design reference system has been developed.

Interviewees believe that technology-based radical improvements should accompany incremental improvements for continuous learning –i.e. the purchase of software or an equipment, which significantly influences the design and modeling processes.

2.5 Training

Interviewees acknowledge the importance of training on various topics. Training may take different forms according to different topics: In the case of a general training, invited speakers address various topics that contribute to the individual professional development of employees. Creating sincere atmospheres, where the owner-manager shares his/her experience on different issues is considered as another form of training. For example, relationships with clients, suppliers and engineering crews or means of architectural expression are typical topics.

Apart from scheduled training sessions, experienced employees are encouraged to transfer know-how to relatively less experienced employees as part of daily problem solving activities.

Relatively more formal forms of training, from which relatively quicker outcomes are expected, focus on various technical issues that are related to ongoing projects. Such training might be arranged within the office or employees might be requested to attend in professional training outside the company. Training on construction systems and equipment is usually arranged with invited speakers from manufacturers or dealers and might focus on various topics that are related to projects. Interviewees believe that visiting trade fairs and field trips are also important channels of learning. Accordingly, employees might be requested to attend in national or international trade fairs, or they might be sent out to see a completed project on site. When they come back, they are expected to share experience with others. Training might also be related to some general topics, without direct link to architectural practice. Finally, all interviewees highlight the need for a well-organized and easily accessible library for individual development.

2.6 Supplier involvement

Interviewees agree on the importance of early involvement of suppliers with projects and they adopt different strategies for collaboration. Owner-managers argue that due to the very nature of building production processes, design changes and delays frequently happen, and it very important them to work with tolerant and constructive suppliers. Interviewees acknowledge the importance of long-term relations for achieving quality targets, although frequent changes of suppliers are part of business.
2.7 Customer relations

Architectural practice requires the participation and guidance of clients in each phase of projects. Clients and architects collaborate to identify needs in each step of project development, so that it becomes possible to proceed with the subsequent step. Some interviewees argue, however, that not all of the clients might be acquainted with the idea of working with a designer. Accordingly, the architects often start with explaining how the project is to be proceeded, then go on with attempts to understand clients’ needs, which typically involves a set of broad questions. Presentation of visuals from previous projects and literature usually helps clients express needs, though the interviewees believe that it is the intuitions of the architect which is fundamental.

When the user is anonymous, the approach to identify clients’ needs may differ – i.e. in a real estate project. In such projects, the designer is to rely on his own experience to identify needs and take into account an average user profile to ensure the required flexibility. According to interviewees, customer relations is another field where it is difficult to transfer skills to employees.

2.8 Management commitment and leadership

Most of the interviewees believe that it is a management liability to ensure high quality processes and products. The leader should encourage continuous improvement; set sustainable and improvable standards; provide necessary equipment and comfort; enable teamwork to be carried out effectively in a participation and dialog-oriented atmosphere, and meet employee satisfaction. He/she should act as a role model and inspire employees to behave like professionals.

All interviewees appear to appreciate a management style, which is based on authority delegation and which encourages employee participation.

We have realized that if they take responsibility and actively participate in the conceptualization phase as much as possible, then we are likely to achieve better progress...

3 Discussion and conclusion

Findings from the analysis of qualitative research data suggest that various practices, which are targeted at achieving high quality products and processes as part of professional practice in architectural offices overlap in many aspects with the principles and applications of Total Quality Management (TQM), though those principles and applications are not systematically described as TQM. Empirical data present strong evidence that various aspects of TQM have already been integral to the daily routines of architectural practice. To illustrate, each project is unique in terms of technical problem solving and this is a motivation for continuous improvement; various forms of formal and informal training are adopted by companies, where oral transmission of know-how is a strong tradition; close and strong relationship with client is part of business because of the very nature of professional practice; unlike many other sectors, the designer and his client (and the user) mostly know each other at the beginning of the process, owner-manager is very much expected to demonstrate high leadership skills, as typical of small companies…Thus, it might be safe to arrive at a conclusion that architectural design offices already adopt various strategies to arrive at quality targets, the sophistication degree of which vary with the specific needs of each organization. There are signs that architecture companies adopt a pragmatic approach and they tend to employ relatively more ‘professional’ methods to establish quality systems, only when they actually need them (i.e., to manage human resources when the organizational size grows).
Another conclusion from this study is that the specific characteristics of architectural business should be taken into account when developing any kind of quality management models. The dilemma is that although TQM and other management approaches require that processes and products be standardized as much as possible, the very nature of design practice does not allow the standardization of every aspect of business. Difficulty to transfer particular skills (i.e., the creative technical problem solving skills or the ability to understand and foresee client/user needs) and the traditional emphasis placed on learning-by-doing under the management of a skillful leader, where oral transmission of know-how is important, among others, are some of the peculiar characteristics of architectural design practice.

Translating the findings of this study into a manageable model of quality management for architectural design offices through a quantitative research and exploring linkage between organizational culture and quality-related initiatives in architectural practice would be interesting topics for future work. Further research could also focus on in-depth case studies of the various dimensions of quality (i.e., teamwork, training, statistical methods, etc.) for building design process. One might also analyze the best practices of quality improvement tools for the design process. As the complexity of the buildings increase, further research efforts to provide high quality design services are sine-qua-non.

References


Managing Architectural Design Using an Information Constraint Management Model

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Abstract

The architectural design process can be expressed as a discrete event system. In order to satisfy the design management requirements in the building product design process and to improve the efficiency of design management, focusing on the management and optimization of design activities and considering the relationship between different product design information, a building design information constraint management model was developed which integrates product design information constraint net (PDICN) and fuzzy timed colored workflow net (FTCWF-net). It resolves the design information constraint relationship expression for design activities and to support dynamic system fuzzy timed constraint relations by the model. The model was used for architectural design management and optimization in the scenario of structural detailed design process of an official building. The results implied the validity and accuracy of the model.

Keywords: architectural design management, product design information constraint net, information constraint management model, fuzzy timed colored workflow net, optimization
1. Introduction

The architectural design process is a complicated and interactive process among many stakeholders from multi-disciplines. The design process is limited by various constraint relationships such as time, resources and information, among which the resource constraint relations is the key factor directly influencing the construction project development cycle and economic benefits (Xue et al. 2001, Lin et al. 2008, Liu and Wang 2007).

The resource management model is demanding in terms of accuracy, quantitative analysis, flexibility and independence. Existing resource management modeling methods are used to describe complex systems mainly through discrete-event optimization algorithms to produce optimal or near-optimal solutions with a few numbers of experiments replications (Khattab and Soyland 1996, Reyck and Herroelen 1999, Glover et al. 1996, Alberto et al. 2002, Ahmed et al. 1997). Zhang et al. (2008) described a simulation-based methodology to handle the time constraints. Considering the variable number of breaks or variable break durations for different activities, the authors proposed an algorithm to determine the execution of the time-constrained activities. Joglekar (2005) proposed the Resource Allocation Policy Matrix as a means of describing resource allocation policies in dynamic systems using system dynamics and control theoretic models. Lu (2008) developed the Simplified Simulation-based Scheduling system for resource-constrain Critical Path Method that used the discrete event simulation approach and optimization techniques to automate the formulation of a resource-constrained schedule with the shortest total project duration, further optimizing provision of various types of resources. However, these heuristic approaches generally consider each activity separately and only one activity is determined each time, ignoring the fact that currently available resources may be sufficient to satisfy multiple activities at the same time and accordingly resulting in waste of resources. Moreover, the use of Genetic Algorithm requires a long processing time. Combinations of simulation with optimization methods such as Tabu Search (Glover et al. 1996), Genetic Algorithm (Alberto et al. 2002) and Simulated Annealing (Ahmed et al. 1997) have been proposed to produce optimal solutions. Nevertheless, the difficulty in building objective function still makes it unpractical to optimize dynamic allocation policies (Zhang and Li 2004).

This paper focuses on the management and optimization of design activities considering the relationship of control between different building product design information. A proposed model for managing the building design information integrates product design information constraint net (PDICN) and fuzzy timed colored workflow net (FTCWF-net), which resolves the expression of information constraint relations among various design activities and improves the support to dynamic fuzzy time constraint relations of the system by the resource management model. Finally, the model is implemented and simulated utilizing the software CPNTools in the structural detailed design stage of an office building.
2. Product design information constraint net

During the building product design process, internal constraint relation of product design information affects quality and efficiency of building design. In order to express the design information widely existing among design activities, the concept of product design information constraint relation net (PDICN) is introduced. Each node in the PDICN denotes a design task. Every task transforms the input information to the succeeding node as the needed input information.

As shown in Figure 1, executing design task \( a \) needs design information of task \( b \), task \( c \) and task \( d \). Therefore, before starting task \( a \), task \( b \), \( c \) and \( d \) must have been finished. An arrow and a solid dot denote AND-join relationship of the information. Similarly, task \( b \) needs the information of task \( e \), \( f \) and \( g \). Task \( c \) needs the information of task \( h \) and \( i \). Task \( d \) needs the information of task \( m \) or \( n \) and perhaps needs the information of task \( p \). The OR-join relationship is denoted by more than two arrows and a hollow dot. The NOT-join relation is expressed by an arrow. Task \( e \) is the preceding design activity of task \( c \) and \( d \). The preceding item relation is expressed by a dashed and a solid dot. The information of any task \( e \), \( f \) and \( g \) can influence task \( b \). The “OrFeedback” relation can be expressed by several dashes and a “X” mark hollow dot. Task \( h \) and \( i \) can affect task \( c \) together. The ANDFeedback relationship can be expressed by several dashes and a solid dot. DICN of task \( a \) is established through labelling constraint relations mentioned above and attaching necessary information like completion time.

![Figure 1: A design information constraint net of task a](image)

**Definition 1** Product design information constraint net (PDICN)

\[
\text{PDICN} = (V, R_V, E), \text{ where:}
\]

(1) Finite set \( V = (v_1, v_2, ..., v_n) \) is the set of nodes in the net. Order pair \((v_i, v_j)\) is the side of PDICN indicating the information flow from \(v_j\) to \(v_i\).

(2) Color set \( R = (\text{And-join}, \text{Or-join}, \text{Not-join}, \text{pre}, \text{AndFb}, \text{OrFb}) \). Relation \( R \) refers to information relations of And-join, Or-join, Not-join, precedence relation, And-Feedback, Or-Feedback. \( R_V \) is the constraint relation set of random side \((v_i, v_j)\).
(3) $E$ denotes the tasks execution time corresponded by nodes which is the triangular fuzzy number. $EF$ refers to minimum completion time, $MF$ refers to the most possible completion time and $LF$ refers to the maximum completion time.

If $v_0$ is the final task, there is no information output besides feedback relation line connection. If there is information output for random node $v_i$, $v_i$ is the middle task needed by downstream tasks.

Definition 2 For relationship $R$ and for random node $v_i$, $R(v_i)$ denotes node set with relation $R$ set which point to node $v_i$, for example, And-join denotes required set of node $c$.

The following two deductions are concluded from the definition of PDICN.

Deduction 1: There is no orphaned node in PDICN, that is, $\forall v_i \in V, \forall v_j \in V, s.t. v_i \in R(v_j)$.

Deduction 2: There is no node that only belong to preceding constraint in PDICN and preceding node must have a parent node with required relation, that is $\forall v_i, v_j \in V$, if $\forall v_i \in pre(v_j)$, then $\exists v_k \in V$, so that $\text{And-join}(v_k) \cup \text{Not-join}(v_k)$

Definition 3: For a PDICN, it denotes a relation $R$, for a random node, $\tilde{v} = \{x \in V \mid (v, x) \in V\}$, $\tilde{v} = \{x \in V \mid (x, v) \in V\}$.

It can be concluded from the formalized definition of PDICN that PDICN is a directed information relation constrain net indicating the design information constraint relations among design activities in design process.

### 3. Resource management model for building product design process

Petri net is a type of bipartite, directed and weighted graph, which can capture the dynamics of a Discrete Event System. The definition of an ordinary Petri net can be found in Murata T (1989). In this paper, the concept of fuzzy timed colored workflow net (FTCWF-net) is introduced to extend the workflow net modeling methodology, which can improve the descriptions of Petri net to uncertain time and the characteristics of integration, complexity and dynamics of product design process, as well as effectively support resource analysis, optimization and simulation of design process. The definition of FTCWF-net can be found in Murata T (1989).

Resource management model based on FTCWF-net for building product design process is presented after conducting the resource properties and competition relations. The correctness of structure and operation for the model can be validated by liveness and safety of the workflow net. The general formal description for the model is formulated as following:

Definition 4: Resource management model for building product design process
Resource management model for building product design process is a 10-tuple: \( \text{RMMBPDP} = \{R, P, T, F, D, M_0, C, G, I, S\} \), where:

1. \( R \) is a multi-set of token color;
2. \( P \) is a finite set of places of dimension \( n \);
3. \( T \) is a finite set of transitions of dimension \( m \);
4. \( F \) is a finite set of arcs so that \( P \cap T = P \cap F = T \cap F = \phi \);
5. \( M_0 \) is an initiation status marking;
6. \( C \) is a color function, defined from \( P \) into \( R \);
7. \( G \) is a guard function, defined from \( T \) into expressions;
8. \( I \) is an initialization function, defined from \( P \) into closed expressions.
9. \( S(S \in [0,1]) \) is the firing possibility of transition \( T \) when it conflicts with other transitions. \( S=1 \) when there is no conflict.

### 4. Transforming algorithm from PDICN to FTCWF-net

PDICN denotes information flow view of information constraint relationship among design activities, while workflow net expresses workflow view central on the process. The mapping relationship exists between the two views. Each node of the PDICN corresponds to a place or transition of FTCWF-net representing a design task in the model or design information captured from outside.

![Figure 2: The FTCWT-net model transformed from the PDICT (shown in Figure 1)](image)

Figure 2 illustrates a fuzzy timed colored workflow net model transformed from PDICN. The transforming algorithm is presented in the following steps:

The feedback relationship line connection is not considered firstly. The start point \( v_0 \) of the net is found that is the final design product.
Step 1: Construct a fuzzy timed colored workflow net $PN = \{P, T, F, D, M_0\}$, where $P = \{start_v_0, end_v_0\}$, $T = \{v_0\}$, $F = \{(start_v_0, v_0), (end_v_0, v_0)\}$, and $V = V - v_0$.

Step 2: Choose a subnet $N = \{P, T, F, D\}$. If $V = \emptyset$, then go to step 4; else choose a node $v \in V$ in the net. If $\bar{v} = \emptyset$, then remark label $v$ as $perf_v$, go to step 2; else go to step 3.

Step 3: Add transitions $prep_v$ and $perf_v$ respectively before and after transition $v$. Transition $v$ is replaced by subnet. The description method of transition and place depends on relation $R$.

If $x \in c$ and $R(x, c) = mand$, then $P_{end} = end_x, P_{start} = start_x, F = (start_x, x) \cup (x, end_x), T = x$;

If $x, y \in c$ and $R(x, c) = cho, R(y, c) = cho$, then $P_{end} = end_{(x, y)}, P_{start} = start_{(x, y)}, T = \{x, y\}, F = (start_{(x, y)}, x) \cup (x, end_{(x, y)}) \cup (y, start_{(x, y)})$.

If $x \in c$ and $R(x, c) = opt$, then $F = (start_x, x) \cup (x, end_x) \cup (start_x, skip_x); P_{end} = end_x, P_{start} = start_x, T = \{x, skip_x\}$;

If $x \in c$ and $R(x, c) = pre$, then $F = (perf_x, prep_{(x, y)}) \cup (prep_{(x, y)}, perf_x), T = \emptyset, P = prep_{(x, y)}$.

Traverse each node of $c$, go to step 2.

Step 4: Add feedback relation line. For random node $v$ needs to be review, that is $R(v, x_1) = R(v, x_2) = AndFB$ or $OrFB$, add place $submit_v$ and transition $check_v$, before the place $end_v$, and add place $iterate_v$ and logic transition $t$ after the transition $check_v$ so that a new workflow net model is generated. $P = P \cup \{submit_v, iterate_v\}, T = T \cup \{check_v, t\}, F = F \cup \{(perf_v, submit_v), (submit_v, check_v), (perf_v, iterate_v), (check_v, end_v), (iterate_v, t), (t, start_v), (t, start_v)/(perf_v, end_v)\}$.

Traverse each node that has feedback relationship in the net.

Step 5: Delete the transition $prep$ with only one input and output place together with its input place and output place. Complete the workflow model.

Step 6: Add corresponding fuzzy time parameters to each transition $perf_v$, that is $D_v = E_v$.

5. Application modelling and simulation optimization

5.1 Establishment of building PDICN

The model is implemented and simulated utilizing the software CPNTools, a public domain program developed by Aarhus University, dedicated to modelling, simulation and analysis of colored Petri nets.
Taking the building product structure detailed design process as an example, the process consists of five parts, including making design output plan, doing structural calculations, designing foundation and frame structures, designing external wall and roof structures, and designing complementary structures (Karhu et al. 1997). Each part of the work is influenced by lots of constraint conditions, such as global design, contract, geotechnical information, and external environment. Figure 3 illustrates the PDICN of the detailed structural design process.

5.2 Resource management model for building product design process

According Figure 3 and the establish procedures in section 4, the resource management model based on FTCWF-net for building product detailed structural design process is proposed. The detailed models are shown in Figure 4, 5, 6 respectively.

Figure 3: PDICN schematic diagram of building product detailed structural design process workflow

In Figure 4, transitions $Sn1$, $Sn2$ and $Sn3$ with rectangle tag at the left bottom corner are substitute transitions respectively representing structural calculation design task subnet, foundations and frame structures design task subnet and external wall and roof structures design task subnet. The transition $res$ with rectangle tag at the left bottom corner is also a substitute transition which corresponds to resource allocation subnet in Figure 6.
Figure 4: Resource model for building product structural design process (Top layer)

Figure 5 corresponds to structural calculation design task subnet showing the structural calculation design process. The place $p_1$ in the model is the design task input place in subnet. The place $p_2$ is the output place. They are joined with the top layer of the model. The place $preRes$ is an activity resource request place; the place $res1$ denotes the resource allocation; the place $p$ denotes the resource return place; and the place $Time$ represents time. Each of them is connected with resource layer respectively.
Figure 5: Resource model for building product structural design process (Subnet layer)

Figure 6 shows the subnet in resource management layer. It is the core part of the resource management model which controls resource allocation in the model, minutes the change of activities time, and simulates resources utilization and competition. All the resource allocation is managed by subnet. In the subnet, the place $preRes$ represents resource request, the places $Po1$, $Po2$, $Po3$, and $Po4$ represent four resource pools of four kinds of resources respectively. The places $res1$, $res2$, and $res3$ represent output resource pools allocating to design activity 1, 2 and 3, respectively. The place $p$ denotes resource return orders after the completion of design activities. The transition $t1$ denotes the check for resource request from the activities (Input: requirement request of activity resource; Output: requirement request of activity resource after being checked). The transition $res$ denotes the resource is allocated to corresponding resource request output pool according to the resource request of design activities (Input: requirement request of activity resource after being checked; Output: the allocated resource according to the resource request). The transition $t3$ represents the resource is released by the design activities and returned to the corresponding resource pool (Input: resources returned; Output: resources after being classified).
5.3 Model data and simulation

Table 1 shows the resource list for detailed design process.

Table 1: Resource list for detailed design process

<table>
<thead>
<tr>
<th>Resource category</th>
<th>Total number</th>
<th>The amount of resource needed by each design sub-activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>t11</td>
</tr>
<tr>
<td>R1</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>R2</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>R3</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>R4</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Time (Day)</td>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>

6. Simulation results analysis and optimization

According to the data in Table 1, 10,000 simulations are conducted. The results show the shortest completion time for design activity is 36 days, the longest completion time is 84 days, and average
time in the given resource condition is 50 days. Under the given conditions, the resource utilization efficiencies for \( R_1 \) is 54.72\%, \( R_2 \) is 47.53\%, \( R_3 \) is 42.41\% and \( R_4 \) is 40.80\% respectively.

Based on the simulation results above, under the conditions of given design tasks amount, the corresponding resource demanding amount varies with the time constraint conditions. Thus, the design process completion time and resource utilization efficiency can be affected by changing the resource allocation ratio to obtain the optimal resource allocation in specific situation. The goal of resource management optimization in this case is the most economical resource allocation when the average design duration is within 60 days.

The dynamic programming algorithm (Novoa and Storer 2009) is adopted to statistically analyze the simulation results of system time when each kind of resources change independently, while other three kinds of resources are sufficient. The relationship curve for resource number and system time is obtained in Figure 7.

![Figure 7: Relationship curve for quantity of resource and system time](image)

According to the data in Figure 7, the resource allocation alternatives can be obtained according with the conditions that the design duration is within 60 days. All the alternatives are simulated. The optimal is the one that satisfies the time conditions, as well as minimum resources.

When resource allocation for \( R_1 \) is 10, \( R_2 \) is 11, \( R_3 \) is 10, and \( R_4 \) is 11 respectively, its task completion average time is 59.2 days (10,000 times simulation), and the resource utilization ratio for \( R_1 \), \( R_2 \), \( R_3 \) and \( R_4 \) is 51.44\%, 52.79\%, 46.14\%, and 52.35\% respectively. This program is optimal with the least resource consumption among all the alternatives.

### 7. Conclusion

This paper develops a model for managing the architectural design information in the building product design process. This method can satisfy the practical demand of resource management for dynamic discrete systems in architectural design and realize the objectives of minimizing the overall duration of a construction project and resource allocation. The model is implemented in detailed structural design stage of an office building. The software CPNTools is utilized for simulation. By the analysis of model structure, run-time, resource utilization efficiency, and the relationship between quantity of resources and system time, the expected completion time and resource allocation
solutions under arbitrary pre-supposed duration are obtained. The method can select and evaluate the program plans of different design projects and choose the optimal plan with high efficiency and short duration under the conditions of resource constraints. Further research includes issues of the sensitivity analysis, joint use of the proposed model with optimization algorithms in order to minimize the total duration of the product design process, as well as the extension of the modeling to other stages in the design process and construction.

Acknowledgement

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Toward an Adaptable Architecture
Guidelines to integrate Adaptability in the Building

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Abstract

Urban areas around the world are experiencing many problems related to a poor use of buildings, and high consumption of energy and materials through repetitive buildings’ refurbishment or demolition. Inhabitants and users complain about rigidity of their buildings which become inadaptable to their evolving needs through time.

Architecture must embrace adaptability and flexibility to withstand effectively, and with respect of sustainability, the increasing needs of change that our contemporary society knows, and to create a symbiotic relationship between the building and its users. Adaptability helps to achieve a safe, healthy, effective, responsive, harmless, environmental friendly and well integrated building, and thus to ensure a long term value.

Within the context of my PhD research, an analytic review of flexibility and adaptability integration in the building as well as a study of contemporary approaches dealing with these concepts allowed to come out with a hierarchical deterministic approach that takes into consideration the different dimensions related to the building, including social, professional, economical, spatial, functional, and technical aspects. This paper aims to empower architects and designers with an efficient use of adaptability in the building, in order to meet the requirements of sustainable development.

Keywords: adaptability, flexibility, sustainability, guidelines
1. Introduction

Adaptability is the built-in ability to adapt and adjust to change by meeting different uses, allowing various spatial and functional configurations, and updating technologies without requiring significant disruption of the building, the ongoing activities and the environment (Kronenburg, 2007).

On this basis, adaptability plays a major role to improve the building’s sustainable attributes. The possibility of lasting through time while the building spaces and components continue to change, generates many opportunities including each one of the pillars of sustainable development (Nakib, 2009): at the individual level, adaptability allows to enhance the user’s wellbeing and safety by achieving comfort, health, security, indoor environmental quality, life quality as well as a good interactivity with the building and other users. Socially: Adaptability allows to satisfy continuously the common and individual needs of people, and to support their intervention and interaction (between them and with the space) by providing them a more expressive frame which evolves through time without harming the neighbourhood or compromising future generations. That allows maintaining coherence with social and cultural tendencies and consequently preserving the place identity and specificities. Economically: Adaptability allows the building to fulfil its function more efficiently, remain longer in service, reduce materials consumption through time and take full advantage of technological innovations. It can respond to change faster and at lower cost. That guarantees to keep building viability longer. Environmentally: Adaptability allows reducing resources and energy consumption and ensures a minimum environment perturbation.

Since the Building is a highly complex structure, it is important to highlight that adaptability has to be considered as a combination of many aspects. It can be approached with different perspectives. In this context, and within the framework of my PhD research, an analytic review of flexibility and adaptability integration in the building as well as a study of the different contemporary approaches dealing with these concepts seemed indispensible to put my hand on the different aspects that should be taken into consideration. The most studied approaches are rooted in the hierarchical principle, and most of them are based fundamentally on Habraken (1998) and Brand (1994) works. The most representative among these approaches are: “Open Building”1 rallied under the Working Commission W-104 of the International Council for Research and Innovation in Building and Construction (CIB); “FlexHousing”2 developed by CMHC (Canada Mortgage and Housing Corporation); “Ruimtelab”3 which is a research laboratory in Netherlands supervised by René Heijne and Jacques Vink; and “Adaptable Futures”4 developed by Loughborough’s Innovative Manufacturing & Construction Research Centre (IMCRC). Another approach which is widely applied in the different fields of architecture but very little in adaptability integration is the “fractal geometry”. The exploration of this theory helped to include the human dimension and the harmonization with the natural environment

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1 Information about Concepts and implementation can be found in: [http://www.open-building.org/](http://www.open-building.org/)
3 More information could be found in can be found in: [http://www.ruimtelab.nl/](http://www.ruimtelab.nl/)
4 More information could be found in can be found in: [http://www.adaptablefutures.com/](http://www.adaptablefutures.com/)
(Nakib, 2010a). The above approaches led to come out with a hierarchical deterministic approach that facilitates the integration of adaptability in the building and which takes into consideration the different levels related to the building including social, professional, economical, spatial, functional, and technical aspects.

2. Guidelines to integrate adaptability in the building

It is very important to highlight that every building is unique by its physical structure, its function, as well as its relationship with the users and the surrounding environment. We don’t pretend through these guidelines that we are providing a recipe which adapts to every situation, but just a way to think and some tools to facilitate the adaptability and evolutionability of the building.

2.1 Socio-professional guidelines

The success of adaptability integration is strongly related to the nature and behaviour of the different interveners on the building. A better knowledge of the users’ and inhabitants’ needs and expectations as well as a judicious choice of the professional specialists are both crucial. Furthermore, the following guidelines should be respected:

• Support flexible thinking.

• Encourage open architecture based on a transformation and evolution process rather than a perfect finished product.

• Call for different decision making levels in the design, construction and modification of the building, and precise clearly the responsibilities and rights of every one. The intervention of the different decision making levels must be organized hierarchically from the collective to the individual (ex: building inhabitants – floor inhabitants - flat inhabitants- room inhabitants), and from the formal: authority, organism, town planner, architect, etc. to the informal: the users (Kendall, 2004)

• Involve users in the decision-making process, and guarantee the balance between the freedom of their intervention and formal control assured by of the upper levels (e.g. Regulations). This is crucial for the environmental and socio-cultural coherence of the building.

• Encourage professional interdisciplinarity and coordination between the different specialists (urban designers, architects, interior designers, engineers, etc). Precise and differentiate the different responsibilities in order to reduce dependency, conflict and interferences (Kendall, 2004)

• Ensure the respect of the local context, its identity and specificities.

• Guarantee an active and regular maintenance of the building after its occupation.
• Raise awareness and spread information in all levels (inhabitants and users, professionals, regulatory institutions, clients, investors, etc.). Promote academic researches and practical experimentations.

2.2 Economical guidelines

• Put forward simple and inexpensive solutions before the technically and financially complicated ones. Sometimes, simple local solutions inspired from traditional architecture could be more efficient and cost less than modern ones.

• Invest more in the design and construction to spend less in modifications and maintenance.

2.3 Spatial and functional guidelines

An adaptable building should provide a space plan able to be arranged in several scenarios to meet different needs, life styles and uses. Functional and spatial adaptability can be achieved by respecting the following guidelines:

• Design the building as a combination of independent system-based layers organized hierarchically according to their expected lifespan and rate of change (structure, circulation routes and access, envelope, technical services and installations, space plan and furniture). This differentiation allows upgrading, adding, replacing or removing the components of each layer without affecting the structure of the others or the whole, Fig (1).

• Design every layer to allow different alternatives in the lower layer.

Figure 1: Building’s independent layers (Hinte and Neleen, 2003)
- Include multifunctional spaces allowing for a large variety of functions, as well as transfunctional spaces leading to the creation of new undetermined and unpredictable activities according to the users’ personal experiences and their consumption of space, Fig (2).

- Include mobility: install partitions and furniture that are light, mobile, demountable, reusable and recyclable, Fig (2).

- Support elasticity and divisibility: design the building to be easily extended (vertically or horizontally) or subdivided into different functional entities without hampering its functioning or its coherence, Fig (2). That requires a specific attention to the functional layout arrangement, the relationship between units and the distribution of accesses and services.

![Figure 2: Multifunctionality, mobility, divisibility and elasticity (Blakstad, 2001)](image)

- Optimize the space and its utilization: enhance the space density by multiplying the activities places without expending its topological dimension (e.g. Menger sponge), Fig (3). Take advantage of every millimetre of the space in height and area.

![Figure 3: Space optimization according to 'Menger Sponge', the case of Sarphatistraat office building designed by Steven Holl (www.stevenholl.com)](image)
• Use modularity to facilitate reconfiguration, subdivision and easy rearrangement of spaces. That guarantees evolution of the building through time according to the needs.

• Design spaces that are fluid and continuous and think carefully of the design of storage and its location.

• Include buffer zones allowing to absorb the overflowing caused by the frequent change of close spaces (which have important function and flow) and to avoid any encroach on the other spaces. The buffer spaces should have their own function which can change according to the needs.

• Design internal circulations routes as part of an overall architectural concept. They should be alive, animated, and interactive and should be able to host many activities. Avoid narrow and dead circulations of which the only function is moving from a place to another.

• Provide more than the minimum spatial areas and floor heights to facilitate space adaptation to others functions and conditions. Judicious estimation helps to avoid exaggeration.

• Spread out the design and construction of the building over different phases in order to better meet the progressive change and new needs, and therefore, keep coherence with the socio-cultural and economical conditions as well as technological advancement.

• Integrate the building into the surrounding environment. Design the building as intertwined spaces with the immediate natural and built environment in order to optimise their connection and interaction and enhance permeability and accessibility.

2.4 Structural guidelines

The building structure can also contribute in a number of significant ways to achieve the building adaptability. Thus, the following guidelines should be taken into consideration:

• Design foundations as to allow for potential expansion and extra loads. Reinforce also the lower slabs to bear the eventual supplementary loads resulted from the future functional and spatial modifications. A rational analysis should be made to determine a reasonable estimate.

• Design support structures to fulfill various long term changes and uses, and to accommodate a variety of technical services distribution schemes based on eventual future changes. Minimize the number of internal columns and bearing walls which could compromise building adaptability. Use a wide structural grid based on the multiplication of 7,2m and a generous floor-to-floor height.

• Make the support structure divisible, enabling future independence of compartments. Consider in the design, the separation of entrances, stairs and lifts.

• Use well adapted structural systems to local context, able to resist to major risks.
• Use dry connections with no male-female connections.

• Study carefully the installation of joints in order to avoid any differential settlements due to eventual extra loads.

2.5 Technical guidelines

Architectural adaptability cannot be achieved without a suitable adaptation of technical buildings components (Nakib, 2010b). Servicing and technical installations are considered as a key factor to adapt buildings (Kronenburg, 2007) and should be designed for longevity, expandability, disassembly, recyclability, maintainability, and energy and material efficiency. Therefore, the following guidelines which are based mainly on the work of Geraedts (2001, 2008), should be respected:

• Avoid embedded ducts and pipes in other buildings’ systems (structure, walls, floors or ceiling).

• Ensure an easy access to technical components and installations by using dropped ceilings, raised floors, central cores, plenums, etc. That allows for easy maintenance and upgrading without disruption perturbation. Use generous and adaptable plenum systems (either overhead or under-floor) to meet space needs for future HVAC, power, lighting, and fire protection systems change.

• Make a distinction between collective and individual installations to facilitate maintenance and repair.

• Separate flexible components from inflexible ones, so as to enable change where it is valuable while preserving static elements that constitute the base of the building. Consider the distinction between long and short life cycles.

• Use pluggable connections (plug and play) such that installation components can be easily and safely disconnected, removed or repositioned while limiting the knock-on effect of changes. And Encourage use of wireless systems (low current, infra-red, etc) as they become commercially viable, to reduce problems related to distribution of cables and ducts.

• Locate strategically cables and ducts (backbone pathways) and ensure that the location of fixed services’ rooms is chosen such that it doesn’t compromise different configurations or uses in the future.

• Adopt prefabricated and standardized components, and encourage modular coordination (design and construction according to a fixed module) for easy replacement and recyclability, Fig (4). Use durable, recyclable and sustainable components.

• Over-measure energy to accommodate the growing and evolving demands and provide emergency power supply.
• Design installation systems as a modular and dividable system into several independent subsystems, and the interface between them must be reduced as often as possible, making easier to replace one of the subsystems by another one without affecting the system of the upper level nor the wholeness.

• Work out a precise description of different technical elements specifications (location, functioning, etc,) allowing feedback in case of future change.

Figure 4: Modular and dividable technical systems. The case of Matura system developed by Habraken (www.habraken.com/html/downloads.html)

2.6 Façade guidelines

In order to allow easy interior changes as well as new technologies integration, we should consider the following in the facade design:

• Design a versatile envelop able to meet the building internal changes. Double façade when possible, to allow absorbing internal changes without affecting the exterior skin

• Make the building envelope independent of the structure and provide means for access (to the envelop system) from inside the building and from outside to facilitate maintenance and repair.

• Design sober facades and avoid overabundance of ornaments and extravagance while considering details. That allows easier adaptation to new uses. Choose materials that allow a building to weather beautifully and grow old gracefully.

• Base the façade design on a modular system to allow replacement, updating, integration of new technological features and suit of fashion. Base the modularity on a fractal composition in order to avoid monotony and uniformity while creating mixed, dynamic and personalized facades. Base the design of the façade on hierarchical scales with preferably a ratio of 2.7 between every two
consecutive scales. This constant constitutes the base of natural logarithms and arises in the most successful and psychologically comfortable buildings (Salingaros, 2000).

- Increase the contact and exchange areas of the building by creating an irregular and meandering perimeter. That enable the building and its different parts to breathe, and interact as well as to be better ventilated and lit, etc. it also helps to enhance physical and visual accessibility and permeability (Nakib, 2010a)

3. Conclusion

Buildings should be designed with adaptability in mind to anticipate the accelerating rhythm of change, and absorb its consequent effects. Adaptability plays a major role to improve the sustainable attributes of the building in order to keep harmony with the natural environment and lie within the new imperatives of sustainable development.

This paper has shown that the building is a highly complex system which requires a systemic approach to achieve adaptability. It calls for a combination of many interrelated key factors: social, professional, economical, spatial, functional, technical, and structural as well as some aspects related the facade adaptability. A lack of consideration of one of these aspects may hinder the building adaptability.
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The Five Components of BIM Performance Measurement

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Abstract

Building Information Modelling (BIM) is an expansive knowledge domain within the Design, Construction and Operation (DCO) industry. The voluminous possibilities attributed to BIM represent an array of challenges that can be met through a systematic research and delivery framework spawning a set of performance assessment and improvement metrics. This paper identifies five complementary components specifically developed to enable such assessment: [1] BIM Capability Stages representing transformational milestones along the implementation continuum [2] BIM Maturity Levels representing the quality, predictability and variability within BIM Stages, [3] BIM Competencies representing incremental progressions towards and improvements within BIM Stages, [4] Organisational Scales representing the diversity of markets, disciplines and company sizes and [5] Granularity Levels enabling highly-targeted yet flexible performance analyses ranging from informal self-assessment to high-detail, formal organisational audits. This paper explores these complementary components and positions them as a systematic method to understand BIM performance and to enable its assessment and improvement.

Keywords: Building Information Modelling, performance assessment and improvement, Capability and Maturity Models

1 There is no widely used term-definition which is equally representative of all planning-to-demolition activities within the construction industry. The author opted – after experimenting with many available acronyms like AEC, AECO, AECOO and AEC/FM - to adopt DCO as a preferred acronym as it builds upon the three major project lifecycle phases (Succar, 2009a).
1. Building Information Modelling: a brief introduction

Building Information Modelling (BIM) is a set of interacting policies, processes and technologies (Succar, 2009a) generating a “methodology to manage the essential building design and project data in digital format throughout the building’s life-cycle” (Penttilä, 2006). This definition is one of tens of attempts to delimit the BIM domain which continues to expand in coverage and connotation. It is important – if we acknowledge BIM’s value to the DCO industry and are inclined to favour its systemic adoption - to identify the domain’s knowledge structures, internal dynamics and implementation requirements.

Some signs of the proliferation of BIM

There are many signs that the use of Building Information Modelling tools and processes is reaching a tipping point in some markets2. An increasing number of large institutional clients3 - within the US for example - now stipulate object-based 3D models as the medium for accepting project submissions. Other signs include the abundance of BIM-specific software tools, books4, blogs5, tweets6, tags7 and reports from trusted market watchers8.

Issues arising from the proliferation of BIM

The abundance of industry discussions and academic literature professing the ability of BIM methodologies to increase productivity has not yet been coupled with the availability of metrics and knowledge tools to reliably measure this productivity. Also, organisations attempting to generate new or enhance existing BIM deliverables can find little guidance towards identifying and prioritizing their respective requirements. This mismatch between expected BIM deliverables and unforeseen BIM requirements increases the risks, costs and difficulties associated with BIM implementation, allows the proliferation of ‘BIM wash’ – falsely professing the ability to deliver BIM services or products - and prevents industry players from achieving their BIM potential.

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5 Refer to blog search engine results similar to http://bit.ly/GoogleBlogs_BIM
6 Refer to Tweet searches for the term BIM and/or IPD http://twitter.com/#search?q=bim%20ipd
8 Examples include the Building Design + Construction’s Top 170 BIM Adopters ranking; part of the 2009 Giants 300 survey (http://bit.ly/Giants09).
2. The need for BIM performance metrics

The development of BIM performance metrics is a pre-requisite for BIM performance improvement. On one hand and without metrics, teams and organisations are unable to consistently measure their own successes or failures. Without measurement, no meaningful performance improvements may be achieved, financial investments may be misplaced and much efficiency may be lost. On the other hand and with the availability of measurement metrics, teams and organisations will be able to assess their own BIM competencies or compare them against an industry benchmark. Also, a valid set of BIM metrics will lay the foundations for a formal certification system which can be employed by industry leaders, governmental authorities and large facility owners/procurers to pre-select BIM service providers and attest to the quality of their deliverables.

2.1 Developing metrics and benchmarks

While it is important to develop metrics and benchmarks for BIM performance assessment, it is equally important for those metrics to be consistently accurate and adaptable to different industry sectors and organisational sizes. Much insight can be gained from performance measurement tools developed for other industries (Succar, 2009b); however, it is impractical to rely on any tool which is not specifically designed to measure key BIM deliverables/requirements or is not equally applicable across the construction supply chain.

This paper discusses a set of metrics purposefully developed to measure the specifics of BIM performance. To increase their reliability, adoptability and usability by different stakeholders, the metrics have been tailored to conform to a set of guiding principles partially discussed below:

**Accurate:** metrics are clear, falsifiable and allow accurate, repeatable assessment.

**Applicable:** metrics can be utilised by all stakeholders across Project Lifecycle Phases.

**Attainable:** benchmarks can be achieved through progressive accumulation of defined actions.

**Consistent:** when conducted by different assessors, measurements still yield the same results.

**Cumulative:** benchmarks are set as logical progressions; deliverables from one benchmark act as prerequisites for another.

**Flexible:** assessments can be performed across markets, organisational scales and their subdivisions.

**Informative:** measurements provide “feedback for improvement” and “guidance for next steps” (Nightingale and Mize, 2002).

**Neutral:** measurements do not prejudice proprietary, non-proprietary, closed, open, free or commercial solutions or schemata.

**Specific:** metrics are well defined and serve industry-specific assessment purposes.

**Usable:** metrics are intuitive and can be easily employed to assess BIM performance.

Based on the above guiding principles, the sections below introduce a set of complementary knowledge components which enable BIM performance assessment and facilitate its improvement:
3. Assessment components

There are five BIM Framework components (Succar, 2009a, Succar, 2009b) required to enable accurate and consistent BIM performance measurement:

3.1 BIM capability stages

BIM Capability is the basic ability to perform a task or deliver a BIM service/product. BIM Capability Stages (or BIM Stages) define the minimum BIM requirements - the major milestones that need to be reached by teams or organisations as they implement BIM technologies and concepts. Three BIM Stages separate ‘pre-BIM’, a fixed starting point representing industry status before BIM implementation, from ‘post-BIM’, a variable ending point representing the ever evolving goal of employing virtually integrated Design, Construction and Operation (vDCO) tools and concepts:

**BIM Stage 1:** object-based modelling

**BIM Stage 2:** model-based collaboration

**BIM Stage 3:** network-based integration

BIM Stages are defined by their minimum requirements. As an example, for an organisation to be considered at BIM Capability Stage 1, it needs to have deployed an object-based modelling software tool similar to ArchiCAD, Revit, Tekla or Constructor. Similarly for BIM Capability Stage 2, an organisation needs to be part of a multidisciplinary ‘model-based’ collaborative project. To be considered at BIM Capability Stage 3, an organisation needs to be using a network-based solution (like model servers or BIMSaaS) to share object-based models with at least two other disciplines. Each of the three Capability Stages is further subdivided into Competency Steps. What differentiates stages from steps is that stages are transformational or radical changes while steps are incremental ones (Henderson and Clark, 1990) (Taylor and Levitt, 2005). The collection of steps required when working towards or within a BIM Stage - across the continuum from pre-BIM to post-BIM - is driven by different perquisites for, challenges within and deliverables of each BIM Stage. In addition to their type (the Competency Set they belong to – refer Section 3.3 below), BIM Steps can be also identified according to their location on the continuum (Fig. 1):

- **A Steps:** from pre-BIM Status leading to BIM Stage 1
- **B Steps:** from BIM Stage 1 leading towards BIM Stage 2
- **C Steps** from BIM Stage 2 leading towards BIM Stage 3
- **D Steps** from BIM Stage 3 leading towards post-BIM

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9 The author has stopped using the term Integrated Project Delivery (IPD) to represent the ultimate goal of implementing BIM (AIA, 2007) to prevent any confusion with the term’s evolving contractual connotations.

3.2 BIM maturity levels

The term ‘BIM Maturity’ refers to the quality, repeatability and degree of excellence within a BIM Capability. That is, as opposed to ‘capability’ which denotes a minimum ability (refer to Section 3.1), ‘maturity’ denotes the extent of that ability in performing a task or delivering a BIM service/product. BIM Maturity’s benchmarks are performance improvement milestones (or levels) that teams and organisations aspire to or work towards. In general, the progression from low to higher levels of maturity indicate (i) better control through minimising variations between performance targets and actual results, (ii) better predictability and forecasting by lowering variability in competency, performance and costs, and (iii) greater effectiveness in reaching defined goals and setting new more ambitious ones (Lockamy III and McCormack, 2004) (McCormack, Ladeira and Oliveira, 2008).

The concept of BIM Maturity has been adopted from SEI’s Capability Maturity Model (SEI, 2008), a process improvement framework initially intended as a tool to evaluate the ability of government contractors to deliver a software project. CMM originated in the field of quality management (Crosby, 1979) and was later developed in 1980s for the benefit of the US Department of Defence (Hutchinson and Finnemore, 1999). It’s successor, the more comprehensive Capability Maturity Model Integration (CMMI), continues to be developed and extended by the Software Engineering Institute, Carnegie Mellon University. There are also other varieties of CMMs across many industries (Succar, 2009b) but they are all - in essence – specialised frameworks to assist stakeholders in improving their capability (Jaco, 2004) and achieving process improvement benefits. These include increased productivity and Return On Investment (ROI) as well as reduced costs and post-delivery defects (Hutchinson and Finnemore, 1999).

Maturity models are typically composed of multiple maturity levels - process improvement ‘building blocks’ or ‘components’ (Paulk, Weber, Garcia, Chrissis and Bush, 1993). When the requirements of each level are satisfied, implementers can then build on top of established components to attempt ‘higher’ maturity. Although CMMs are not without their detractors (Weinberg, 1993) (Jones, 1994) (Bach, 1994), research conducted within other industries have already identified the correlation between improving process maturity and business performance (Lockamy III and McCormack, 2004).
The ‘original’ software industry CMM, however, is not applicable to the construction industry as it does not address supply chain issues, and its maturity levels do not account for the different phases of a project lifecycle (Sarshar, Haigh, Finnemore, Aouad, Barrett, Baldry and Sexton, 2000). Although there are other efforts – derived from CMM - which focus on the construction industry (Succar, 2009b), there is no comprehensive maturity model/index that can be applied to BIM, its implementation stages, players, deliverables or its effect on project lifecycle phases.

To address this shortfall, the BIM Maturity Index (BIMMI) has been developed by analysing and then integrating several maturity models used across different industries (Succar, 2009b). It has been customised to reflect the specifics of BIM capability, implementation requirements, performance targets and quality management. The BIM Maturity Index has five distinct levels: (a) Initial/Ad-hoc, (b) Defined, (c) Managed, (d) Integrated and (e) Optimised (Fig. 2). Level names have been chosen through comparing terminology used by many maturity models followed by selecting those easily understandable by DCO stakeholders and able to reflect increasing BIM maturity from ad-hoc to continuous improvement (Succar, 2009b).

![Fig. 2. Building Information Modelling Maturity Levels at BIM Stage 1](image)

**3.3 BIM competency sets**

A BIM Competency Set is a hierarchical collection of individual competencies identified for the purposes of BIM implementation and assessment. The term Competency – as used by the author – does not necessarily reflect human abilities but a generic set of abilities suitable for implementing as well as assessing BIM Capability and/or Maturity. If a BIM Competency Set is used for active implementation, they are referred to as BIM Implementation Steps. However, if used for assessing existing implementations, they are referred to as BIM Assessment Areas. The below diagram (Fig. 3) reflects how the BIM Framework (Succar, 2009a) generates BIM Competency Sets out of multiple Fields\(^\text{11}\) , Stages and Lenses\(^\text{12}\):

\[^{11}\text{BIM Fields are conceptual clusters of domain players interacting and overlapping within the DCO industry (Succar, 2009a). There are three BIM Field Types (Technology, Process and Policy) and three Field Components (Players, Requirements and Deliverables).}\]

\[^{12}\]
BIM Competencies are a direct reflection of BIM Requirements and Deliverables and can be grouped into three sets – Technology, Process and Policy:

**Technology sets** in software, hardware and networks. For example, the availability of a BIM tool allows the migration from drafting-based to object-based workflow (a requirement of BIM Stage 1)

**Process sets** in leadership, infrastructure, human Resources and products/services. For example, collaboration processes and database-sharing skills are necessary to allow model-based collaboration (BIM Stage 2).

**Policy sets** in contracts, regulations and research/education. For example, alliance-based or risk-sharing contractual agreements are pre-requisites to network-based integration (BIM Stage 3).

Below (Fig. 4) is a partial mind map of BIM Competency Sets shown at Granularity Level 2 (to understand Granularity Levels, please refer to Section 3.5):

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12 BIM Lenses are distinctive layers of analysis which allow domain researchers to selectively focus on any aspect of the DCO industry and generate knowledge views that either (a) highlight observables which meet the research criteria or (b) filter out those which do not (Succar, 2009a).
3.4 BIM organisational scales

To allow BIM performance assessments to respect the diversity of markets, disciplines and company sizes, an Organisational Scale (OScale) has been developed. The Scale can be used to customise assessment efforts and is depicted in Table 1 below:
Table 1: Organisational Scale

<table>
<thead>
<tr>
<th>Low Detail</th>
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<th>Detail</th>
<th>High Detail</th>
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<th>Short Definition</th>
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</tr>
<tr>
<td>Isp</td>
<td>Specialty</td>
<td>Specialty is a focus area of knowledge, expertise, production or service within a sub-discipline.</td>
<td></td>
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</tr>
<tr>
<td><strong>MESO</strong></td>
<td>P</td>
<td>Project Teams</td>
<td>n/a P</td>
<td>Project Team</td>
<td>Project Teams are temporary groupings of organisations with the aim of fulfilling predefined objectives of a project - a planned endeavour, usually with a specific goal and accomplished in several steps or stages. <a href="http://bit.ly/dqMYg">http://bit.ly/dqMYg</a></td>
<td></td>
</tr>
<tr>
<td>Projects and their teams</td>
<td></td>
<td></td>
<td>(Macro O) O</td>
<td>Organisation</td>
<td>An organisation is a ‘social arrangement which pursues collective goals, which controls its own performance, and which has a boundary separating it from its environment. <a href="http://bit.ly/v7p9N">http://bit.ly/v7p9N</a></td>
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</tr>
<tr>
<td>(Meso O) Ou</td>
<td>Organisational Unit</td>
<td>Departments and Units are specialised divisions of an organisation. These can be co-located or distributed geographically.</td>
<td></td>
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<tr>
<td>(Meso O) Ot</td>
<td>Organisational Team</td>
<td>Organisational Teams consist of a group of individuals (human resources) assigned to perform an activity or deliver a set of assigned objectives. Teams can be physically co-located or formed across geographical or departmental lines.</td>
<td></td>
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<tr>
<td>(Micro O) Om</td>
<td>Organisational Member</td>
<td>Organisational members can be part of multiple Organisational Teams.</td>
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</tbody>
</table>
### 3.5 BIM granularity levels

Competency Sets include a large number of individual competencies grouped under numerous competency headings (refer to Fig. 4). To enhance BIM Capability and Maturity assessments and to increase their flexibility, a Granularity ‘filter’ with four Granularity Levels (GLevels) has been developed. Progression from lower to higher levels of granularity indicates an increase in (i) assessment breadth, (ii) scoring detail, (iv) formality and (iv) assessor specialisation.

Using higher-granularity levels (GLevels 3 or 4) exposes more detailed Competency Areas than lower-granularity levels (GLevels 1 or 2). This variability in breadth, detail, formality and specialisation enables the preparation of several BIM performance measurement tools ranging from low-detail, informal and self-administered assessments to high-detail, formal and specialist-led appraisals. Table 2 below provides more information about the four Granularity Levels:

<table>
<thead>
<tr>
<th>GLevel Number, GLevel Name, Description and Scoring System (Numerical and/or Named)</th>
<th>OScale applicability</th>
<th>Assessment By, Report Type and Guide Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 <strong>Discovery</strong> A low detail assessment used for basic and semi-formal discovery of BIM Capability and Maturity. Discovery assessments yield a basic numerical score.</td>
<td>All Scales</td>
<td>Self</td>
</tr>
<tr>
<td>2 <strong>Evaluation</strong> A more detailed assessment of BIM Capability and Maturity. Evaluation assessments yield a detailed numerical score.</td>
<td>All Scales</td>
<td>Self and Peer</td>
</tr>
<tr>
<td>3 <strong>Certification</strong> A highly-detailed appraisal of those Competency Areas applicable across disciplines, markets and sectors. Certification appraisal is used for Structured (Staged) Capability and Maturity and yields a formal, Named Maturity Level.</td>
<td>8 and 9</td>
<td>External Consultant</td>
</tr>
<tr>
<td>4 <strong>Auditing</strong> The most comprehensive appraisal...In addition to competencies covered under Certification, Auditing appraises detailed Competency Areas including those specific to a market, discipline or a sector. Audits are highly customisable, suitable for Non-structured (Continuous) Capability and Maturity and yield a Named Maturity Level plus a Numerical Maturity Score for each Competency Area audited.</td>
<td>8, 9, 10 &amp; 11</td>
<td>Self, Peer and External Consultant</td>
</tr>
</tbody>
</table>
Granularity Levels thus increase or decrease the number of Competency Areas used for performance assessment. For example, the mind map provided in Fig. 4 reveals **ten Competency Areas** at GLevel 1 and **thirty-four Competency Areas** at GLevel 2. Also, at GLevels 3 and 4, the number of Competency Areas available for performance assessment increase dramatically as depicted in Fig. 5:

**Fig. 5. Technology Competency Areas at Granularity Level 4 – partial mind map v1.1**

The partial mind map depicted in Fig. 5 unveils many additional Competency Areas under GLevel 3 like Data Storage and Date Exchange. At GLevel 4, the map unveils even more-detailed Competency Areas like Structured and Unstructured Data which in-turn branch into computable and non-computable components (Kong, Li, Liang, Hung, Anumba and Chen, 2005) (Mathes, 2004) (Fallon and Palmer, 2007).

### 4. Applying the five assessment components

Using the above five complementary Framework components, BIM performance assessments can be conducted - in conformance with the guiding principles discussed in Section 2.1 - at multiple combinations of Capability, Maturity, Competency, Organisational Scale and Granularity. To manage all possible configurations, a simple assessment and reporting workflow has been developed (Fig. 6):
Expanding on the above diagram, a total of five workflow steps are needed to conduct a BIM performance assessment. Starting with an extensive pool of generic BIM Competencies - applicable across DCO disciplines and organisational sizes – assessors can first filter-out non-applicable Competency Sets, conduct a series of assessments based on remaining Competencies and then generate a suitable Assessment Report.

5. In summary

The five BIM Framework components, briefly discussed in this paper, enable an array of assessment possibilities for DCO stakeholders to measure and improve their BIM performance. These components complement each other and enable highly-targeted yet flexible performance analyses ranging from informal self-assessment to high-detail and formal organisational audits. Such a system of assessment can be utilised to standardize BIM implementation and assessment efforts, enable a structured approach to BIM education and training as well as establish a solid base for a formal BIM certification process. The five components and other related assessment, scoring and reporting tools are currently being extended, tested and validated. A mechanism for identifying and continuously updating BIM Competencies by subject matter experts is actively being developed. Also, a sample online tool (focusing on a sample discipline, at a sample granularity) is currently being formulated. Once conceptual validation, field testing and tool calibration are successfully conducted, the five components may be well-placed to consistently assess, and by extension improve, BIM performance.
Acknowledgement

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Eco-Management in Traditional Iranian Architecture and Methodology of Sustainable Architecture Design Process

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Abstract

From beginning of the global movement of sustainable development, architects in line with other authorities’ thinkers, have researched on solutions to promote the quality of life and adapt the designs to environment. The result expands the sustainability approaches in architecture having common rout and emphasis on adaptability to ecosystem. However, practical methods of achieving sustainable architecture goals are non codified and non combined in trend and needs practical tactics. On the other hand, sustainable Architecture has inadequate attention to traditional Architecture and designs methods which have lots of applicable principles. This article uses content analysis research method and reviews the sustainable architecture approaches then studies eco-tropism approach. Iranian traditional architecture exactly is described and analyses as a real instance of sustainable architecture from eco-tropism view point. Base on Sachs model, this paper, tries to codify Iranian traditional architecture principles and strategies in sustainable architecture design process. Understanding and integration with environment are main features of Iranian traditional architecture that lead to eco-management. Eco-management is a reliable pattern for sustainable architecture and makes it possible to adapt the global principles of sustainable architecture to local scale. Complete cognition of traditional architecture principles and vernacular patterns in the design process of sustainable architecture are some of the requirements to further this research.

Keywords: Eco-management, Iranian traditional architecture, design process methodology, sustainable architecture
1. Introduction

From 1970s energy crisis became politic and economic controversial issues especially in developed countries. At the beginning of 1980s, the awareness about crucial influences of ecology on man’s life increased and understanding the real importance of perimeter conservation result in intelligent act in regulating the interaction between built environment and nature. Attention to natural aspects of ecology became base of sustainable development issue. Essence of sustainable development is answerable to sustain and durability of factors that must be steady among variable phenomena world, means a dynamic, oriented and futurist development to insure present and future generations’ life. Sustainable development has three foundations; environment, economic, and society (Figure 1).

![Figure 1: Three basic approaches of Sustainability (www. Sustainabledevelopment.com)](image)

Architects attempt to professionalize sustainability principles in their Profession. Building integrity with its natural environment and acting as a part of environment circle, can lead to building and environment sustainability. Main goals of sustainable architecture are high quality standards, safety and human Convenience. Sustainable architecture is not a style or special attitude and is not belonged to only present time, because its logical basis is valid in all time and conditions. Improvement of quality of designs in sustainable architecture follows human comfort. It is important to understand that all effective factors on human comfort interact with each other in a unique system. Traditional vernacular architecture has lots of practical and useful patterns. Compatibility to ecological context in different periods of time is one of the basics of traditional architecture so its strategies and tactics contribute to sustainable building and conservation of ecology. But nowadays traditional basics are not used in building widely. One of its reasons is absence of clear method for cognition and application.

2. Sustainable architecture and its scope

Base of most definitions of sustainable architecture is creation a dynamic balance among different domains of environment. This concept encompasses sustainability of ecological, socio-cultural, and economic orders in efficient prospects. Charles Kibert (1994) defines sustainable architecture as creation of man-made environment and its management, according to basics of vernacular adaptability and source
performances. Susan Maxman (1993) emphasizes her claim on sustainable architecture which is method of architecting, theory and Procedure, therefore it is better not to assign specific name and just call it architecture. Also Norman Foster (2001) affirms that the sustainable architecture means good designing, As well, sustainable architecture is defined by environmental campaigner Jonathan Porteous (2002) as architecture which meets human culture, as well as the world’s natural resources (Cowan, 2005).

The method of this research is content-analysis research method that is used to cognize data not as materialized events but as symbolic phenomena and analyzes them without intervene in social reality (Krippendorff, 1980). Recognizing and classification of approaches must be in a systematic view. Linda Groat (2001) suggests a system of inquiry, considering to strategies and tactics. The term “Strategy” is defined as the skillful management and planning of anything and “Tactics” is referred to skillful move (Groat & Wang, 200). In an overall view, sustainable development can be a system of inquiry for sustainable architecture with different approaches. Also, each of the approaches of sustainable architecture can be a system of inquiry which presents the specific technical strategies and their tactics (Figure 2). By Groat’s framework clearer and more completed cognition of sustainable architecture approaches can be gained. The below table is organized with the purpose of understanding structure of different approaches of sustainable architecture (Table 1).

![Figure 2: A system of inquiry frames, Strategies and Tactics (Groat & Wang, 2001)](image)

All Approaches to sustainable architecture can be generally categorized in Theory and Guidelines. In this paper, sustainability is intended in eco-tropism approach with considering socio-cultural, local, historic and traditional aspects beside functional and natural aspects to clear the conceptualism concept.

### 3. Overview of Eco-tropism approach

In ecology field, there are two general viewpoint, first, natural ecology or partial ecology and second, completed ecology (Williamson et al, 2003). Natural ecology is involved with natural science and its Prerequisite is usage of basic knowledge like physics and chemistry from primary form of plans to intricate figures of animals. Completed ecology viewpoint as axis of ecological topics revolution, is opposite to first viewpoint.
In this Beacon, human is accounted as incomparable organizer of physical and biological characteristics of any ecology or human system with psychological, social, cultural, economic and historical aspects in addition to a part of ecology. In completed ecology, there are three kinds of affective factors on design; natural, cultural and technological factors. By putting definition of sustainable architecture on the base of completed ecology, it is more facilitated to develop multi orientate theories about effective factors on interaction between human and environment. Then designers are more successful to fill the blanks between total goals and design decisions. Thus comprehensive and balanced view on environmental design, transforms architecture definition to sustainable architecture. From 1980s, Because of different inference from sustainable architecture concept, some critics believe that this concept shouldn’t be considered as a prescription, but it is an approach can turn to a new definition of architecture in future (Guy and Farmer, 2001). Through this conclusion, sustainable architectural design alters its orientation from merely physical design to codification of inclusive design criteria with attention to non mentioned affective factors on design and balance among them. As first step, designers regard to moral, social and environmental values to promote the Interior Conditions beside visual and physical contact between
buildings and nature. By gradual development of this approaches, in 1980s-90s, Eco-tropism emerged as a conceptualism approach with a great consideration on vernacular condition. Eco-tropism tries to coordinate architecture and context through studying the natural forces, vernacular cultures, traditions and history, sprite of location and balance among effective factors. In this case, Eco-tropism and traditional architecture are common interest since both of them follow socio-ecological sustainability and emphasize on providing a specific eco-efficiency in architectural design and its environmental functions. Contextual sustainability means conservation of sprite of locality and attention to native limitations, potentiality and facilities. Essence of eco-tropism is that sustainability of any building is depended on its location and users sustainability since inhabitants are in correlation to their life location and architecture and have special expectations differ from habitants’ of other locations. Eco-tropism desires a health society with special local identity. Technology can help to reach this goal.

Eco-Tech strategy as a subset of eco-tropism takes pattern from natural life and living organism functional properties like organization, flexibility, changeability, etc. It adapts the architectural spaces and climate through a modern technology. Its purpose is to combine the technology and ecology to design buildings and plan cities with minimum damage on ecosystem (Edwards, 2001). Using compatible forms and materials to cultural appearance and prevalent traditions in any locality, in addition to respecting to natural environment and use of renewable energy resources are the principles of eco-tech strategy. However, coordination between technology and ecology or eco-efficiency is a recent finding in sustainable architecture.

4. Traditional architecture

In the word of Bernard Rudolfsky (1964), vernacular building is architecture without architects. Integrity, participation and anti elitism are celebrated factors of vernacular architecture as touchstones of environmental architecture. In cultures and languages topics, vernacular means native and indigenous, (Gurence, 1990:295). Vernacular building as a model for environmental architecture has two types, first, pursuing an anti industrial, pro craft vernacular revival, and second, as a source of valuable principles to try and test techniques of passive environmental design and learn from its idea of living within the limits of resources (Hagan, 2001:103). Traditional vernacular architecture is a Treasury of the native passive environmental techniques developed to create compatibility between environment and building. Creative techniques in traditional structures and combination of the buildings -the fabric- are friendly and harmless to nature. They integrate external climate and internal condition with heavy or light walls, large or small glazed openings, orientation toward or away from the sun, various shading devices such as shutters, overhangs, etc and ventilation techniques such as cross ventilation, stock ventilation, wind ventilation, etc.

A literal return to traditional architecture illustrate that every object was used, reused and adapted until it wore out and even then the parts were recycled. In fact, it did the best it can with what was to hand in an economical approach. Iranian sustainable architecture in near seven thousands years represents excellent
examples of integrity among environment, culture, history and human demands. Architecture, respects to
culture and religious beliefs and keeps alive the historical features of ancient architecture. Recognition
and analyze the traditional Iranian Architecture needs to borrow a system of enquiry to extract its
practical principles and patterns.

5. System of inquiry to recognition of traditional Iranian architecture

Ignacy Sachs (1980) prepares a system of inquiry for sustainable architecture strategies. He emphasizes
on importance of providing a relation between human and nature as complementary of each other and
says that the nature is neither unchangeable ecological system, nor economic infinite source that can be
exploited proudly; on the contrary it should be utilized by human creative attitude. Sachs (1980)
distinguishes and identifies three fields in ecosystem include natural environment, built environment and
social environment. In this framework an intersection of economic, social and ecological goals are
defined in three deviation; first, inclusive social demand or consumption in its vast meaning, second,
choosing the place of production and supply, mixing the space and energy and third, management and
qualitative conduction of ecosystem.

Relation among demands, supply and environment is shown in Figure 3. This model can be a suitable
system of Inquiry for recognition and analyse of traditional Iranian architecture. Its divisions are
comprehensive and clear. Level A depicts social and economic demands and the relation between them.
Level C is the integration of influences on environment. Level B is the combination of demand (Level A)

![Figure 3: The model of Sachs; relation between demands, supply, and environment (Sachs, 1980)](image)
and quality (Level C), which supply professional responsive methods to fulfill the social demands with consideration to quality of the environment. Redefining the final goals of development in terms of demand and supply is necessary in order to coordinate among social, economic and ecosystem goals. The supply (Level B) has special importance because of its numerous factors and applicable professional fields such as architecture and technology that should be adapted to social, economic and directorial goals regarding to quality of environment. Producing goods and services in accordance with social demands in level A should be driven from a combination of strategies in technology and energy, consumption of the resources and space application fields. Strategies provide coordination among economic goals, social goals and environmental resources conservation; it means that practical strategies are uses to manage the production and environment. These strategies have vital need to effective tactics and selection of safe and suitable techniques for ecology. Economizing energy consumption, conservation of energy resources and recycling must be the main energy tactics. Optimized utilization of cultural and natural resources in any vernacular order can be possible by strategies of development; and technology should be adapted to this purpose. It means that flexibility is vital for technology not for economics, ecosystem or resources.

6. Eco-Management in traditional Iranian architecture

In composition of settlements in Iran plateau, there is a coherence that makes it hard to understand fabric components separately. Because of this coherence, cities have within oriented features. The essence of space organization in Iran is crossover design (four soffeh) with courtyard; an integrated structure responses to secular and spiritual life simultaneously. This structure in both formal (geometric and within oriented forms) and visibility (material and technology) aspects strongly affected by setting features and local capacities thus it has most efficiency and least vandalism in nature. Two natural elements, sun and water that are vital and inspirator for metaphysical beliefs integrated with architecture. Central Courtyard sides are perpendicular to main solar directions and the water locates in the center. This space is an interpretation of centre of world and presents the time lapse. Evaporation cooling of water in courtyard refreshes the open space. Building orientation is coordinated to sun movement line and abstracts the relation between human and nature as an ancient pattern intelligently. Thoughtful encounter with natural forces causes to maximum elegancy and environmental buoyancy in incompatible setting and climate. Central courtyard lets large families to live together in one or more related courtyard thus it organize a small-scale social life, in other words its function is coordinated to culture. Iranian traditional architect understands the Human and environment Coexistence as a bilateral relation so they donate something to each other.

Energy (sun, light, and wind) and resources (water and earth) are environment gifts. Man uses two kinds of Techniques to manage these properties and build an efficient structure. Some time he creates systems and sometimes applies supervisor techniques to control the systems’ efficiency. Bad-gir and khish-khan are systems result of innovative techniques. They conduct the air flow into the rooms to cool the inner spaces passively. Keeping exact maintenance of passive systems is necessary for its desirable performance. Suitable isolation of walls, proportion between area and volume, use vernacular materials, etc are some of supervision techniques in Iranian building. Function of spaces has a close relation to their
arrangement and juxtaposition. It means the location of rooms and spaces is important. For example northern section of building is used in cold seasons because of receiving southern sun light while southern section with taller *eivan cause* shadow in summer and protect most parts of building from hot sun radiation. In other words, horizontal arrangement of these sections is important for their functional definition. Vertical arrangement is determining factor for the spaces that located underground or in second floor for example, *sardab* and *gowdal-baghcheh* always locate in lower level than yard to be cool.

Iranian traditional architecture has three climatic parts; elements, systems and spaces. Element is the smallest member of building that contribute to climatic comfort without spatial function. *orosi* doors with colored glaze, *tabeshband*, *roshan-dan* and *fountain* are main Iranian climatic elements. Passive heating and cooling systems are essential part of building and are designed to be dynamic. All systems are passive and provide physical comfort. Passive means acceptance of external, reliable, permanent and dynamic natural energies like sun light and wind. Passive systems have static appearance and dynamic inward. They totally depend on natural flow of renewable energies exist through and around the building. Flows of renewable energies that are transmitted naturally enable the systems to act without any fossil fuel and mechanical force. System is a set of elements, can use natural energy through absorbent, storage and transmitter components.

The best instance of systems is *bad-gir* including these components. Performance efficiency of passive systems needs supervision. Secondary elements improve energy flow through building and prevent its loss. Damper, moveable isolator, channel, *tabesh-band*, *roshan-dan* and *na-kesh* and sunshade are supervisor elements. Climatic spaces of building have alternatively climatic and architectural function base on climatic and functional demands. For example *howskhaneh*, having a fountain and a skylight to penetrate smooth light in lower level than courtyard, is the springhouse for hot summer at the same time is a climatic system since it cools the air flow from *bad-gir*.

The above description briefly illustrates the diversity of intelligent architectural solutions to coexistence with natural and cultural context. Spaces are different in shape, differently combined and differently located. In order to greater spatial comfort, totally different climatic tactics have been utilized. All of these realize the eco-management concept. Eco-management means sustainable self support and self sufficiency of building with minimum injected cast. Building is in continues relation to nature but is self sufficient at the same time. Comparing Iranian house components with middle level varieties of Sachs model in a comparative table present eco-management tactics.
Table 2: comparing Iranian Traditional house components and middle level varieties of Sachs model present Eco-Management tactics

Residential building is the best example to study Iranian traditional architecture, having excellent eco-management tactics. Abbasian mansion is a case study to illustrate the suggested methodology.

7. Abbasian mansion, Kashan.

This is one of the most interesting examples of Iranian traditional architecture. Like all Iranian buildings, space is organized according to central rectangular courtyard on main directions. Roofed spaces are arranged around the courtyard and water located in the center. Orientation from North West to south east, is in line with qeble and control the amount of sun light download. In fact, it provides cultural and climatic demands simultaneously. Northern and southern eivans have superior identity. Northern eivan interpreted to sun dome since contacts with sun longer. Southern one is shadow dome receiving minimum light in opposition with its northern counterpart and always is protected from sun light. With the shadows in the Southern part, temperature difference between northern and southern parts causes air to flow during the day. Water and plants increase the humidity and take dust from air. Bad-khan by chimney property beside double walls reverse flow of air and activate the cooler air in thermo siphon method, thus wind as third venerable element along with sun and water stable the condition. In addition to the role of central courtyard as breathing space, it eases the connection among rooms therefore the least communication spaces are needed. Whether small rooms or Large surrounded ones are generally used coordinated with their area and volume and environmental conditions in different seasons so that they can accept a variety of functions by changeable furniture and soft decoration.
Adobe, produced with least change in nature and the most compatibility with it, is the most economical building material in traditional Iranian architecture. Thick adobe wall due to the high thermal capacity, acts as heat storage. Low heat conduction coefficient of adobe introduces it as a good thermal insulator, in addition, rough texture and natural color districts the heat absorption and increase the reflection. Acoustic performance of adobe wall is acceptable because of its large mass. In traditional building, material transportation was very difficult. Using the site earth and some water-in aqueduct-it was possible to build without needing to transportation and destructive effects on environment. This point is one of most important indicators of sustainability. According to comparative table, elements of this mansion are roshan-dan, tabesh-band and Na-kesh. Spaces constitute the Mansion are howzkhaneh, sardab, eivan, Northern section, Southern section and courtyard. The mansion has a small courtyard which is widened at higher levels; a disposition without which the airy spaces of the edifice would have seem sadly cramped.

Thanks to this progressively expanded volume of the courtyard, some fronts enjoy a relatively large open space beside an elevated independent yard. Windward openings contribute to natural ventilation also inner windows conduct fresh air between rooms. Arrangement of spaces has significant importance. sardab locate in underground to be the coolest space while mahtabi on second level is a favorable open space for nights. howskhaneh is surrounded by various spaces arranged on two levels. The central courtyard expands in front of the reception hall and provides a nice and deep view from the eivan that is higher than the rest of the mansion. Behind the eivan, there is a large cross-section reception hall which together with eivan constitutes an important spatial enclosure. Kordar on the walls cause shadow and control the heat absorption of the wall. Sunshades, canopies and openings are flexible to penetrate sunlight in. The two story height of howzkhaneh dispels the heat higher than the body height to make a comfortable space by a simple tactic.

8. Conclusion

Sustainable architecture totally means creation a dynamic balance between human demands (secular and spiritual) and environment in its bilateral meaning as culture and nature. Eco-management means sustainable self support and self sufficiency of building with minimum injected cast. Building is in continues relation to nature but is self sufficient at the same time. According to Sachs model, Iranian traditional architecture (locates in supply level) has a harmonized, friendly and responsive relation with both human demands and quality of environment levels. At the same time, Iranian traditional architecture, in its level has an internal interaction among its sections include function of space, energy, resource and technique. Qualified relation among inner varieties of Iranian traditional architecture and its coordination with environment follow the human demands. In the other words, space with functional goals provides human demand in collaboration with other varieties. This interaction illustrates a pattern of eco-management in architecture with three features; respect to other related scopes, nondestructive expression and responsive identity.
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The Influence of the Colour Behaviour of External Envelope Materials in the Quality of the Buildings

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Abstract

In order to increase the quality of existing and new buildings it is important to act at several levels. In existing buildings, better rehabilitation techniques and materials are needed. For new buildings, quality must be regarded as a target that is present in all stages of the life cycle of the building.

Environmental issues call for reuse and higher durability of construction materials. The quality of the buildings external envelope depends on the quality of finishing materials, whose characteristics should not vary a lot with different atmospheric conditions, reason why it is very important to determine the effects of sunlight, heat, humidity and other climate factors in the properties of these materials, namely colour and gloss.

The use of any industrial waste as a material for buildings construction contributes not only to minimize the environmental problems but also promotes the reuse of these materials and the development of sustainable products.

In the present study, experiments are carried out using the addition of industrial waste to white cement, intended to be used a finishing construction material. We analyse the effects on the colour and gloss of the new materials when exposed to two different environments (with different levels of light, heat and humidity). The samples have been prepared with cement and additions in proportions of 100/0 and 70/30 and a water/solid ratio of 0.5. These samples were exposed to the outdoor environment and indoor environments with artificial light. Colour and gloss were measured initially and weekly with a Minolta CM-2500d spectrophotometer and a Konica Minolta GM-268 glossmeter respectively. The purpose of this study is to determine the effects of light, heat, humidity on the properties and behaviour of white cement blended with different waste materials. Our aim is to investigate the possibility of using these materials as construction or restoration materials, to improve the quality of the external envelope of buildings.

Keywords: building quality, envelope materials, white cement, pozolanic materials, colour
1. Introduction

The quality of buildings is nowadays one of the most important aspect for the users, not only because of the comfort provided, but also because of the price that it will cost. The quality of buildings depends on the types of materials used in construction. If these materials have good performances and low cost, then they may contribute to improved construction solutions.

One of the main types of finishings used in construction is the white cement, which has a key role in the appearance and consequently in the cost of the building. To add industrial waste to white cement may lead to a solutions that still performs adequately, while lowering the cost. The development of these new materials for the external envelope of buildings will contribute, not only for the reuse of various types of industrial waste, but also for the development of more sustainable solutions.

These materials, used as a coating on the walls, are exposed to different weather conditions for long periods of time, reason why it is very important to determine the effects of sunlight, heat, humidity and other effects of climate changes in the properties of these materials, namely in colour and gloss. A better understanding of these properties is indispensable for the evaluation of the performance of the materials.

Determining the colour of materials is important not only for aesthetic reasons, but also because any change in hue may be a sign of pre-decay alterations. Chromatic alteration is one of the aspects of variation in the initial colour of the material. Moreover, interventions on building façades may affect the initial colour of the material; prior tests should be conducted to ascertain the possible impact in restoration, conservation, protection or similar actions [1-2].

2. Colour

Colour is the visual perceptual property corresponding in humans to the categories called red, yellow, blue and others. Colour derives from the spectrum of light interacting in the eye with the spectral sensitivities of the light receptors. Colour categories and physical specifications of colour are also associated with objects, materials, light sources, etc., based on their physical properties such as light absorption, reflection, or emission spectra. By defining a colour space, colours can be identified numerically by their coordinates. The visible spectrum is the portion of the electromagnetic spectrum that is visible to (can be detected by) the human eye. Electromagnetic radiation in this range of wavelengths is called visible light or simply light. A typical human eye will respond to wavelengths from about 380 to 750 nm, see figure 1.
Figure 1: Sensibility Curve of Human Eye

The intensity of solar radiation varies throughout the spectrum, depending on climate and atmospheric conditions, which change frequently (cloudiness, water vapour, pollution, etc.). Reflectance of surfaces also varies depending on the wavelength of the incident rays. Thus, the behaviour of each optical surface can be represented by a curve of distribution of its reflectance over the solar spectrum [3].

To get more precise data on how white cement with the addition of some types of industrial waste behaves, experiments have been conducted using a spectrometer to study the variation of reflectance and brightness in samples of these materials. In this paper, the gathered data is analysed.

2.1 Materials

The materials used in this study were white cement (CEM), limestone filler (LF) and pozzolanic materials such as paper sludge (PS), metakaolin (MK), spent cracking catalyst (FCC) and two types of silica fume (SF1 and SF2). The characteristics required of such materials for the present purposes were a high silica content in the amorphous phase and a large specific surface.

2.2 Sample preparation

The white cement-addition blends were mixed using high-speed powder induction to ensure material uniformity without altering fineness. The proportions by weight of white cement and addition used to prepare the specimens were 100/0 and 70/30, cement/addition. The water/blend ratio used was 0.5 throughout. The mixtures (water, cement, addition) were poured into plastic moulds and wet-cured for 24 hours.

Table 1: Sample Nomination and Constitutions

<table>
<thead>
<tr>
<th>Sample Nomination</th>
<th>Sample Constitution</th>
</tr>
</thead>
<tbody>
<tr>
<td>(CEM)</td>
<td>100% White Cement</td>
</tr>
<tr>
<td>(LF)</td>
<td>70% White cement + 30% Limestone filler</td>
</tr>
<tr>
<td>(MK)</td>
<td>70% White cement + 30% Metakaolin</td>
</tr>
<tr>
<td>(PS)</td>
<td>70% White cement + 30% Paper sludge</td>
</tr>
<tr>
<td>(FCC)</td>
<td>70% White cement + 30% Spent Cracking Catalyst</td>
</tr>
<tr>
<td>(SF1)</td>
<td>70% White cement + 30% Silica Fume type 1</td>
</tr>
<tr>
<td>(SF2)</td>
<td>70% White cement + 30% Silica Fume type 2</td>
</tr>
</tbody>
</table>
2.3 Experimental work

Colour and gloss readings were taken of the specimens at the outset, and then weekly throughout the experiment with a Minolta CM-2500d spectrophotometer and a Konica Minolta GM-268 glossmeter.

The colour was determined employing the CIELAB system, with a D65 illuminant and a 10° standard observer. The L*a*b* colour space is defined by L*, that denotes lightness and a* and b* are the chromaticity coordinates, a* and b* indicate the position of a colour between red and green (+a* signifies red, -a* green), and the blue and yellow (+b* indicates yellow and –b* blue). The determination of these parameters was made with a portable Minolta CM-2500d spectrophotometer [4].

The Gloss was determined used a Konica Minolta GM-268 glossmeter, and it was measured at three angles: 20°, 60° and 85°. Angles and aperture are chosen in accordance with the following criteria:

- The 60° geometry is used for intercomparing most specimens and for determining when the 20° geometry may be more applicable.
- The 20° geometry is advantageous for comparing specimens having 60° gloss values higher than 70.
- An 85° angle is used to compare specimens for sheen or near-grazing shininess. It is most frequently applied when specimens have 60° gloss values lower than 10 [5,6].

2.4 Exposure conditions

E1: The samples were exposed to artificial light during the eight-hour laboratory working day, and kept in the dark the rest of time.

E2: The samples were exposed to the elements, rain, sun, wind, humidity, every 24 hours.

3. Discussion of the results

3.1 Colour

2.1.1 Reflectance

Figure 2 shows the variation of reflectance with exposure E1. For white cement (CEM), reflectance decrease, for limestone filler (LF), metakaolin (MK), and paper sludge (PS), reflectance slight decrease and they have a scant variation of the colour and in the specimen of spent cracking catalyst (FCC) and silica fume (SF2) reflectance have a significant decrease, colour dimming and in silica fume (SF1) reflectance had a significant increase. In other words, most of the kind type of samples dimming under these conditions. At figure 3 the variation of lightness with exposure E2 as in the
exposure E1, reflectance decrease in all the samples except the silica fume (SF1). These samples dimming more than the others.

Figure 2: Samples Colour in Exposure 1 at 0 and 150 days

Figure 3: Samples Colour in Exposure 2 at 0 and 150 days

2.1.2 Chromatic coordinate

The chromatic coordinates obtained for the samples before (figure 4 and 5) are shown. At 0 days of exposure 1 and 2 the general tendency is turn to yellow, respect the chromatic coordinates the white cement (CEM), metakaolin (MK), spent cracking catalyst (FCC) and silica fume (SF1) are yellow-green and the limestone filler, paper sludge and silica fume (SF2) tendency are yellow-red. After 150 days of exposure 1 the tendency is turn to yellow all the specimens. At exposure 2 the specimens the generally tendency are yellow-red.
2.1.3 Lightness

Figure 6 shows the variation of lightness with exposure E1. For white cement (CEM), limestone filler (LF), spent cracking catalyst (FCC), metakaolin (MK), and paper sludge (PS), and substantially in the specimen of silica fume (SF2) ($\Delta L^* = -11.05$), lightness decreased exposed at this conditions, whereas it increased at silica fume (SF2) ($\Delta L^* = 12.10$). In other words, most of the samples darkened under these conditions.

The variation of lightness with exposure E2 as with exposure E1, lightness declined in all the samples except the silica fume (SF1), see figure 7. The lightness declined substantially in the sample with silica fume (SF2) ($\Delta L^* = -26.17$) and in the white cement (CEM) and paper sludge (PS) specimens ($\Delta L^* = -8.13$) and ($\Delta L^* = -8.18$) respectively. These samples darkened more than the others.
3.2 Gloss

All the three geometries (20º, 60º, 85º) were used to measure the samples. The 60º values recorded under indoor conditions with artificial light, i.e., less than 10 units, were indicative of a matte finish.

Gloss changed very little between the initial and end measurements in the exposure 1, see table 2. Gloss declined slightly in white cement (CEM), metakaolin (MK), paper sludge (PS), spent cracking Catalyst (FCC) and silica Fume (SF2), and increased in the specimens containing limestone filler (LF) and silica fume (SF1).

The 60º geometry findings for the samples in exposure 2, table 2, (values of under 10 units) were indicative of a matte finish. Gloss declined in limestone filler (LF), the silica fume (SF1 and SF2), metakaolin (MK), paper sludge (PS) and spent cracking catalyst (FCC). Under these conditions, the gloss on white cement (CEM) remained unchanged.

Table 2: Gloss Measures at Exposure 1 and 2

<table>
<thead>
<tr>
<th>Sample</th>
<th>Exposure 1</th>
<th></th>
<th>Exposure 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20º</td>
<td>60º</td>
<td>85º</td>
<td>20º</td>
</tr>
<tr>
<td>Days of exposure</td>
<td>0</td>
<td>150</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>White cement (CEM)</td>
<td>1.83</td>
<td>1.82</td>
<td>7.61</td>
<td>1.51</td>
</tr>
<tr>
<td>Limestone Filler (LF)</td>
<td>1.09</td>
<td>1.41</td>
<td>3.83</td>
<td>1.04</td>
</tr>
<tr>
<td>Metakaolin (MK)</td>
<td>1.23</td>
<td>1.21</td>
<td>5.11</td>
<td>1.11</td>
</tr>
<tr>
<td>Paper Sludge (PS)</td>
<td>1.16</td>
<td>1.15</td>
<td>2.92</td>
<td>1.15</td>
</tr>
<tr>
<td>Spent Cracking Catalyst (FCC)</td>
<td>1.37</td>
<td>1.21</td>
<td>6.24</td>
<td>1.62</td>
</tr>
<tr>
<td>Silica Fume (SF1)</td>
<td>0.80</td>
<td>0.81</td>
<td>2.02</td>
<td>0.79</td>
</tr>
<tr>
<td>Silica Fume (SF2)</td>
<td>0.82</td>
<td>0.84</td>
<td>2.29</td>
<td>0.80</td>
</tr>
</tbody>
</table>

3.2 Gloss

4. Conclusions

One of the conclusions that can be drawn from the results of this study is that reflectance decreased consistently in all samples, with the exception of silica fume (SF1), in which it increased under all exposure conditions. With reduced reflectance, sample colour darkens.

Another conclusion drawn is that chromatic coordinate b* remained positive in all cases, while a* fluctuated between positive and negative values. In other words, samples remained white/yellow and changed between white/red and white/green.

Lightness was likewise observed to decline over time under all conditions. Under exposure 1, lightness decreased in all samples except (SF1) and limestone filler (LF). In exposure 2, lightness declined in all the samples, but much more steeply in the specimens of silica fume (SF1 and SF2).
All samples were found to have a matte finish and gloss values that did not change with time.

Finally, since the samples containing metakaolin (MK) and limestone filler (LF) were observed to behave very much like white cement in terms of both colour and gloss change, these materials are initially more suitable than the others for use in building construction and restoration, in order to improve quality. The reuse of materials in building construction contributes to the reduction of waste, while saving in energy and resources.

References


International Project Management Practices of Mega-sized projects in China

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Abstract

International construction management generally depict style and techniques adopted in managing multinational projects. Undertaking large international construction projects does not only involve uncertainties that arise from construction projects in host countries, but also from the complex risks particular to executing large construction projects. This is complicated by the keen competition in the construction industry which creates a need for better project performance output. These two forces, complexity and competition, result in an increasing need for highly organized project execution plans derived from highly standardized management practices. The objective of this study is to identify critical project management (PM) practices used by foreign architectural, engineering and construction (AEC) firms for successfully managing mega-sized projects when operating overseas. Thirty-three sets of data were collected through structured questionnaire from China-based projects that had the involvement of foreign firms. Using Statistical Package for Social Sciences (SPSS) software, analyses are carried out. Two sample independent t-test was employed to identify crucial PM practices that led to successful management of large projects. The result shows that high quality schedule is a very critical PM practices particular to successfully managing mega-sized projects in China. Also, harmonious working relationships with clients and team members are also important for achieving better project performance. The findings of this research would serve as a guide to foreign clients, consultants and contractors when preparing to undertake projects in China. It is recommended that project managers adopt the identified practices when undertaking mega-sized construction projects in China to obtain desired and favourable outcomes.

Keywords: international construction, Project Management (PM) practices, China, mega-sized projects
1. Introduction

China’s construction industry has been enjoying an average of 20% annual growth since it commenced an open door policy (NBSC, 2002). The rapid economic expansion in China has resulted in many construction activities and has contributed to ranking the industry as one of the largest construction market in the world (Sjoholt, 1997). As a result of this economic expansion, more foreign AEC firms have ventured into China to contract businesses. Various problems have been associated with managing international construction in China most especially those of large projects. They include costs overrun and schedule delay, low project quality and stakeholder’s dissatisfaction (Wang and Jiang, 1999). Among a series of initiatives sought to solve these problems are good management practices, strategies and competencies that international firms should adopt at the project level when undertaking large projects in China. These management practices may be effective because they emphasized good central mechanism in business transactions, especially by Chinese business culture. This study intends to investigate these practices. The objective of this paper is to investigate PM practices adopted by foreign architectural, engineering and construction (AEC) firms for managing mega-sized projects in China. The study will help identify critical PM practices at the firm’s and project level that will drive the management of large construction projects to successful completion. This finding is vital as it will help foreign firms venturing into China for the first time and those already in China to successfully manage large projects, improve their project performance and market competitiveness.

2. Background

Globalization of construction markets allow more local firms to compete internationally and work outside their home countries undertaking various aspects of construction projects. Large construction projects constitute one of the most important business sectors of the world. These projects tend to be massive, individual and long term artifacts with huge investment taking place progressively. Large international construction projects are usually multidisciplinary; a characteristic which can adversely impact project success. They are usually characterised by subtle web of political, economic and cultural risks (Han and Diekmann 2001) while, existing survival strategies in international construction markets are difficult to implement due to uncertainties associated with the international construction domain. Undertaking large international construction projects does not only involve uncertainties that arise from construction projects in host countries, but also from the complex risks particular to executing large construction projects (Lee and Walters 1989). The consequences of these risks include poor profitability, loss of market share and reputation, increased turnover of management and work force, lower productivity and costly litigation. Failure to understand the political, economic, cultural, and legal project conditions can significantly affect the firms strategic decisions associated with foreign market (Ling, et al., 2008). This is complicated by the keen competition in the construction industry which creates a need for better project performance output. These two forces, complexity and competition, result in an increasing need for highly organized project execution plans derived from highly standardized management practices. Despite the complexity and difficulty of international market entry decisions, most construction firms have
entered international markets based on personal intuition or previous experience, both of which are easily influenced by uncertainties and biases.

Findings from literature reveal that many studies on construction and PM practices have been carried out. Many of these studies have been centred on management of general projects in China. For instance, Ling et al. (2007) considered key management practices of Singapore firms operation in China and also in 2008, worked on models for predicting project performance in China. However, no clear distinctions were made with managing projects of large sizes (projects with contract sum greater than USD50M). Assaf et al. (2006) emphasised that large construction projects are usually characterised by project delays which are caused by factors such as financial provision, contractual relationships and bureaucracy in project-owner organisation. Also, more knowledgeable clients are emerging with increasing intricate demands. They are demanding more management practices in the project execution plans with the hopes of getting higher levels of project performance. This places a huge burden of project performance and most especially on foreign firms. Understanding client’s requirement is a significant contributing factor to project success (Ling et al., 2006). Also, understanding and adapting to local working environment and regulations as well as relating with the local authorities have been identified as the main problems facing multi-national firms handling large projects in China. Chan et al. (1999) emphasised the importance of understanding the local regulations and forming good relationship with the local authorities. Chan and Chan (2002) noted that there are salient differences in the China’s construction industry when compared to international mode of practice, with special regards to the professional system in China. For international AEC firms to thrive in China there is a need to learn the PM practices that are particular to the Chinese construction industry for managing large and complex projects. It is thus necessary to examine PM practices that are particular to the Chinese construction industry for managing mega-sized projects.

In summary, an overview of literature suggests that though several works have been carried out on different strategies adopted by foreign AEC firms when working in China, little or no empirical study has been conducted to investigate critical PM practices adopted for successfully managing mega-sized projects in China by international AEC firms. This study has been designed to fill that gap in knowledge.

3. Research method

In order to investigate the critical PM practices for successfully managing mega-sized projects in China by international AEC firms, survey method was designed for this research. Structured questionnaire was used as the data collection instrument. 73 PM practices were identified from both literature (CIOB 2002 and PMI 2004) and exploratory interviews. The nine PM aspects in the Project Management Institute (PMI) guide (PMI 2004) were used for the questionnaire development. The sampling frame comprised of consultants and contractors selected from the top 225 engineering news record (ENR) list of AEC firms for 2005, which had undertaken projects in China. 200 questionnaires were sent out and 33 completed forms were received. The returned questionnaires were checked and edited to ensure completeness and consistency. Four cases with missing values of ratios less than 10% were retained and treated with mean of nearby points. Data analyses were carried out using Statistical
Package for Social Sciences (SPSS) software. The study aims to identify if there are differences in the PM practices adopted by foreign AEC firms to manage large and small projects in China. The rationale is to test whether there are significant differences between practices used to successfully manage large (>US$50 Million) or small projects (<US$50 Million). The cases collected were categorised into two groups based on their contract sum. The total contract sum is assumed to depict the size of the project. Group 1 comprises of projects greater than US$50 million, while Group 2 comprises of projects less than US$50 million. Two-sample independent T-test was employed to reveal significant PM practices that led to successful management of mega-projects in China. Colman and Pulford (2006) noted that independent two sample t-test can be used with groups of unequal size and within the same population. The appropriateness of using independent t-test was tested using normality, homogeneity of group variances and group independence. In response to the research aim, a broad hypothesis was formulated and presented as follows:

Null hypothesis (H₀): There is no significant different between the means of the two groups

$$H_0: \mu_1 = \mu_2$$

Alternative hypothesis (Hₐ): There is significant difference between the means of the two groups

$$H_a: \mu_1 \neq \mu_2$$

The Levene’s test (F-test) was used for evaluating the quality of the variance. If the p-value is > 0.5, it indicates that the variances of the two groups are not significantly different and the statistics in the equal variance assumed section would be used and vice-versa. Also, the result of the t-value with a probability of p < 0.5 signifies that there is a significant difference between the means of the two groups.

### 4. Sample characteristics

The data collected comprises different types of respondents and project characteristics. Table 1 summarises the profile of the respondents. 45.5% of the respondents were senior managers, while 54.5% were professionals. The average working experience of the respondent in China construction industry is 8 years, with a minimum and maximum of 2 years and 14 years respectively. The average of 8 years working experience in the Chinese construction industry indicates that most respondents have extensive working experience in international construction, hence the reliability of the data.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of service provided</td>
<td>Construction</td>
<td>13</td>
<td>39.1</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>5</td>
<td>15.2</td>
</tr>
<tr>
<td></td>
<td>Consultancy</td>
<td>15</td>
<td>45.5</td>
</tr>
<tr>
<td>Designation</td>
<td>CEO, MD, Senior Manager</td>
<td>15</td>
<td>45.5</td>
</tr>
<tr>
<td></td>
<td>Architect, Quantity Surveyor</td>
<td>18</td>
<td>54.5</td>
</tr>
<tr>
<td></td>
<td>Project Manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal involvement in the project</td>
<td>Involved</td>
<td>32</td>
<td>97.0</td>
</tr>
</tbody>
</table>

Table 1- Respondents Profile
Table 2 shows the characteristics of the project carried out by the respondents in China. The projects were divided into two groups. Group 1: (mega projects; greater than 50 Million) and Group 2; (small projects; lesser than 50 Million). There are some similarities among the projects characteristics of both groups. Both groups have most of their projects located in Shanghai and eastern China, and mainly within the private sector. This distribution indicates that foreign AEC firms should also focus in other parts of China, which may be less competitive. Having a large portion of the jobs within the private sector is expected, as many public projects would have been undertaken by indigenous firms. This suggests that foreign AEC firms should work closely with indigenous enterprises. Also, selective bidding and negotiation was found to be the predominant form of project procurement. This highlights the importance of developing business relationships in China rather than relying on open bid invitations. Most of the mega-projects executed in Group 1 are predominantly commercial, factories and institutional buildings while in group 2, projects ranges across all sectors. Also, services provided among firms handling mega-projects are predominantly consulting, while group 2 has a fair share of both construction and consulting.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of Experience in China</td>
<td>Not Involved</td>
<td>1</td>
<td>3.03</td>
</tr>
<tr>
<td></td>
<td>&lt; 5 years</td>
<td>2</td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td>6 - 10 Years</td>
<td>6</td>
<td>18.2</td>
</tr>
<tr>
<td></td>
<td>11 - 15 Years</td>
<td>11</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>&gt;15 years</td>
<td>14</td>
<td>42.4</td>
</tr>
</tbody>
</table>

Table 2: Project Characteristics

<table>
<thead>
<tr>
<th>Project Characteristics</th>
<th>Group 1 (Contract sum &gt; 50 Million)</th>
<th>Group 2 (Contract sum &lt; 50 Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percentage (%)</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shanghai</td>
<td>7</td>
<td>38.9</td>
</tr>
<tr>
<td>Beijing</td>
<td>3</td>
<td>16.7</td>
</tr>
<tr>
<td>Suzhou</td>
<td>3</td>
<td>16.7</td>
</tr>
<tr>
<td>Kunming</td>
<td>2</td>
<td>11.1</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>Tianjin</td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>Fuzhou</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Chengdu</td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>Gross Floor Area (m²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 100,000</td>
<td>5</td>
<td>27.8</td>
</tr>
<tr>
<td>100,001- 500,000</td>
<td>12</td>
<td>66.7</td>
</tr>
<tr>
<td>500,001- 1 million</td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>Ownership</td>
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<td></td>
</tr>
<tr>
<td>Public</td>
<td>3</td>
<td>16.7</td>
</tr>
<tr>
<td>Private</td>
<td>12</td>
<td>66.7</td>
</tr>
<tr>
<td>Joint Venture</td>
<td>3</td>
<td>16.7</td>
</tr>
<tr>
<td>Selection</td>
<td>Open bidding</td>
<td>4</td>
</tr>
</tbody>
</table>

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5. Results - Managing mega-sized projects successfully in China

This section discusses only significant PM practices used as added advantage by foreign AEC firms for managing mega-sized projects in China. The discussion focuses on only significant PM practices that would help international AEC firms understand what critical strategies to focus on in order to achieve success on large projects. Other significant PM practices used generally by foreign firms have been published earlier (Ling, et al., 2007). A two sample independent t-test of equal variances using a pooled estimate of variance was performed in SPSS to test the hypothesis that the resulting mean of PM practices used for managing large projects and small projects would differ significantly. A PM practice is considered significant when p< 0.05 (see Table 3) using significance level of 5% level. This suggests that there is a significant difference in the means of the two groups. The mean difference of the two groups indicates that PM practices for managing the different sizes of projects differs. The PM practices adopted by firms managing large projects are worth noting because the projects have achieved significant cost, time and quality performance and have satisfied both the clients and the public.

Table 3: Exclusive PM Practices for managing Mega-Sized Projects

<table>
<thead>
<tr>
<th>PM Practices</th>
<th>Levene's Test for Equality of Variances</th>
<th>T-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selective bidding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negotiation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-3 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-6 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-10 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (Recreational, factories, institutional etc)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$1M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$1M- $100M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$101M- $200M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;$200M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 5.1 Quality of project schedule (Time22)

The results in Table 3 show that foreign firms managing mega-sized projects focus more on the project quality schedule (mean = 3.7857) than firms handling smaller projects (mean = 4.9375). This indicates that high quality of project schedule with frequent updates is an important PM practice in managing large projects and ensuring high-quality project time performance. High quality schedule with regular updates ensures that project deadlines are met at different stages of project development. Such schedule is realistic and takes into account every significant activity which allows timely completion of the project. The finding agrees with Harrington et al. (2000) who identified project time control as an essential management function for achieving successful construction projects. Also, high-quality schedule reduces project delays which often lead to disputes between contracting parties, usually associated with large and complex projects. Project profits are usually increased if there is no need to pay for liquidated damages and contingency sum is not expended (Ling et. al, 2009). Implementing appropriate construction programme can also improve project budget performance (Jaselskis and Ashley, 2000). Meeting project deadlines increases firms’ competency. Firm’s competence is crucial to developing and maintaining trust and respect in a relationship. It can imply that the firm is able to deliver a project based on trust (Lazar 2000), which can lead to improved client-consultant-contractor’s relationship with many positive outcomes. It can lead to working together in the future or good recommendation from the client. Likewise, timely project completion can lead to high owner and public satisfaction as projects will be completed on time with minimal or less inconvenience to the public (Ling et al., 2009). It is therefore imperative for firms managing large projects in China to focus more on completing projects on time by improving the quality of their schedule.

### 5.2 Previous working relationship with project clients (Com72)

Good working relationship with clients and owners helps projects to proceed smoothly and in a timely manner without much interference from clients as a result of existing relationship and trust (Jin and Ling, 2005). Table 3 show that maintaining good previous working relationship with clients (Com72) is a significant PM practice for managing large projects (Means for large projects = 4.4286;
Means for small projects = 5.5000). Good working relationship which entails good communication between owners and consultants reduces severe changes to project scope, ensures low level of conflict and builds trust. This can help to improve project performance (Harrington et al., 2000). Firms practising good working relationships do not exhibit opportunistic behaviour, which yields only short-term benefits (Hill, 1990). This creates the advantage of future project procurement from clients to firms of worthy behaviour as a result of previous experience because of low probability of misbehaviour (Granovetter, 1985). This in turn increases their competitiveness in the market, as it can be considered as an edge over firms without client’s recommendation. Harmonious relationships and trust also have the capability to diminish community and project-based risks in different project development stages and also lower cost (Jin and Ling, 2005).

5.3 Prior working relationship among project team members (Com73)

The independent sample t-test in Table 3 shows that good working relationship among team members [Com73] is predominantly used by most foreign firms in China undertaking large projects than firms undertaking smaller projects (Means for large projects = 4.5000; Means for small projects = 5.4375). High-quality relationship among team members involves clear communication and distribution of project data and information. The exchange of data may be called communication. The achievement of a goal by an organization will become more probable if there is a reliable exchange of knowledge between the people within the project teams. Appropriate communication and working among team members can enhance project performance in several ways. It can help improve mutual understanding among individuals and also reduces the barrier of inter-cultural communication diversity, which is inherent in international construction (Loosemore and Muslmani, 1999). Also, it can significantly help to reduce potentials for misunderstanding and conflicts on projects. This will subsequently improve project cost, quality and time performance (Henderson, 2004). Pinto and Pinto (1991) showed that project managers’ efforts to clarify and establish shared agreement for deliverables positively influence team members’ contribution, task performance and satisfaction. It is thus advisable that managers of large construction projects understand the need of their team members in line with the project objectives and adequately cater for them.

5.4 Self-selection of partners for project collaboration (Proc81)

In today’s construction marketplace where large organisations in the industry are facing increased global competition, careful consideration in selecting project partners is essential for maximising efficiency and competency. Self-selection of project partners indicates that firms are likely to choose partners with similar objectives and with whom they can trust and adequately work together with minimal conflicts. Table 3 shows that foreign firms executing mega-sized projects usually self-select partners for project collaboration [Proc81 Means for large projects = 3.8571; Means for small projects = 5.0000]. Having the capacity to self-select partners has an edge to achieving project success than firms managing smaller projects with no such means or opportunities. Selection of suitable partners can enhance project performance and lead project to success (Gale and Luo, 2004). Selective partnering considers project partners as a network of work teams guided by well-developed
communication link and feedback system (Woolthuis et al., 2002). This can assist in overcoming collaboration barriers such as cultural diversities and pressures from different ways in which organisations are managed and organised. It can also help to create some form of trust and informal control over project partners. This is one of the ways of mitigating relational risk (Monsted 1998 and Hill, 1990). Firms without the capability to selectively select partners for project collaboration are at a greater disadvantage on running the risks associated with joint ventures such as project delays, conflicts and disputes.

5.5 Engaging local/foreign partners (Proc 82)

Table 3 shows that many foreign firms managing large projects in China engage more local partners (mean = 3.5714) than firms undertaking smaller projects (mean = 5.000). Working with the locals as joint venture partners in China presents opportunities that can bring potential benefits as well as generate many risks. Partnering for project collaboration has generated considerable attention in the construction industry. It is considered as a common strategy for foreign firms to enter and survive in host countries (Badger and Mulligan, 1995) and plays an important role in determining the future growth of many businesses. Foreign firms operating joint venture with local firms have the advantage of having access to the local partner’s market without having to carry all the risks. This helps to quicken the understanding and adaptation to the local market and environments than firms working alone. Engaging a local partner makes sourcing for material and labour cheaper and easier. It also helps in the breaking down of large project into different manageable units, which can enhance project cost, time and quality performance and owners satisfaction (Ling et al., 2009 and Zhang and Zou, 2007).

Other benefits are associated with engaging local partners for managing large projects in China include broadening client’s base and market share, enhancing competitiveness and increasing labour/staff productivity. A foreign firm could also engage a local partner in one or more cities in China covering several aspects of construction projects such marketing, tendering, design, construction and commissioning. Such alliance agreements could incorporate reciprocal commitments on the basis of mutual organizational goals. Local partners also benefit from partnering with foreign firms. For example, penetrating foreign direct investment construction market, financial back up from foreign firms, adaptation of international practice, obtaining advanced management skills and state-of-the-art technologies. Though many risks are associated with engaging local and foreign partners when working outside their home countries, Chan and Suen (2005) emphasised that they are still the preferred form of cooperation used in practice in China. In order to provide complementary competency, foreign AEC firms need to look for local partners to advance their interests in China.

6. Conclusion

This study uncovered five critical PM practices that can be used by international AEC firms for successfully managing mega-sized projects in China. The significant PM practices are; preparing high-quality schedule (Time22), having prior working relationship with the owners/clients (Com72)
and other members in the project team (Com73), having an opportunity to select partners and engaging local partners. This research is beneficial to firms which are already in China and those intending to venture into China to manage large construction projects. Those with the intention of venturing can learn from the experiences of the other foreign firms who have already undertaken large projects successfully in China and for firms that are already in China, there is still room for them to learn from the experiences of others and improve on their existing PM practices. It is important to understand the distinction between these PM practices and accordingly cater to their effect at the project conception stage.

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Stimulating Value Creation in the Initial Phase of Urban Developments

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Abstract

City planners, project developers, architects and many other players initiate urban developments when certain sub-developments, within that area, trigger a ‘need’ to intervene. The various players involved are consequently analyzing the power structures of key stakeholders in the environment, and thus analyzing the opportunities for development. All actions, or sometimes still only creations in one’s head, usually lead to the initial steps of an urban development project. However, the early decisions made are based on ill-defined problems and weak, intangible goals. Participants are confronted with messy and unstructured criteria for decision-making; goals may conflict and are highly subjective, so directing such initial decision-making is a delicate process. In an attempt to manage these conflicting interests, urban development practices increasingly integrate human values in designing objectives. So based on literature and contemporary Dutch urban development practices we assume that the goal of urban development is value creation. Value for all stakeholders as well as value for the geographical area subjected to various interventions. This led to the following research question: How can value creation be stimulated in the initial phase of urban developments? The research project concerns a qualitative exploration for an advisory company focusing on real estate and urban development. We focused on finding conceptual and empirical determinants of value creation in Urban Development. Based on the findings a value-creating framework was constructed as a management tool for real estate companies.

Keywords: value creation, urban development, initiative phase, strategy, intervention
1. Introduction

Research concerning architectural and urban design management (e.g. Lynch, 1982; Prins, 2009; Oswald & Bacini, 2003; Carmona, 2004; Kelly, 2007) has stressed the fact that it is imperative for stakeholders to manage value creation in urban development projects. However, the value-oriented research field, within the broader scope of urban design management, is relatively new. Contemporary value theories actually stem from ancient philosophy streams such as axiology or ethics. Afterwards, distinguished research fields such as economics, sociology, psychology etc. have utilized this progress regarding our understanding of human values to structure the ways we organize the ‘visible’ world around us.

The discipline of urban design management has made considerable steps forward in developing theories regarding the design of shared objectives in complex multi-actor environments (Hawkins, 2007, Emmitt et al., 2009). However, most of these theories do not explicitly draw knowledge or build further on prior knowledge gained from the aforementioned disciplines. It is also true that a robust value creating framework for urban design management practices is lacking, or has not yet been generally acknowledged [Emmitt et al, 2009].

Research concerning the relationship between individual values and business decisions actually encompasses a well-explored theoretical classification of values (Barnett & Karson, 1987; Spranger, 1928; Allport et al., 1960; Brogden, 1952). Spranger (1982) proposed six classifications of subjective values, namely aesthetic, economic, political, religious, theoretical, and social. According to Barnett and Karson (1987) three challenges present themselves to the researcher attempting to build upon this foundation of value theories:

- Category definition: Considerate paradigm shifts or even minor changes in social norms could account for modifications of these value categories.

- Another concern is the assertion of the ethical relativist that there are no ethical absolutes. Kelly (2007) also stresses this notion. Even if categories of values are well-documented and accepted, each ethical or value-oriented choice is situation specific. So there is often a ‘best’ ethical action that is not based on pre-existing value sets, but upon the specifics of the situation at hand.

- Predictability: Researchers must live with the problem of the difference between what subjects say they would do and what they actually do. Until now the predictive capabilities of pre-determined value sets have not yet had much attention in management literature.

- Type of relationship: Often it is assumed that personal values influence the decision-making process. Nevertheless the relationship between values and decisions need to be investigated systematically, rather than based on theoretical assumptions. However, this is only possible when contemporary scholars agree on the value framework that guides these ‘state of the art’ research programs.
So the theoretical goal of this research was to draw further on our knowledge of value oriented decision-making, and to eventually construct a value creating framework for the field of urban design management. The practical goal of this research was to transform this conceptual framework into an analytical process management instrument that assists the strategy formulation process in the initial phase of urban developments. In other words, a tool supporting the management of value creation by systematically tackling the “why-question” of urban developments.

2. Value creation in urban development

2.1 The decision-making process

A decision-making process in urban development involves a wide range of actors with fragmented powers at different spatial and organizational levels [Pennen, 2005]. The factual decision-making between these interdependent actors takes place within a networked environment in which the actors have to cooperate to get things done. However, cooperation does not emerge spontaneously and is not a given fact [Pennen, 2005]. Hajer and Sijmons (2006) stated that a mutual understanding amongst players is the basic condition needed to cooperate, with respect to achieving the intended spatial quality: ‘…they have to develop a set of shared terms that all parties concerned will use when formulating a plan and establishing the quality of that plan’. In The Netherlands the various steps leading to the signing of the cooperation contract, which marks the end of the initial phase, can be depicted as followed (of course the sequences of the described steps are very situation specific, it depends on the party initiating the development, the nature of the relationships between stakeholders etc.):
Often it is necessary to support interaction between the various parties working together in the complex network they are embroiled in. This is done by means of coordination and directing. In order to direct the highly preference-based decision making process, the Dutch Ministry of Housing, Spatial Planning and the Environment stated that spatial quality should be expressed in the following three generic (spatial) value domains (VROM, 2004): Usage value; Perceptive value and Future value. A high usage value is contained when “the space can safely be used for diverse functions (as living, working, recreating, learning and mobilizing), when these functions do not hinder each other, when they are mutually reinforcing each other and when they are accessible to all demographic layers and groups” [VROM, 2004]. Perceptive value is an important factor or determinant for the quality of life of the people living in an urban or rural area. Topics that are entailed in this concept are “cultural awareness and diversity, spatial/artistic characteristics (identity), spatial variation (in form, color, texture, measurement dimensions, harmony and contrast, noise and smell) readability of (cultural) history and beauty” [VROM, 2004]. Future value contains characteristics such as sustainability, biodiversity, adaptability and flexibility in time (changeability towards new usable forms and admissibility of new cultural and economic meanings) and robustness.
For Dutch urban development practices this means a first step in systemizing the integration of values in designing spatial quality objectives. The value creating framework developed in this research project integrates these value domains in its structure, as will be described in chapter four. The next paragraph highlights the paradigm through which this research has dealt with the complex nature of the term ‘value creation’.

### 2.2 Value creation

The term ‘value’ is often identified with economic measures such as money. However, monetary terms are just one of the ways in which the value of a certain object or operation can be expressed. For some objects it is rather difficult to estimate their value in terms of money. Take for example a wife’s value of her husband; a numerical measurement of a husband has not yet been put forth. And the mere fact that the value of an object varies from person to person adds to the complexity of the value concept.

The paradigm, through which this research has regarded the concept of value, stems from the Marginal Utility Theory of Carl Menger [1950]. According to Menger [1950] the individual is the unit of analysis, because it is only at the individual level that meaning can be assigned to actions. So according to Menger [1950] value is formed subjectively on the basis of inescapable objective requirements. In this sense it could be said that the value of an object is determined by the fulfilment of a certain goal for the valuing person or entity. And according to the Marginal Utility Theory this can not be done in cardinal terms, but in ordinal measurements. The theoretical framework of this research is built on the following set of assumptions concerning value creation:

- Value is dependent on the position of the valuing person;
- Value is dependent on the situation in which the object is manifested;
- Value is dependent on the quantity that can be exchanged;
- Value should be expressed in ordinal measurements;
- The three generic (spatial) value domains - usage value, perceptive value and future value - form the basis for managing value creation in urban development efficiently and effectively. These value domains stem from the three well-known ‘vitruvian types of value’, namely utilitas (usefulness, commodity), venustas (beauty, delight) and firmitas (firmness, durability);
- Spranger’s (1982) six classifications of subjective values - aesthetic, economic, political, religious, theoretical, and social values - are determinants of one’s subjective appraisal of the aforementioned value domains. This because the manner at which a person assesses the highly context-driven value domains, depends on his/her evaluation of Spranger’s six value categories that are (not) manifested in the immediate environment. However, Barnett and Karson (1987) argue that considerate paradigm shifts or even minor changes in social norms
could account for modifications of these value categories. So these six value determinants have been tested for its actual-ness in contemporary urban design management practices.

3. Research approach

The theoretical goal of this research was to draw further on our knowledge concerning value oriented decision-making, as to answer the question that was raised for this investigation: “How can value creation be stimulated in the initial phase of urban developments?”, and to eventually construct a value creating framework useful for urban design management. The practical goal was to transform this conceptual framework into a useful and analytical process management instrument that assists the management of value creation in decision-making processes in the initial phase of urban developments. This implies that knowledge regarding current decision-making processes, and the availability of tools for the management of value creation, was to be obtained. To that account literature reviews, document analysis, and a substantial number of interviews have been executed. By means of data triangulation the outcomes were related to each other as to find similarities and differences. The unit of analysis in this research concern the perception of urban developers. Therefore, sixteen open-ended interviews with urban development experts of a Dutch specialized advisory company took place and fifteen semi-structured interviews with three different developing organizations (five municipalities, five project developers and five housing corporations).

In order to analyze actual decision-making processes through interviewing, the methodological standpoints of Pettigrew [1985] and Doz & Prahalad [1991] were used: 1. Processes need to be made explicit by active concept descriptions 2. Relations ought to be described in clear time perspectives (past, present, future) 3. Descriptions of strategic actions ought to be explained within a certain context.

These enquiries have been facilitated by means of a coding system. Results from the open-ended interviews conveyed the following four concepts to be important and thus subjected to further exploration, namely location/environment analysis, value creation, decision-making process and conflict management. These concepts had respectively been given the codes A, B, C and D. The codes have then been placed to certain pieces of text, acquired from the interviews which have been recorded and re-written into transcripts. These transcripts have consequently undergone further investigation, whereby the contexts of these processes have been analyzed (content analysis). This coding technique ensures that differences and similarities between subjects’ perceptions concerning the nature of the phenomenon in question are easily detected. This might be compared to the methods and implications of content analysis, which is used to quantify and analyze words, concepts, and relationships within certain passages. In order to arrange the analysis of the qualitative data in an efficient manner, a “Monster matrix” was used (Miles and Huberman, 1994). Each interviewed party (municipality, project developer and housing corporation) had its own matrix with the four concepts on the vertical axis, and the different respondents describing these concepts on the horizontal axis. By examining the transcripts, narrative extracts from the interviews that best fit the identified indicators have been selected and consequently listed on the matrix. The results were used to develop a framework for stimulating value creation in urban development that can be used by all stakeholders.
The findings and the framework were discussed afterwards by an expert panel consisting of the respondents of the interviews, the directors of the advisory firm and the urban development experts. The aim of this action was to test the coherence, the theoretical foundation and the practical usability of both the findings and the value creation framework.

4. Findings and framework

The literature review, combined with the outcomes of the first sixteen interviews, revealed crucial insights regarding the status of current value management beliefs and knowledge.

As mentioned earlier, the main goal of urban development is to create value. However the question can be raised for whom value is created, and how it can best be obtained. Often this is not identified. We found little back-up for stating that all Dutch urban developments are systematically managed on value creation. However, attention from practitioners and policy makers has been increasing to improve this situation. This is due to the assumption that by linking project objectives to the various value systems that people within a specific geographical area hold, program failures would decrease.

For the management of value creation in Dutch urban developments, we found one practical instrument that policy-makers have intended to adopt in various projects throughout Holland [Hooimeijer et al., 2001]. This instrument concerns a matrix that utilizes the three value domains (usage, perceptive and future value) on one axis, and four ‘merit concepts’ (economical, social, cultural and ecological merit) on the other axis. According to the makers, the instrument makes the term spatial quality more tangible, and thus discussable, by coupling qualitative valuation (by means of the value domains) with local social considerations (by means of the merit concepts). However, when analyzing the definitions of the three value domains one encounters a formal logical flaw in the utilization of the matrix. All four ‘merit concepts’ are somehow integrated in the definitions of the three value domains. For example the economical merit of a building or intervention can be expressed by means of the usage value and/or future value; or the ecological merit can be expressed by the future value. So a danger of filling in the matrix is that the results could unexpectedly be a ‘contradictio in terminis’. Therefore, even though the various instruments (the Habiforum’s matrix and the three value domains) were major advances for Dutch urban development practices, we claim them to be insufficient in capturing the entire aspect of value creation.

The results of the conducted interviews show that most current Dutch urban developments are not consciously directed on value creation. Value management was being referred to as an ‘unconscious and individual act, covered by a collective ambiance of hidden agendas’. More than half of the respondents found the three generic value domains, as described in paragraph 2.1, too abstract for practical usage. Although they stated that project objectives ought to be linked to the three value domains. Further questioning regarding this topic resulted in the modification of the six value determinants as described in paragraph 2.2. The respondents found the term social value to be a dubious concept, which should be split up into demographic values and social-cultural values. The terms theoretical and religious values were replaced by technological and ecological values. When analyzing the newly described value determinants, many similarities arise with the DESTEPA (DESTEPA stands for Demographic, Economical, Social-Cultural, Technological, Ecological,
Political and Artistic) variables that stem from strategic management literature. These variables are often used as a means to analyze business environments (Porter, 1998; Weggeman, 1997).

Approximately 60% of the respondents believe that thinking about the value determinants and the three value domains is insufficient to direct value creation. These respondents found this to be a good manner to figure out the ‘why-question’ of urban development, but value is also created in figuring out the ‘what-question’ and the ‘how-question’. This is in line with the arguments of Prins (2009) concerning value creation. The how-question takes place within the vision-forming and realization phase, and is therefore not of importance to this research, because we focused on the initial phase. The what-question is mostly part of the vision-forming phase, however most respondents stated that thinking about the ‘what question’ in abstract terms already occurs in the initial phase. Respondents also posit that during the discussions regarding the what-question in the initial phase many conceptual misperceptions arise, particularly when possible intervention schemes for an area were discussed. In Holland most geographical interventions or solutions are described in terms of economic, social or physical solutions. However, for some concepts it is not clear if it is a social, economic, or mere physical one. Take for example a discussion concerning facilities; it is often not clear if the physical, social or economic element of the facilities is meant. This led to the creation of differing conceptual intervention schemes, divided in the following abstract steering-concepts: 1. Hardware: real estate, infrastructure and public space 2. Orgware: social services (education, healthcare, welfare, assistance org.) economic services (business) and liveability services (police, fire dep., maintenance org.) 3. Software: formal and informal institutions (respectively law enforcement, norms and values).

Furthermore, approximately 80% of the respondents stated that value management should also incorporate thinking about the specific power forces that could influence the project in the initial phase, namely: type of stakeholders in the geographical area, the power these players enjoy, and the type of relationships that exist between the various players. This knowledge led to the incorporation of a power field analysis to the process management instrument. These results and feedback from the expert panel concerning the results were important input for the development of a value creation framework:
Targets for the use of the framework are organizations that can influence both the process and the outcome of urban developments. To that account the framework should be used by managers that govern such processes, for example the manager in charge of negotiating project objectives with key stakeholders. A collective use and open dialogue concerning the assessment of the framework should be prescribed in project teams. If not, stakeholders can unconsciously be denied of introducing key knowledge to the team. Collective application of the framework thus encourages transparency, safety and progress of the project. Project managers can for example utilize the framework to organize start-up workshops. Accordingly, depending on the situation and type of information that is needed, the framework can be used in various ways. One must remember that the force of this framework lies in its analytical technique to systematically link one’s ideas with current developments within an area. Organizations can for example link demographic growth, economic changes and socio-cultural movements within an area to the valuation (in terms of the value domains) of an idea or a certain object. The framework thus also facilitates market research. The more variables that are included in developing one’s idea, the better arguments one can proclaim for the continuation of the development intention. One could also think backwards, by for example stating that a certain intervention in the hardware, the orgware or the software of an area might lead to higher appraisals of the usage value of an artefact concerning certain demographic groups. From the value management perspective the use
of the framework leads to a higher consciousness, and therefore aggregation of value development in the early phase of urban developments.

5. Conclusions, discussions and future research

Finally it can be concluded that complex designing activities, as apparent in urban developments, are mainly viewed as goal-oriented social engagements with a high uniqueness factor. Every project is different, whereby various product and/or process solutions are possible. However, urban developers working together in a specific area usually enter new projects with fixed value systems. This is due to the experience and knowledge they have accumulated along the years, and the natural tendency for humans to work with pre-defined categorizations. The literature reviews and the interview results indicate that it is necessary to constantly re-evaluate the value systems of all stakeholders and the geographical area at hand, for urban development projects to run smoothly. So this research intended to not only understand the “why-question” of urban developments better, but also to design a framework that assists in systematically re-answering this question.

Value is created by improvements of the status quo of a certain environment. However, the value of a tangible or intangible intervention can only be interpreted by monitoring the communication through the perspective of the valuing person’s position and the situation in which the object or subject is manifested (Newcomb, 1953). Additionally, we claim that value should only be expressed in ordinal measurements, for value cannot be understood in absolute terms. These conditions can be met by assessing the DESTEPA variables to a specific area. These variables are somewhat ‘objective’ values that are (none) present in a certain area. The assessment is best done in the first or third step of the initial phase (as described in paragraph 2.1). The individual or collective valuation of an area in terms of the three generic value domains (usage, perceptive and future value) can only be executed after careful assessment of the DESTEPA variables within an area is performed. In other words, one’s subjective perception of the generic value domains is influenced by the character and/or interplay between the seven value determinants (DESTEPA) in a specific area. In addition to this we found that knowledge concerning the type of stakeholders (types categorized as allies, collaborators, challengers and opponents) and the power they enjoy to be imperative for stimulating value creation. The designed conceptual framework should support managers in stimulating value creation in an early phase of urban development. This is done by increasing the awareness of all stakeholders involved concerning the higher values in the development. In this way better solutions in terms of durability and liveability are created.

Due to data and investigator’s triangulation this research scores high on credibility, neutrality and consistency. However, the focus on Dutch data sources causes the results not to be easily generalized. Furthermore, the data of this research relied heavily on the perception of urban developers. And as stated in the introduction, researchers must live with the problem of the difference between what subjects say they would do and what they actually do. This certainly influenced the validity of this research. Future research should therefore focus on comparing the various international models for managing value creation (For example Lynch’s [1982] dimensions of performance; Carmona’s [2004] Sustainable urban design principles; the VALiD approach; the CABE approach; the Design Quality
Indicator etc.), and should incorporate field research as a method to obtain data. Also the assumption that the DESTEPA variables are in fact determinants of one’s subjective valuation of the three value domains, should further be investigated.

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Cost Centres for Restoration Work: A Case Study of Town Hall in George Town, Penang

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Abstract

Purpose: The purpose of this paper is to identify the cost centres of conservation works for Town Hall in George Town. Design/methodology/approach: The case study approach is one of the most commonly used research designs in qualitative research. The case study method is adopted in this research to enable in-depth and detail probing of the cost centres from the total costs of conservation works and also to understand the reasons for the high costs in certain work items for the chosen building. Findings: Generally, the major costs found in building conservation works are for restoration works and upgrading or improvement of M&E services to the building. This paper discusses the findings from the case study of one of the selected buildings in George Town. Further studies on the various costs under restoration works revealed that roof, ceiling, decorative elements, internal wall and columns finishes, door, ironmongeries and windows, external finishes and plumbing and sanitary installation are the major cost centres for restoration works. The paper then further discusses the reasons for the above findings. Originality/value: This study attempts to identify the cost centres of conservation works for a historical building in George Town. Understanding the cost centres will enable a better cost estimation for similar works in the future.

Keywords: building conservation works, cost centres, George Town, restoration works, cost studies
1. Introduction

Building conservation generally involves the renovation of old structures, which could bring them back to fulfilling their original functions by contemporary standards or adapt them to new uses. According to Ahmad (1998), historical buildings are preserved and conserved for various reasons, namely retention of historical values and development and also to promote tourism. The state of Penang is well known for the heritage character of its capital city, George Town. Compared to the fast industrializing and urbanizing landscape of Penang State, the old city still retains its charms and historical ambience. The Penang Island Municipal Council (MPPP) has adopted a heritage conservation policy for Georgetown and on 7th July 2008, UNESCO has listed Melaka and George Town as Joint Historic Cities of the Straits of Melaka to the World Heritage List. According to the document submitted to UNESCO, the nominated property in the Historic City of George Town covers 109.38 hectares and consists of the historic inner city on the north-east cape of Penang Island. There are more than 1,700 historic buildings within the core zone aligned on four main streets of Pengkalan Weld, Lebuh Pantai, Jalan Masjid Kapitan Keling and Lorong Love besides other perpendicular streets of Jalan Tun Syed Barakbah, Lebuh Light, Lebuh Bishop, Lebuh Gereja, Lebuh China, Lebuh Pasar, Lebuh Chulia, Lebuh Armenian and Lebuh Archeh.

Due to the listing, more property owners are starting to have an interest in restoring their property to take advantage of the city new status, causing an increase in restoration works. As such the demand for professionals such as conservation architect, quantity surveyors, building surveyors has also increase. However, the education and training of a quantity surveyor has always focussed on new building works. Due to the lack of experience in this area, many quantity surveyors are not familiar with the pricing for building conservation works. Unlike new building works where there are cost data to refer to, anecdotal evidence suggests that there is very limited cost data that quantity surveyors can refer to for historical building conservation work. Experience in new building works has shown that cost data plays an important role in the construction industry as it is an important source of reference for construction cost to both the quantity surveyor and the contractor. As such, the objective of this study is to define and identify cost centres for building conservation works to provide a guide for quantity surveyors in estimating such works in the future.

2. Cost centres of building conservation works

It is important to start out this paper with a clear definition of the terms ‘cost centre’, ‘building conservation’ and ‘historical building’. According to Ashworth (1988), ‘cost centre’ is defined as items of cost importance identified within a building project. In old buildings, the demolition and structural costs are minimal and the major factors that determine the overall cost of a project lie in the architectural and mechanical work (Fitch, 1992). Frequently, costs for mechanical and electrical work are high due to the complex nature of the systems installed. This element of the work is likely to remain an expensive item because historical buildings do not lend themselves to the installation of the quantity of ductwork and chases normally associated with mechanical and electrical equipment. Feilden (1994) recognises that, whilst the general renewal of building engineering services gives ‘life’
to these historic structures, their installation also causes acute technical and artistic problems. Fidler (1987) fears that old buildings are under threat from adaptive use, because it is often difficult to reconcile the technical requirements with the principles of conservation.

According to Lee (2006), Building Restoration Works and Mechanical and Electrical Works are the two major cost centres that need to be considered when preparing costs for all restoration projects. He also divided the restoration works into two elements called major and minor elements. Major elements are considered as important elements that must be priced and taken into account during the preparation of the estimate for restoration works. These major elements include roof and rainwater goods, floor structure and finishes, wall and column finishes and ceiling structure and finishes. The minor elements only appear on certain circumstances or can be interpreted as uncommon building trades or activities.

Ahmad (1998) has defined ‘building conservation’ as the practice of keeping historical buildings intact. The term ‘historical buildings’ usually refers to old building that has historical and architectural value. The scopes of works for conservation works to historical building are different from new building works. There are some special scopes of works that is specifically for conservation works. These special scopes include the preparation of the dilapidation survey report and from this report, repair methods and techniques can be identified. All building defects, methods and techniques will be recorded systematically by using the Historical Architectural Building Survey (HABS) documentation method. Scientific studies and laboratory tests will also be carried out before the completion of building conservation works.

3. Methodology

The main aim of this paper is to obtain an indication of which elements form the cost centres for building conservation works. In order to have an in-depth study of the cost centres, the research methodology chosen is case study. The case study research represents one of the most commonly research design in qualitative research. The sampling method used in this research is selective rather than based on random sampling. The authors acknowledge that the core criticism of case study research is that the results can not be generalised to a population (Woodside and Wilson, 2003). Below are the criteria used to select the sampling for this study:

- The building must be a historical building.
- The building must be within George Town area.
- It must have complete bill of quantities in the tender document.
- No study has been conducted on the building before.
From a survey of all conservation works in George Town, fifteen projects are short-listed and upon closer examination, Town Hall is chosen as the case study as it fulfils all criteria. The other projects are rejected because some have been studied by other researcher while some does not have sufficient information for case study or the information is too old. As part of the data collection, the contract document for this project was reviewed to obtain the relevant information. Other than secondary data, interviews were also carried out with the consultants who have been involved in this project. In order to determine the cost centres, the study applied the Pareto principle which is also commonly known as the 80-20 rule. The Pareto principle states that, for many events, roughly 80% of the effects come from 20% of the causes (John, 1997). Based on this principle, the study will define cost centre as those elements that contribute to 80% of the total cost.

4. Case study project

4.1 Introduction

Many heritage buildings in George Town, Penang have exceptionally survived the decades amidst intense development pressure and rapid urbanization. Some of them have been gazetted under the Malaysian Antiquities Act 1976, a condition that provides these buildings some protection and encourages their preservation. One such example is the Town Hall, a British colonial building located at The Esplanade in George Town, Penang. This distinctive building is considered by many local and foreign tourists as one of the notable heritage buildings in Penang. In February 2003, the Penang Municipal Council had granted a sum of RM4.17 million for the restoration of the Town Hall. A team of consultants including architect, engineers, quantity surveyor and conservation consultant were duly appointed to take on the restoration project, which was completed in August 2004.

![Figure 1: During restoration](http://www.hbp.usm.my/conservation/SeminarPaper/TownHall.htm)

![Figure 2: After restoration](http://www.hbp.usm.my/conservation/SeminarPaper/TownHall.htm)
4.2 Historical background

The Town Hall, Penang’s oldest Municipal Building was built around 1879 and is categorised as Grade 1 heritage building which means that it must be maintained in its original design. A building of British Palladian architecture, with classical arches, columns, pilasters, quoins, ornamental elements on roof parapet and balustrades, the Town Hall stands on Lot No. 70, Section 19, Georgetown, North-East District, Penang. With a land area of 70,711 square feet, the Town Hall is situated along Jalan Padang Kota Lama or formerly known as the Esplanade Road. On 1st January 1879, Lt. Governor Sir Archibald Edward Harbord Anson laid down the foundation stone of the Town hall and it was declared open by Governor Sir Frederick Weld of the Straits Settlement in 1880. It was formerly the social venue for the town’s elite, namely the European community. Hence, the Chinese called it ‘Ang Mor Kong Kuan’ or ‘The European Club’.

The Town Hall had been the focus of social live and civic pride. It had within its building an assembly hall with a stage as well as a ballroom with adjoining supper rooms. In the past, the Town Hall had functioned as a venue for Council meetings, Council elections, public speeches, balls, dramas and amateur concerts. For instance in 1891, the English Evening Service of the Wesley Church was held here while the “Bangsawan Wayang Kulit”(shadow play show) had performed in 1903. In addition, a group of Filipino musicians called the “Manila Band” had performed in this Town Hall regularly from 1890-1954. Apart from administrative and social functions, the Town Hall housed the Penang Library for more than 20 years and a private college (Kolej Damansara Utama) for 8 years. Due to its immense historical and architectural values, the building was gazetted on 29th July 1982 under the Antiquities Act 1976.

The Town Hall has a balcony that overlooks the Esplanade. In the olden days, the elite used to gather on the balconies of the Municipal Council buildings to view the processions and games held below. Through the years, the Town Hall has undergone five extensive expansions in 1890, 1903, 1938, 1958 and 1991 to accommodate the increasing demand for internal space and now comprises a front portico, an assembly hall, a ballroom with adjoining supper rooms, a stage, office rooms and a library. The Town Hall was also used for the filming of the movie “Anna and the King” in 1999. In the year 2003, archaeological excavations unearthed a small tunnel with a 96cm opening underneath the building. Artefacts’ discovered in the tunnel included broken pieces of pottery, Chinese roof tiles, bricks, glasses, porcelain, coins and even nails.

4.3 Elemental cost breakdown

The total cost incurred for restoring Town Hall is RM4,157,063.20. The costs for conservation works can be divided into four sections which consist of preliminaries, prime cost and provisional sums, building restoration works, and mechanical and electrical works. From the Table 1 below, it shows that building restoration works and mechanical and electrical works are the two major items which have the highest cost. This is similar to the literature review which also proved that building restoration works and mechanical and electrical works are the major cost centres.
Table 1: Elemental Cost Breakdown

<table>
<thead>
<tr>
<th>Schedule No.</th>
<th>Item</th>
<th>Amount (RM)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preliminaries</td>
<td>352,150.00</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>Prime Cost and Provisional Sums</td>
<td>598,900.00</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Building Restoration Works</td>
<td>1,584,793.20</td>
<td>38</td>
</tr>
<tr>
<td>4</td>
<td>Mechanical and Electrical Works</td>
<td>1,621,220.00</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>4,157,063.20</td>
<td>100</td>
</tr>
</tbody>
</table>

4.3.1 Preliminaries

Table 2 below shows the major cost items for preliminaries. The elements are arranged in descending order according to the cost of the element. The highest cost item is contractor’s superintendence item. This item include provision of on and off site management supervision including site agent and all necessary clerical and supporting personnel. This item also includes the allowance for a qualified and approved conservationist to assist contractor in supervision and other related matters to the conservationist works. The conservationist shall be engaged full time and based at site throughout the duration of the works.

The second highest cost item is safeguarding of the works. This item includes safeguarding the works, materials and plant against damage and theft including all necessary watching and adequate lighting. The contractor is also responsible for the safety of all materials, fixed and unfixed of his own, other sub-contractors and suppliers. This item also includes the cost for the employment of sufficient uniformed security guards for round the clock duties for the full duration of the contract. The equipment for supervision of the works includes computer, software, scanner, printer, camera, video camera and photocopy machine. The plant item includes provision of all necessary proper and modern mechanical and non-mechanical plant, vehicles, machineries, tools and whatever else devices that may be required for the proper and efficient execution and completion of the works.
Table 2: Major Cost Items for Preliminaries

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Amount (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contractor’s Superintendence</td>
<td>100,000.00</td>
</tr>
<tr>
<td>2</td>
<td>Safeguarding the Works</td>
<td>50,000.00</td>
</tr>
<tr>
<td>3</td>
<td>Equipments for Supervision of the Works</td>
<td>25,000.00</td>
</tr>
<tr>
<td>4</td>
<td>Plant</td>
<td>25,000.00</td>
</tr>
<tr>
<td>5</td>
<td>Consultant’s Site Office</td>
<td>16,000.00</td>
</tr>
<tr>
<td>6</td>
<td>Temporary Buildings</td>
<td>12,500.00</td>
</tr>
<tr>
<td>7</td>
<td>Performance Bond</td>
<td>12,000.00</td>
</tr>
<tr>
<td>8</td>
<td>Construction Industry Development Board Act 1994</td>
<td>11,000.00</td>
</tr>
<tr>
<td>9</td>
<td>Contractor’s Workmen Accommodation</td>
<td>10,000.00</td>
</tr>
<tr>
<td>10</td>
<td>Scaffolding</td>
<td>10,000.00</td>
</tr>
<tr>
<td>11</td>
<td>Setting Out</td>
<td>10,000.00</td>
</tr>
<tr>
<td>12</td>
<td>Temporary Electricity Supply</td>
<td>10,000.00</td>
</tr>
</tbody>
</table>

4.3.2 Prime cost and provisional sums

Table 3 below shows the cost breakdown for prime cost and provisional sums. From the breakdown below, it shows that contingency sum is found to be the highest cost item. Contingency sum is a sum allocate for unforeseen works. Under the requirement by the Museum and Antiquity Department of Malaysia, conservation work should involve a systematic method of recording and documentation based on the HABS. The HABS involved three major stages: before, during and after restoration works. Five copies of documentation for each stage must be prepared and according to the interviewee the minimum fee for prepare one copies of HABS report is RM10,000.00. Hence, total documentation fee for a building is RM150,000.00.

Table 3: Cost Breakdown for Prime Cost and Provisional Sums

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Amount (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Prime Cost Sums</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Motorised Blinds</td>
<td>153,500.00</td>
</tr>
<tr>
<td>2</td>
<td>Curtain</td>
<td>42,800.00</td>
</tr>
<tr>
<td>3</td>
<td>Sky Lift</td>
<td>32,600.00</td>
</tr>
<tr>
<td></td>
<td><strong>Provisional Sums</strong></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Support for Backdrop</td>
<td>20,000.00</td>
</tr>
<tr>
<td>5</td>
<td>Restoration Work Documentation</td>
<td>150,000.00</td>
</tr>
<tr>
<td>6</td>
<td>Contingency Sum</td>
<td>200,000.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>598,900.00</td>
</tr>
</tbody>
</table>
4.3.3 Building restoration works

Table 4 below shows the elemental cost breakdown for building restoration works. The elements are arranged in descending order according to the cost of the element. The major cost item are roof; ceiling; decorative elements; internal wall and column finishes; doors, ironmongeries and windows; external finishes; and plumbing and sanitary installation.

The item contributing to the highest cost for the restoration of roof element is roof covering. Type of roof tile used in this building is second hand Chinese roof tile and new “Peranakan” V profile clay roof tiles. The second highest cost for roof restoration is the temporary roof item. The third highest cost for roof restoration is the timber roof trusses item. These roof defects are one of the common building defects that occur in this country. There are some reasons why roof covering form the major cost. The damaged or missing roof tiles are unavailable in the current market and to specially manufacture it will incur extra cost. Besides that, some of the restoration works may require skilled artisan or skilled labourer from overseas. These factors must be taken into consideration when pricing for the conservation works.

For the ceiling element, the item contributing to the highest cost is restoration of existing timber board ceiling. It takes up 53% of the total cost of restoration for this element. This is because almost 80% of the ceiling finish is timber board ceiling finish. For the restoration of decorative element, the highest cost element is restoration of mouldings and decorative flowers. It takes up 40% of the total cost of restoration for this element. This is because most of the plaster mouldings on the walls and columns are in a poor state. The decorative flowers which situated along the front parapet wall and on the ceiling of the hall are also in a bad condition. Besides that, a set of carved timber decorative flower design proscenium arch which was built on the stage have been badly affected by termite infestation. Urgent attention is needed to save this structure.

All the walls of the case study building are masonry except for openings that have been closed with plywood to create an enclosure or partitions. The item contributing to the highest cost for the restoration of this element is the restoration of existing wall finishes. It takes up 76% of the total cost of restoration for this element. The installation of new hardwood panel door cost the highest cost for the restoration of doors, ironmongeries and windows element. There are a total of 87 numbers of new hardwood panel doors that are needed to be installed in this case study building. The hardwood panel doors have either one-door or two-door leaves of various sizes.

The item contributing to the highest cost for the restoration of external finishes element is the restoration of existing external wall. This is because external wall covers a big portion of the building. For the restoration of plumbing and sanitary installation, the sanitary appliances elements form the highest cost. This is because almost all the sanitary appliances need to be change. The sanitary appliances included water closet, vanity basin, urinal, basin tap, bidet spray set, toilet roll holder, soap dispenser, floor strainer, hand dryer, jumbo roll holder, guard rail and mirror.
Table 4: Cost Breakdown for Building Restoration Works

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Amount (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Roof</td>
<td>499,765.35</td>
</tr>
<tr>
<td>2</td>
<td>Ceiling</td>
<td>175,070.20</td>
</tr>
<tr>
<td>3</td>
<td>Decorative Elements</td>
<td>154,264.00</td>
</tr>
<tr>
<td>4</td>
<td>Internal Wall and Columns Finishes</td>
<td>148,723.30</td>
</tr>
<tr>
<td>5</td>
<td>Doors, Ironmongeries and Windows</td>
<td>134,371.90</td>
</tr>
<tr>
<td>6</td>
<td>External Finishes</td>
<td>96,769.75</td>
</tr>
<tr>
<td>7</td>
<td>Plumbing and Sanitary Installation</td>
<td>82,140.00</td>
</tr>
<tr>
<td>8</td>
<td>Floor</td>
<td>55,772.40</td>
</tr>
<tr>
<td>9</td>
<td>Floor Finishes</td>
<td>49,724.40</td>
</tr>
<tr>
<td>10</td>
<td>Damp Proofing Works</td>
<td>43,500.00</td>
</tr>
<tr>
<td>11</td>
<td>Wall and Columns</td>
<td>36,415.90</td>
</tr>
<tr>
<td>12</td>
<td>Ramp and Corridor</td>
<td>28,472.60</td>
</tr>
<tr>
<td>13</td>
<td>Staircases and Balustrade</td>
<td>27,000.00</td>
</tr>
<tr>
<td>14</td>
<td>Demolition Works</td>
<td>20,303.40</td>
</tr>
<tr>
<td>15</td>
<td>Anti Termite Treatment</td>
<td>16,000.00</td>
</tr>
<tr>
<td>16</td>
<td>External Works</td>
<td>10,500.00</td>
</tr>
<tr>
<td>17</td>
<td>Scientific Testing and Analysis</td>
<td>5,500.00</td>
</tr>
<tr>
<td>18</td>
<td>Archaeological Excavation</td>
<td>500.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1,584,793.20</strong></td>
</tr>
</tbody>
</table>

4.3.4 Mechanical and electrical works

This element forms the highest cost for building restoration works. The total cost for this element is RM1,621,220.00. The item under mechanical and electrical works can be divided into three items which are electrical and telephone; air conditioning; and plumbing. Costs for mechanical and electrical works are high due to the complex nature of the system installed.

For the electrical and telephone item, all existing electrical wiring must be completely removed with minimum damage. Works include installation of new telephone and electrical wiring, switches, power sockets and lighting points with minimum damage to existing wall. Also to provide for centrally located switchboards, concealed conduits for electrical and telephone wiring. All power/telephone points are to be located at floor skirting level.

For air conditioning item, all air conditioning are ceiling mounted type. Besides that, all existing internal plumbing and toilet fittings are removed and new system installed.
5. Conclusion

Historical building is one of the largest assets in George Town. Since George Town has been listed into World Heritage List, much of the conservation works will be done on the historical buildings. By knowing the major costs of conserving a building, a quantity surveyor would be able to focus on the critical items and ensure that the costs for items specific to conservation works are included in the estimate or tender. As such, this study attempts to identify the cost centres of conservation works for a historical building. Its aim is to obtain an indication of which elements form the cost centres for building conservation works. It is hopes that the findings may be use as a baseline reference for future conservation projects.

As such, the cost centres derived from this case study consists of roof, ceiling, decorative elements, internal wall and columns finishes, door, ironmongeries and windows, external finishes and plumbing and sanitary installation. Besides that, the mechanical and electrical works is also important it constitute a cost centre for building restoration works. By understanding the major cost centres in building conservation works, a quantity surveyor would be able to provide a better estimate of the cost as the major elements are given careful consideration.

References


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Construction and Building research Conference of the Royal Institution of Chartered Surveyor, Oxford Brookes University.


Green living technologies in sustainable refurbishment strategies

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Abstract

The aim of this research is to study the limits and the benefits deriving from the application of a “green surface” in a refurbishment action on existing buildings. Requalification processes are often related to sustainable issues as energy and water saving: the introduction of plant technologies on roofs and facades can produce an increase of performance in buildings’ envelopes and positive effects on indoor comfort. A green shading can have positive impacts on energetic balance of a building. Furthermore a green roof can be considered a strategic solution for retaining and reusing rainwater. The methodology used is composed of different steps concerning “green technologies” analysis and refurbishment strategies as well. Theoretic analyses are compared to some studies investigating the contribution of plant surfaces in the reduction of thermal impacts on walls and roofs. In the same time a cost/benefit analysis is led to assess the feasibility of the “green strategy” in a requalification action. Durability of the different technological solutions adopted is specifically investigated in order to have a life prediction comparable to the expected lifespan of the renewed building. Maintenance activity is assessed too. As a result, on the one hand the application of a “green strategy” doesn’t bring to a critical increasing of costs, on the other hand it implies positive factors in the energetic balance of the intervention. As it is underlined by the results of the studies the implementation of the building envelope through plant technologies can be considered, especially in dense urban areas, a suitable solution to offer a green answer to refurbishment action demand.

Keywords: green technology, refurbishment, durability, building envelope, energetic balance
1. Main features of the green envelope technologies

1.1 Plants in a built environment: thermal behaviour effects

Before analysing the opportunities offered by the “green strategy” in interventions aimed to promote a requalification of the built environment it is useful to point out some of the most important features of this technological solution in order to face some sustainable issues in this field.

The application of plants on the building’s envelope could have important benefits at two different scales of the built environment: the architectural one - reducing the superficial temperatures of the internal envelope - and the urban one mildening the air temperature of the surroundings.

As plants are living organisms, they exchange matter and energy with the environment: indeed they feed on inorganic substances transforming them in organic and inorganic ones through the action of solar energy. Because of their adaptability with the environment, built surfaces integrated with plants could be defined as a balanced system with a potential great impact on urban areas characterized by an high level of density. Even if the behaviour of the system is strongly influenced by local conditions, it’s demonstrated that the introduction of plants in anthropic areas improves the air quality. Furthermore this “technological solution” allows to introduce green surfaces, vegetation and connected benefits without using public areas.

Considering plants as the last layer of the envelope, they influence the building system trough their size and position referring to the following factors:

1. Shading: overlapping facades and roofs, plants are the first exposed layer to the sun intercepting at least the 70% of its radiation (Hoyano, 1988). This property derives from the plants’ attitude to change their configuration depending on sun exposure, wind, etc. to gain the solar radiation needed to develop the photosynthesis. This attitude is known as phototropism. The self-regulation has two main effects: the first is the reduction of the solar radiation absorbed by the under-laying structure with a consequent decrease of temperature, the second one is the superficial emissivity reduction of the built elements at long wavelength. This produces a reduction of the radiant heat. The plants’ shading effect is related to two geometrical values: the foliage density (LAI, Leaf Area Index) and the foliage height. The control of solar radiation of different kinds of green surfaces, walls and roof has been tested by Hoyano (1988) on a building in Tokyo. Different kinds of green screen, on walls and roofs, have been investigated. The results about the wall (concrete cm 15 thick) oriented to west demonstrated that during the hottest hours of the day the technological system with the ivy plants work as cooling (without the vegetal sunscreen the heat flux entering was maximum 200kcal/m²h - with the ivy’s covering was 50kcal/m²h) and as reducer of the urban heat island effect. Graph 1 shows clearly the thermal buffer behaviour.
2. **Soil stratum insulation**: vegetation needs soil to feed and to root so this is an essential part of the system. Furthermore this layer gives thermal inertia bringing a considerable time lag and a smaller variation of thermal flux (Theodosiou, 2003), acting as thermal insulation or cooling device. The properties of soil are established by the mixture of elements but above all by its thickness.

![Diagram of Heat flow graphs (Hoyano, 1988)](image)

**Figure 1: Heat flow graphs (Hoyano, 1988)**
Moreover the plants applied to the envelope mitigate the air temperature because of some metabolic effects:

3. **Evapo-transpiration**: this physical dimension measures the water quantity passing through the soil and from the body’s plants to the air as vapour, adding the equivalent water values of the plants’ transpiration phenomena to the soil’s evaporation. The change from liquid to gaseous state implies the use of energy (which is not re-irradiated as heat) originating air flows between the foliage which help to dissipate heat from the envelope. With the optimal water condition, low humidity in the air and high availability in the soil, plants can intercept the 80% of incident solar energy (Wilmers, 1988).

4. **Photosynthesis**: metabolic activity by which plants transform, through solar energy, carbonic anhydride and water into organic substance. This process, like others, develops through the use of energy and solar radiation absorbed: this energy is not re-irradiated as heat. Under this point of view, photosynthesis is an important process to improve air quality.

All these effects, connected each others, transform the green surface into a technological system able to adapt itself to variable environmental conditions. Many experiments analysed the green surface behaviour during summertime: during July and August the heat flux entering through a green roof is more than halved and the superficial soil temperature is slightly higher or lower than the one of the air – 30° C compared to 60° C of other built surfaces like asphalt, etc. (Castellotti, 2003). This property can be very useful to reduce the heat island effect in high density urban areas.

### 1.2 Rain water control in green roofs technologies

Green roofs have a high water retaining capacity: different layers and components saturated with water during precipitations, can hold back and release it later on. The water retaining capacity, in opposition to the draining attitude of all the other traditional roofs, seems to be an effective device for preventing overflows: especially in dense built areas where the impervious surfaces cause a fast flow of rainwater. Some green roofs represent an effective collector-system contributing to decrease the rainfall peak returning water as vapour to the atmosphere. These characteristics appear very interesting particularly when heavy rainfall periods combine with high temperatures periods.

*Table 1: Example of extensive green roof non-sloping type located in Brussels (precipitation 821mm/year), (Menten, Raes, Hermy, 2003).*

<table>
<thead>
<tr>
<th>Roof type</th>
<th>Runoff/year</th>
<th>Runoff in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>665mm</td>
<td>81%</td>
</tr>
<tr>
<td>Standard with 5cm of gravel</td>
<td>636mm</td>
<td>77%</td>
</tr>
<tr>
<td>Green roof with 5cm of substrate</td>
<td>409mm</td>
<td>50%</td>
</tr>
<tr>
<td>Green roof with 10cm of substrate</td>
<td>369mm</td>
<td>45%</td>
</tr>
</tbody>
</table>
Green roof with 15cm of substrate | 329mm | 40%

Since all climatic parameters, firstly air temperature, air humidity, rainfall, wind speed and so on, influence green technology, the technical parameters that influence the retaining capacity are mainly soil depth, drainage system and slope degree (Mentes, 2003). As a consequence of the water retaining capacity of green rooftops another important feature can be underlined: that one of a delayed releasing of water. The green roof can be used as water storage and filter useful to separate rain water drainage from the sewer net collectors in order to save a great volume of reusable water. The seepage possibilities are: drainage basin/tank (micro-biologically depurative action), sumps system (delayed release of water in the soil), alternative net for white and black waters, localized use. These remarks allow to point out that the application of green roofs and facades is particularly suitable in case of: high density contexts (where the built surfaces are impervious to water); an extensive application to several surfaces (because of the multiplicative trend of the effects). If on one hand some advantages (like a global air quality, a noise reduction and also a perceptive and psychological pleasure) deriving from the presence of plants in all their possible forms are evident, on the other hand the technologies that combine plants and constructions put many questions on their own performances: first of all the quantification of thermal efficiency and water retention. This topic is linked to three main features: the specific physiological characteristics and configurations of the different plants’ species, the variable absorbing ability of vegetation, the influence of different climatic parameters. All these elements make very difficult to produce a mathematical model suitable to describe the thermo-hygrometer behaviour of the green systems. For this reason a great caution should be exercised in extending the results of different and former experiences. As Hoyano says: “since plants cannot be handled as artificial materials, which have uniform qualities, systematic experiments should be conducted repeatedly to accumulate the data”.

2. The green envelope: opportunities in refurbishment strategy

2.1 Phase A: applicability

As it has been remarked in first part of the paper the advantages of a green envelope strategy are so suitable to suggest its application in refurbishment actions on existing buildings. Of course this chance must be assessed considering the potential degree of transformation of the existing structures. The procedures for planning green roofs and green facades are different. For both, preliminary analysis is aimed to verify the loading possibilities of the structures: in fact, only estimating the residual loading abilities, it is possible to choose the right green technology to satisfy the settled energetic and formal performances for the function. The scheme is:

<table>
<thead>
<tr>
<th>ROOFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>step</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>Step</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td><strong>A</strong></td>
</tr>
<tr>
<td><strong>B</strong></td>
</tr>
<tr>
<td><strong>C</strong></td>
</tr>
<tr>
<td>Self-carrying or stakes and netting</td>
</tr>
<tr>
<td>Hang box</td>
</tr>
<tr>
<td>Panels</td>
</tr>
<tr>
<td><strong>D</strong></td>
</tr>
<tr>
<td><strong>E</strong></td>
</tr>
</tbody>
</table>
2.2 Phase B: energetic update

Green envelope performances depend, besides the geometrical characteristics of the plants, on many factors proper of all the layers of the technological system suitable to root the plants. The refurbishment through these technologies must add all the properties of the new green layers to the performances of the original element in order to reach an higher energetic efficiency. The main advantages are:

1- Reduction of insolation
2- Reduction of superficial temperature
3- Reduction of surface emissivity/ heat island effect
4- Meteoric water collection
5- Thermal insulation in summer period
6- Thermal insulation in winter period

<table>
<thead>
<tr>
<th>System</th>
<th>Advantages</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>low roof thickness</td>
<td>2 = lower is the soil and drainage’s thickness → less is the superficial temperature’s reduction 6 = to guarantee insulation in cold period it is necessary a thermal insulation layer</td>
<td></td>
</tr>
<tr>
<td>medium roof thickness</td>
<td>6 = to guarantee insulation in cold period it is necessary a thermal insulation layer</td>
<td></td>
</tr>
<tr>
<td>high roof thickness</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In this frame it’s evident that green roofs, in all their typologies, present overall good energetic performances, either for the internal environment of the building, or for the external one. Even when the plants doesn’t grow homogeneously and the green surface doesn’t cover all the building surface, the sub-components (like soil, organic layers, etc.) are able to balance the behavior of the system. With its thickness (cm from 8 to 50) this layer is able to offer insulation with its mass and its contribution to the evapo-transpiration process (especially in warm season). Also the water...
accumulation and drainage elements, below the soil, guarantee an air-volume that works as another insulation layer when dry. It is possible to say that higher is the thickness stratigraphy of the roof, higher are the energetic performances; on the other hand higher is the thickness stratigraphy, higher are the weight and the operating costs. In case of a refurbishment action it is very important to evaluate the introduction of a layer specifically designed for the thermal insulation: for the absorption capacity green roofs cannot hold back the heat coming from inside during the cold seasons, so it is necessary to arrange the appropriate location for an insulation component.

As far as it concerns green facades the energetic performances are mainly related to two variables: the first is the geometrical characteristics of the species’ foliage (height and leaf area index) because the vigour of the plant, with a high LAI value, use more energy for their own metabolic processes besides on being a thick shadow surface; the second one is the morphological growth of the species, that can be conveniently shaped for covering partially or entirely the built surface, according to the project, to the movable element, to the windows, to the supporting structures and so on. Moreover the supporting structure of plants can influence the energetic behaviour of the wall: next to the traditional technological details, like stakes and nettings, there are now new technologies as panels and hanging solutions often combined with metal nettings. These technologies are able to guarantee the agronomic requirements but also to offer some further functions like the protection of the back surface, the ventilation and the integration of the irrigation system components. The technologies, trademarks and patents are increasing slowly, but it’s important not to forget that the main property of the green application in facades is the shading effect obtained with a very low intrinsic energy.

2.3 Morphological aspects of “green envelopes” in refurbishment

The choice of a refurbishment action with a planted surface modifies the building perception radically, or at least the most involved parts like façades and roofs. The deep dichotomy natural/artificial is particularly pointed out in the relation between the original structure and the new elements: in the case of a new green façade the original image of the building can be completely transformed. A planted built surface always gives an unexpected layout, where the contrast offered by spontaneity and roles strongly enhance the technical brilliance to join opposite essences. The vegetal texture, compared to the traditional building materials, is characterized by a variable behavior in a short time: not only the plants’ aspect changes quickly because of the growth and as a consequence they take up new surfaces parts, but also at the most of their extension they change colors and dimensions during the seasons. Another interesting factor is the opportunity to easily generate new surfaces through the substitution or addiction of new plants: this option makes the system reversible in one way and flexible to changes in the other one. With appropriate differences and according to the roof or wall elements it means the plants are simple and economic. The vegetal interface, since it is natural, could be used as a bridge between nature and building in particular contexts, where the buildings presence could compromise the landscape’s perception. The vegetal matter could be used for specific formal qualities giving a vast range of heterogeneous possibilities.
2.4 Maintenance and durability

The green technologies maintenance is a central issue for a possible refurbishment action. It is likely that at least two annual maintenance interventions to walls and roofs have to be done. So in the refurbishment project it is necessary to foresee safe and useful paths to operate on the green surface in order to foresee an adequate maintenance program that is a very relevant factor in the evaluation of the intervention scheme and in the choice of the technology to be applied.

Maintenance actions of the green structures can be classified as follows:

<table>
<thead>
<tr>
<th>Maintenance Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sturt-up maintenance</td>
<td>Starting agronomic works + ordinary maintenance actions</td>
</tr>
<tr>
<td></td>
<td>Roofs - control of the thickness/depth of the substratum, reseeding, replanting, control of the system efficiency, control of the system behaviour after climatic events.</td>
</tr>
<tr>
<td></td>
<td>Façade - check that the growth follows the supports, control of the stability of shape of the structures and of the anchorages</td>
</tr>
<tr>
<td>Ordinary maintenance</td>
<td>Watering, fertilizing, trimming, mowing/scything, clearing of weeds</td>
</tr>
<tr>
<td>Extraordinary maintenance</td>
<td>Roofs - particular situations after extraordinary meteorological events, diseases must be monitored. Yearly control of the draining elements in order to avoid occlusions.</td>
</tr>
<tr>
<td></td>
<td>Facades - particular situations after extraordinary meteorological events, diseases must be monitored. Control of of the back closing surface conditions</td>
</tr>
</tbody>
</table>

Closely linked to the maintenance operations is the durability concept: theoretically plants last as long as their life is, but the reproductive capacity gives them the possibility to be a durable regenerative material. Of course the evaluation of durability involves the whole system and this is linked to a comprehensive quality of the project. A well planned green envelope’s life can increase the life span of the below components and materials, either in the facades or in the roofs. But more than in traditional technologies, because of the critical contact with alive organisms, the choice of a wrong solution or an uncorrected construction can turned out as a failure itself or, worst, as a damage for other parts of the building.

3. Conclusions: two scales of costs and benefits

The benefits deriving from the use of a green envelope demonstrate that the most significant contribution to the control of the energetic costs is obtained during the summer. Some studies, though referring to different geographical backgrounds, report quite homogeneous data compared to the annual energy saving tied to the cost devoted to achieve thermal comfort: such experimental data
highlight a reduction of the temperature of the internal air of about a 1°C in the summer period. The immediately quantifiable ratio cost/benefit, obviously related to the type of climate, demonstrates an economical return of the highest initial cost for a green roof in about 20 years (Castellotti, 2003). This value looks prudential and above all without that emphasis to which green technologies are usually submitted. In fact, the cost/benefit balance, in addition to the real costs and to the reduction of the energetic ones charged to the owner of the building, should include some other items. As the green claddings are technologies suitable to produce mechanisms of compensation, as they can be considered in their whole low-impact environmental technologies, the effects of the climatic improvement appear besides the same building systems also in the urban quality in general. Such improvements have costs not easily quantifiable, but anyway they concern the whole society. Ralph Velasquez subdivides them in this way:

Table 2: Impact categories and actors involved (Velasquez, 2007).

<table>
<thead>
<tr>
<th>Impact category</th>
<th>Impact sub-category</th>
<th>Applicable to Society or Owner: S/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stormwater management</td>
<td>Quantity reduction</td>
<td>S/O</td>
</tr>
<tr>
<td></td>
<td>Offsetting potable water use through irrigation reuse</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Quality of run-off, e.g., reduced downstream treatment</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Downstream erosion control</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Reduced municipal infrastructure requirements</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Reduced combined sewer overflow into waterbodies</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Roof storage vs other on site sw storage or mngt method</td>
<td>O</td>
</tr>
<tr>
<td>2. Energy savings</td>
<td>Heating load</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Cooling load</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Peak demand reduction</td>
<td>S/O</td>
</tr>
<tr>
<td></td>
<td>HVAC Equip’t downsizing</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Building integration e.g., PV</td>
<td>O</td>
</tr>
<tr>
<td>3. Roof durability/maintenance</td>
<td>Extended roof life</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Reduced annual maintenance</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Less waste going to landfill</td>
<td>O</td>
</tr>
<tr>
<td>4. Heat Island Effect Mitigation</td>
<td>Energy savings</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Peak demand reduction</td>
<td>S</td>
</tr>
<tr>
<td>5. Improved air quality</td>
<td>Pollution abatement</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Population health effect</td>
<td>S</td>
</tr>
<tr>
<td>6. Improved aesthetic / Livability</td>
<td>Improved building marketability</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Increased commercial space salability/rentability</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Public relations benefit</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Other income sources</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Noise abatement</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Reduced EM fields</td>
<td>S</td>
</tr>
</tbody>
</table>
So, if a cost/benefit balance concerning the architectural scale of the building is possible and it is useful to owners and promoters to decide which kind of intervention is suitable for their own needs, especially in case of refurbishment, a cost/benefit evaluation concerning the urban scale is very difficult. Really, not as for the individuation of the positive impacts of the green choice on the built environment, but for their quantification. The problem is that not all the items involved in the process can be assessed by an economical point of view (which is usually the one of investors). There are social, cultural, environmental implications that justify the application of this technology even if the economic advantages will take place at a medium time. Anyway, as this paper summarizes, there are some benefits on the urban scale which simply derive by the attention given in the project to a conscious way of operating a refurbishment intervention in the frame of a sustainable requalification process.

References


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- international networking between academia, R&D organisations and industry
- participation in local and international CIB conferences, symposia and seminars
- CIB special publications and conference proceedings
- R&D collaboration

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- Revaluing Construction
- International Construction Client’s Forum

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- TG63 Disasters and the Built Environment
- TG64 Leadership in Construction
- TG65 Small Firms in Construction
- TG66 Energy and the Built Environment
- TG67 Statutory Adjudication in Construction
- TG68 Construction Mediation
- TG69 Green Buildings and the Law
- TG71 Research and Innovation Transfer
- TG72 Public Private Partnership
- TG73 R&D Programs in Construction
- TG74 New Production and Business Models in Construction
- TG75 Engineering Studies on Traditional Constructions
- TG76 Recognising Innovation in Construction
- TG77 Health and the Built Environment
- TG78 Informality and Emergence in Construction
- TG79 Building Regulations and Control in the Face of Climate Change
- TG80 Legal and Regulatory Aspects of BIM
- TG81 Global Construction Data
- W014 Fire
- W018 Timber Structures
- W023 Wall Structures
- W040 Heat and Moisture Transfer in Buildings
- W051 Acoustics
- W055 Construction Industry Economics
- W056 Sandwich Panels
- W062 Water Supply and Drainage
- W065 Organisation and Management of Construction
- W069 Housing Sociology
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- W077 Indoor Climate
- W078 Information Technology for Construction
- W080 Prediction of Service Life of Building Materials and Components
- W083 Roofing Materials and Systems
- W084 Building Comfortable Environments for All
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- W112 Culture in Construction
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- Performance Criteria of Buildings for Health and Comfort (CIB 292)
- Performance Based Building 1st International State-of-the-Art Report (CIB 291)
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- Condition Assessment of Roofs (CIB 289)
- Proceedings from the 3rd International Postgraduate Research Conference in the Built and Human Environment
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- Benchmarking of Labour-Intensive Construction Activities: Lean Construction and Fundamental Principles of Working Management (CIB 276)
- Guide and Bibliography to Service Life and Durability Research for Buildings and Components (CIB 295)
- Performance-Based Building Regulatory Systems (CIB 299)
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- Value Through Design (CIB 280)

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- Revaluing Construction
- Integrated Design and Delivery Solutions

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Membership will be automatically renewed each calendar year in January, unless cancelled in writing 3 months before the year end

<table>
<thead>
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<th>Fee Category</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
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<tr>
<td>FM1 Fee level</td>
<td>11837</td>
<td>12015</td>
<td>12195</td>
<td>12378</td>
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<td>FM2 Fee level</td>
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<td>8010</td>
<td>8131</td>
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<td>FM3 Fee level</td>
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<td>IM Fee level</td>
<td>271</td>
<td>275</td>
<td>279</td>
<td>283</td>
</tr>
</tbody>
</table>

All amounts in EURO

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