TABLE OF CONTENTS

Heritage and Culture

Inclusive Design for the Conservation of Built Heritage: Two Examples in Matera, Italy

Antonella Guida

Department of Architecture, Planning and Transport Infrastructures, Faculty of Engineering, University of Basilicata, Italy

Branka Dimitrijevic

The Centre for The Built Environment, Glasgow Caledonian University, UK

Antonello Pagliuca

Department of Architecture and Planning, Polytechnic of Bari, Italy .... ***Page 1***

Facilities Management and Built Environment Conservation: Competences and Issues

Phil Banfill and Barry Bridgwood

School of The Built Environment, Heriot-Watt University, Edinburgh, UK ... . ***Page 9***

Facilities Management in Heritage Buildings: Stakeholder Attitudes

Phil Banfill,

School of The Built Environment, Heriot-Watt University, Edinburgh, UK.

David Mclean,

Scottish Court Service, 23 Lauriston Street, Edinburgh, UK. .... ***Page 17***

Interventions in Built Heritage: Managing Which Risks and for Whom

Ana Pereira Roders

Faculty of Architecture, Building and Planning, Eindhoven University of Technology, NL

James Douglas

School of The Built Environment, Heriot-Watt University, UK....................... ***Page 25***

Increasing Sustainability in Cultural Heritage: A Case Study of School Buildings

Maria Fianchini, Serena Ferazza, Elena Galimberti and Alessandra Tondini

Politechnic of Milan, Italy .... ***Page 33***

Modernization of Concert Halls To Contemporary Requirements

Elzbieta Trocka-Leszczynska, Joanna Jablonska

Wroclaw Technical University, Faculty of Architecture, Poland.................... ***Page 41***

The Governance of Italian Cultural Heritage Properties: The Enhancement Process

Maria Rita Pinto

DICATA, Faculty of Architecture of Naples, University of Naples "Federico Ii", Italy

Stefania De Medici

DARP, Faculty of Architecture of Syracuse, University of Catania, Italy ...... ***Page 49***

Alternative Uses for Redundant Churches

Max Ingar Mørk

The Norwegian Association of Church Employers (KA) and The Norwegian University of Science and Technology (NTNU).. ***Page 57***

Brazilian 16th Through the Beginning of 20th Centuries Buildings As Housing for the Twenty First Century

Jeanine Ribeiro Claper

University of Rio De Janeiro, Rio De Janeiro, Brazil

Mônica Santos Salgado

Federal University of Rio De Janeiro, Rio De Janeiro, Brazil .... ***Page 65***

Maintenance On Measure for the Monumental Heritage

Serena Viola, Teresa Napolitano, Donatella Diano,

Università degli Studi di Napoli Federico II, Italy... ***Page 73***

Recovery of Built Heritage in Nineteenth Century Architecture. Fragapane Palace in Grammichele (CT)

Fernanda Cantone, Giovanna Cantone, Patrizia Carnazzo, Alessia Giuffrida

Department of "Analisi, Rappresentazione E Progetto Nelle Aree Del Mediterraneo" (ARP), Faculty of Architecture of Syracuse, University of Catania, Italy................... ***Page 79***

Information Technology

Computer-Aided Facilities Management (CAFM) of Intelligent Buildings: Concepts and Opportunities

Abbas Elmualim

School of Construction Management and Engineering, University of Reading, UK

Abayomi Pelumi-Johnson

Interserve FM, London, UK .... ***Page 87***

Best Practice for a Successful CAFM Implementation:CAFM Experiences From Germany, Austria and Switzerland

Thomas Madritsch

University of Applied Sciences FH KufsteinTirol, Austria

Michael May

University of Applied Sciences FHTW Berlin, Germany................................. ***Page 95***

Decision Support By Computer Aided Facility Management

Thomas Madritsch,
University of Applied Sciences FH KufsteinTirol, Austria;
Michael May,
University of Applied Sciences FHTW Berlin, Germany................................ ***Page 107***

RFID Technology Changes FM Services Deliveries

Pentti Vähä, Tapio Matinmikko, Kauko Tulla, Anne Tolman and Veli Möttönen
VTT Technical Research Centre of Finland, Finland.................................... ***Page 119***

The Benefits and Obstacles of Mobile Technology in FM Service Procurement

Anne Tolman, Tapio Matinmikko, Veli Möttönen, Kauko Tulla and Pentti Vähä
VTT Technical Research Centre of Finland, Finland.................................... ***Page 127***

Inclusive and Accessible FM

Accessible Toilets in Shopping Centres

Patrik Skogster
School of Technology, Rovaniemi University of Applied Sciences, Finland ...
.... ***Page 133***

Tactile Paving Site Selection Criteria

Mohammad Faruk, Marcus Ormerod, Rita Newton and Hamish Maclennan.
Surface Inclusive Design Research Centre, The Research Institute for The Built and Human Environment, The University of Salford, UK... ***Page 141***

Will current Emergency Evacuation Systems be Accessible, Safe and Usable in 2030?

Hamish Maclennan, Mohammad Faruk, Marcus Ormerod and Rita Newton
Surface Inclusive Design Research Centre, The Research Institute for The Built and Human Environment, The University of Salford, The Crescent, Salford, UK.............. ***Page149***

Refurbishment and Projects

An Innovative System for Control in Building Sites

Mauro De Luca Picione
Department of Architecture D.A.P.I.T., University of Basilicata, Italy
Guido R. Dell’Osso
Department of Architecture D.A.U., Polytechnic of Bari, Italy...................... ***Page 159***

Facilities Management, Health and Safety (H&S), and the Impact of the Construction Regulations

J. Smallwood
Department of Construction Management, Nelson Mandela Metropolitan University, South Africa

T.C. Haupt

Southern African Built Environment Research Center, Cape Peninsula University of Technology, South Africa.. ***Page 167***

The Problem of Flat Roofing System in Tropical Climate: Case Study – A Highrise Building in Kuala Lumpur, Malaysia.

Roslan Bin Talib

Architecture Department, Limkokwing University, Cyberjaya, Malaysia.......
.... ***Page 177***

Service Provision

Delivery of Continuous Improvement and Innovation: A Survey of Facilities Management Organisations

Shalu Madan and Sam Wamuziri

School of Engineering and the Built Environment, Napier University, Edinburgh, UK
.... ***Page 185***

Cleaning Management of Owner-Operated Real Estate

Christian Stoy, Nannette Terashima and Christopher Hagmann

Institute for Construction Economics, University of Stuttgart, Germany........
.... ***Page 197***

Using Repertory Grid Technique for the Appraisal of Library Servicescapes

Maimunah Sapri, Ammar Kaka and Edward Finch

School of The Built Environment, Heriot-Watt University, Edinburgh, UK ...
.... ***Page 209***

Indoor Air Quality

Feasibility Study On Benchmarking Indoor Air Quality (IAQ) of Air-Conditioned Offices in Hong Kong

K. W. Mui, L. T. Wong and P. S. Hui

Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong, China. .... ***Page 217***

Computational Analysis of Indoor Ventilation To Improve Sustainable Air Circulation in Built Environments – Use of Wind Capture

Patricia R C Drach and José Karam F.

National Laboratory for Scientific Computing, LNCC/MCT, Brazil............... ***Page 225***

Management of Airborne Infection Isolation Rooms

Greg Powell and Francis W. H. Yik

BSE Department, Hong Kong Polytechnic University, Hong Kong S.A.R., China
.... ***Page 233***

Health Facilities

Infrastructure Costs in Hospitals: A Process Oriented Analysis of Facility Management Services As Basis for Strategic Planning

Karin Diez and Kunibert Lennerts

Institute for Technology and Management in Construction, Facility Management, Universität Karlsruhe (TH), Germany.. ***Page 241***

Implications of the Architecture of Service Provision for Healthcare FM: The Case of Israel

Sarel Lavy

Department of Construction Science, Texas A&M University, TX, USA

Igal M. Shohet

Department of Structural Engineering, Ben-Gurion University of The Negev, Israel .... ***Page 251***

Clinic Facility Maintenance Using Life Cycle Costs Principles

Igal M. Shohet

Department of Structural Engineering, Ben-Gurion University of the Negev, Israel.

Nataly Kot

Construction & Maintenance Department, Technion – Israel Institute of Technology, Haifa, Israel

Itzhak Karako

Head, Department of Logistics and Maintenance, Maccabi Healthcare Services, Tel-Aviv, Israel .... ***Page 259***

Efficient and Healthy Environments in Public Buildings: A Strategic Question in the FM Organization?

Anne Kathrine Larssen

Faculty of Engineering Science and Technology, Norwegian University of Science and Technology and Multiconsult AS, Norway

Marit Støre Valen

Faculty of Engineering Science and Technology, Norwegian University of Science and Technology, Norway .... ***Page 269***

Healthcare in Housing – Space and Organisation

Inga Malmqvist

Department of Architecture, Chalmers University of Technology, Sweden ... . ***Page 277***

Creativity and the Workplace

Real Estate Stereotypes and the Working Environment

Alenka Temeljotov Salaj, Andrej Baričič
GEA College, Slovenia
Silvija Kovič, Miha Praznik
Building and Civil Engineering Institute, Slovenia .... ***Page 285***

FM Tools To Ensure Healthy Performance Based Buildings

Anne Tolman, Tommi Parkkila
VTT Technical Research Centre of Finland .... ***Page 295***

Unlocking Creativity with the Physical Workplace

Yuri Martens
Center for People and Buildings, Delft University of Technology, The Netherlands
.... ***Page 303***

Creativity Demands New Office Designs

Jesper Steen and Henrik Markhede
Spatial Analyses & Design, School of Architecture and Built Environment, KTH, Sweden
.... ***Page 313***

The Impact of Workplace Redesign on Customer Perception

Anssi Balk, Nils Gersberg, Suvi Nenonen
CEM Facility Services Research Group, Department of Structural Engineering and Building Technology, Helsinki University of Technology, Finland .... ***Page 321***

Sustainable Housing

An Epistemic Analysis of Per Capita Water Consumption in Residential Buildings of Hong Kong

L. T. Wong, K. W. Mui, P. S. Hui
Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong, China .... ***Page*** *329*

Online Benchmarking of a Sustainable Initiative in Slovenia

Marjana Sijanec Zavrl, Marta Skubic, Andraz Rakuscek
Building and Civil Engineering Institute ZRMK, Slovenia
Branko Noc
JEKO-IN, Jesenice, Slovenia .... ***Page 335***

Sustainable Housing – Part of a Healthy and Attractive Community

Vida Maliene

School of The Built Environment, Liverpool John Moores University, UK

Naglis Malys

MCISB, Faculty of Life Sciences, University of Manchester, UK .... ***Page 343***

Affordable Dwelling Quality and Preferences for Urban Young and Poor

Benedict D. Ilozor

School of Engineering Technology, Eastern Michigan University, USA

Michael I. Okoroh

Faculty of Arts, Design and Technology, University of Derby, UK .... ***Page 351***

Routine Maintenance and Sustainability of Existing Social Housing

Justine Cooper and Keith Jones

School of Architecture and Construction, University of Greenwich, UK........
.... ***Page 361***

Performance Measurement

Update on the Development of a Customer Performance Measurement System (CPMS) for Facilities Management: Enabling Generic Market Benchmarks

Matthew Tucker and Michael Pitt

School of Built Environment, Liverpool John Moores University, UK ....
.... ***Page 369***

Benchmarking the Costs for Operating and Maintaining Engineering Facilities of Luxury Hotels in Hong Kong

Joseph H.K. Lai and Francis W.H. Yik

Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong.. ***Page 377***

Locating Subjective Assessments in Local Government Corporate Real Estate and Facility Management

Christopher Heywood

University of Melbourne, Australia .... ***Page 385***

Organisation of Facilities Management in Municipalities

Per Anker Jensen

Technical University of Denmark, Denmark

Poul Henrik Due

COWI A/S, Denmark.. ***Page 395***

A Conceptual Framework for Measuring Facility Performance of a Co-Located Higher Education and Further Education Campus

Alaa Abdulrahman, Stephen Allen and Ammar Kaka,

School of Built Environment, Heriot-Watt University, UK .... ***Page 403***

Sustainability

Trees - Training for Renovated Energy Efficient Social Housing

Nesje, Arne,

SINTEF Building and Infrastructure, Trondheim, Norway .... ***Page 411***

Energy Management – a Question of Organisation

Jäschke, Stefan

ZHAW - Institut for Facility Management, Switzerland .... ***Page 419***

Considering Alternative Energy Systems in the Facility Management Process

Marjana Sijanec Zavrl

Building and Civil Engineering Institute Zrmk, Slovenia

Suzanne Joosen

Ecofys, Netherlands

Åsa Wahlström

Sp Technical Research Institute of Sweden, Sweden .... ***Page 427***

Extreme Weather Events and Business Continuity Planning

Keith Jones

School of Architecture and Construction, University of Greenwich, Uk

Bingunath Ingirige

School of The Built Environment, University of Salford, UK.......................... ***Page 435***

Contaminated Land Legislation: European Anomalies As They Affect Facilities Management and Clean-Up

Gabriela M Medero and Edward Finch

School of The Built Environment, Heriot-Watt University, UK

Michael J. Vowinckel

Heiko Rehse

Bilfinger Berger Umweltsanierung Gmbh, Germany..................................... ***Page 443***

Environment-Behaviour and FM

The Role of the Behavioural Environment in Enhancing Office Productivity

Barry P Haynes

Built Environment Division, Sheffield Hallam University, UK .... ***Page 451***

Affective Psychology in Australian Local Government Corporate Real Estate and Facility Management

Christopher Heywood

University of Melbourne, Australia .... ***Page 463***

Individual and Situational Influences On Perceived Office Noise

Lukas Windlinger

Institute of Facility Management, Zurich University of Applied Sciences ......
.... ***Page 471***

Knowledge Management in FM

Knowledge Creation in Entrepreneurial Firms: The Role of Real Estate Management Activities

Patrick S.W. Fong

Department of Building & Real Estate, The Hong Kong Polytechnic University, China

Paul Dettwiler

The Institute of Facility Management, Zurich University of Applied Sciences, Switzerland
.... ***Page 477***

Modelling Knowledge Exchange Among End-Users Using Social Network Analysis

Zehra Waheed and Edward Finch

School of The Built Environment, Heriot-Watt University, UK....................... ***Page 485***

The Potential of Knowledge Management Processes for Facilitating PFI Projects

Muzani Mustapa and Patricia M. Carrillo

Department of Civil and Building Engineering, Loughborough University, UK
.... ***Page 493***

Maintenance Management

Targeting Client Goals within a Performance Framework: Facility Maintenance KPIs as Facilitators of Strategic Organizational Objectives

Debajyoti Pati,

HKS Architects, Dallas, Tx, USA.

Cheol-Soo Park,

Dept. of Architectural Eng., Sungkyunkwan University, Suwon, 440-746, Korea

Godfried Augenbroe

College of Architecture, Georgia Institute of Technology, Atlanta, GA, USA
.... ***Page 501***

COST SAVINGS FROM PERFORMANCE-BASED MAINTENANCE PARTNERING

Ad Straub

OTB Research Institute for Housing, Urban and Mobility Studies, Delft University of Technology, The Netherlands .... ***Page 509***

Maintenance Budgeting Methods

Carolin Bahr and Kunibert Lennerts

Department for Facility Management, Universität Karlsruhe (TH), Germany

Uwe Pfründer

Engineering Consultant, ikl Ingenieurbüro Prof. Dr. Kunibert Lennerts, Germany .... ***Page 519***

Real Estate Portfolio Management

The Management of Small Public Real Estate Properties: The Portfolio of the University of Catania

Stefania De Medici and Carla Senia

DARP, Faculty of Architecture of Syracuse, University of Catania, Italy .... ***Page 527***

An Integrated System for Managing Complex Buildings:An Application for the Neurointensive Care Unit of the Hospital G. Rummo, Benevento

Erminia Attaianese, Gabriella Duca, Paola De Joanna

Dipartimento Di Configurazione E Attuazione Dell'architettura, Università Di Napoli Federico Ii, Italy .... ***Page 535***

The Impact of City Improvement Districts on the Informal Trading Sector

Keith Cattell, Kathy Michell, Paul Bowen and Laila Paleker

Department of Construction Economics and Management, University of Cape Town, South Africa.. ***Page 543***

A Systematic Framework for Corporate Relocation

Danny Shiem-Shin Then

Department of Building Services Engineering, The Hong Kong Polytechnic University, HK

Rose Yuen-Wah Poon

FRA Group, Hong Kong .... ***Page 551***

A Systems View of Corporate Facilities

Moacyr Eduardo Alves Da Graça and Rogerio Fonseca Santovito

Polytechnic School at São Paulo University .... ***Page 561***

Hierarchical Approach to Managing Risks of Large-Scale Construction Projects

Dey, Prasanta Kumar

Aston University, United Kingdom .... ***Page 571***

Workplace Management

Post-Occupancy Evaluation of a New Office Concept in An Educational Setting

Theo Jm Van Der Voordt

Department of Real Estate and Housing, Faculty of Architecture, Delft University of Technology, The Netherlands.

Wendy Van Der Klooster

Center for People and Buildings, Delft, The Netherlands. .... ***Page 579***

Future Workplace: Raising Awareness of the Potentials and the Needs of An Ageing Labor Force.

Giovanni Binda

Zurich University of Applied Sciences, Institute of Facility Management, CH
.... ***Page 589***

City Space Models in Office Design

Wacław Szarejko

Faculty of Architecture, Wroclaw University of Technology, Poland

Elzbieta Trocka - Leszczynska

Faculty of Architecture, Wroclaw University of Technology, Poland ....
.... ***Page 597***

Work Space Planning and Amenity Areas

Keith Cattell and Kathy Michell

Dept. of Construction Economics and Management, University of Cape Town, South Africa
.... ***Page 605***

Open Plan and Academe: Pre- and Post-Hoc Conversations

Ilfryn Price and Jill Fortune

Sheffield Hallam University, Facilities Management Graduate Centre, UK ..
.... ***Page 613***

Industry View

Better Strategic Procurement for Maintaining Schools: An Australian Context

Jim Smith

School of Sustainable Development, Bond University, Queensland, Australia.

Brian Wood

Oxford Brookes University, Oxford, UK... ***Page 621***

Preference for Plants in an Office Environment

Andrew Smith, Michael Pitt

School of The Built Environment, Liverpool John Moores University, UK ....
.... ***Page 629***

Providing Knowledge Worker Requirements: A Framework for Decision-Making and Evaluation

Kathy O. Roper

Building Construction Program, College of Architecture, Georgia Institute of Technology, USA. .... ***Page 639***

Users' Perceptions of Health in Sustainable Buildings – Worldwide

George Baird and Hedda Oosterhoff

School of Architecture, Victoria University of Wellington, New Zealand

.... ***Page 649***

Evaluating Buildings in Relation To Users' Exercise Activity

Edward Finch

School of The Built Environment, Heriot Watt University, Edinburgh

Samantha Fawkner and Ailsa Niven

School of Life Sciences, Heriot Watt University, Edinburgh........................... ***Page 657***

INCLUSIVE DESIGN FOR THE CONSERVATION OF BUILT HERITAGE: TWO EXAMPLES IN MATERA, ITALY

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ABSTRACT

In the restoration and re-use of inherited buildings and parts of cities, it seems necessary to develop more specific design and construction guidelines which assist the selection of the best option while ensuring that a balance of technical and cultural characteristics of the built heritage will be achieved in the process of its conservation and transformation. The central problem is the question of the heritage usability which can be addressed by developing an approach for comparing different design solutions in order to select the design which provides an inclusive environment. The above methodological approach has been tested on two recent interventions, “Locanda di S. Martino” and “Hotel S. Angelo” in Matera. The case studies have enabled the confirmation of the proposed method, demonstrating that the design of an inclusive environment guarantees the conservation of the heritage.

KEYWORDS: inclusive design, restoration, function, re-use

INTRODUCTION

The problem of the re-use of built heritage is one of the central points of debate in architecture nowdays. Various trends and views produce different and often conflicting methodological approaches. Therefore, it is necessary to plan the re-use of built heritage as a system in which technical and cultural variables create a balance between the conservation and transformation decisions and processes.
The specific objective is to produce a balanced synthesis of the dichotomous relationship between conservation, transformation and use, making the last one the instrument for preserving the values which have always characterised each re-used building. It seems necessary to develop a more comprehensive technological and design system which includes a method that permits the comparison of dishomogeneous design solutions for an architectural environment which can be used by everyone.
The answer to the problem is to design an “inclusive environment” for “human diversity, social inclusion and equality” (Stockholm Declaration – 9 May 2004). The paper provides an overview of the evolution of design approaches in relation to the usability of space. It then discusses the re-use as a conservation instrument and draws attention to the innovations in the

re-use of Sassi of Matera. The application of the Universal Design principles is analysed on two case studies of flexible design for the re-use of built heritage.

INCLUSIVE DESIGN IN ARCHITECTURE

The problem relevance

The accessibility of built heritage is a very important problem. A recent demographic research undertaken by EUROSTAT in 2003 shows that on average the popoulation of the European Union affected by a permanent or temporary disability represents 15% of the population of the entire continent (http://ec.europa.eu/employment_social/index_it.html). Estimating that the European population is 320 million people, it is evident that 48 million people are interested in the problem. Considering that each person affected by a disability lives, on average, with another person, the population interested in the problem becomes 96 million people, i.e. 30% of the total population. In the context of adopted European Union policies for a more sustainable built environment, the accessibility of new and existing buildings is an important social issue which can be tackled by designing inclusive environments.

Another relevant social issue is the ICOMOS (1998) declaration that “the right to cultural heritage is an integral part of human rights”. It implies that the built heritage should be made accessible to as many people as possible. Considering the economic issues of sustainable built environment, it is in the interest of the built heritage managers/owners to provide access to buildings and attract all the visitors whose spending power can support the heritage maintenance. As disability does not necesseraly prevent people from moving and visiting architectural heritage, their spending in relation to tourism and leisure activities should be considered. The environmental impact of buildings is reduced if they are not demolished or left abandoned but re-used. As Grammenos and Russel (1997) put it: ‘The most environmentally benign building is the one that does not have to be built.’ As the reduction of the environmental impact of built heritage through re-use contributes to a more sustainable built environment, it is another concern of relevance to the topic.

From Functionalism to ergonometry

Born as a reaction to the exuberance of architectural forms of 19th century Eclecticism, Functionalism found its strongest expression in the work of Walter Gropius whose slogan was “Form follows function”, a concept that emphasises the importance of a search for an appropriate form for a proposed function. In the context of architectural heritage this means the identification of an appropriate function for an existing space. Le Corbusier’s famous theory of “Modulor”, the concept expressed in 1947, is based on the idea of universal design that recognises the existance of universal measures deduced directly from a human body.

This represents the basis of a science named ergonometry. The word ergonometry consists of two Greek words which mean work (ergon) and rule or norm (nomos), and can be synthesised as “the norms which rule the work”. Ergonometry developed at the start of the 1940s in the United Kingdom, in the field of engineering; the first studies were related to the use of military equipment, but soon included the medical sector (Spinelli, 2006). Nowdays, ergonometry can be considered as an interdisciplinary science that converges the knowledge related to technical-design issues (e.g. physics, engineering, architecture) with that related to medical-biological issues (e.g. physiology, anthropometry, work medicine, psychology, sociology).

The concept of Universal Design

To design means to plan and structure a system that allows human beings to satisfy their needs. In the assessment of various options, the designer should aim to select the best one. The evaluation of design options is regularly undertaken in relation to a large number of actions, from those of a very simple nature to more complex ones. This process model is defined as "ideal" because it does not only refer to the optimal selection conditions, but also to an "abstract" user, i.e. a healthy, adult and perfectly able-bodied human being (http://www.hbgroup.it). The concept of a standard project seems limited and limitating for a very complex human reality, risking to create spaces that are not completely usable by everyone.

A transition is proposed from a standard design concept to the design for disability, a design that also takes into account temporary or/and permanent physical or/and sensory impediments which can affect anyone. In the evaluation process, the assessment criteria should not only include aesthetic and/or economic aspects, which are an important part of a project, but also address the usability of designed spaces by analysing the real and potential needs of the occupants. A special attention should be given to the preliminary project definition stage. Although this model, defined as "design without barriers", does not dialectically question the design method, it identifies "architectural barriers" as the principal obstacle to be overcome in order to guarantee accessibility to people affected by temporary or permanent physical and/or sensory disability. However, this is a non-inclusive, "ghetto" approach in terms of setting disability against an ordinary condition of "normality", which effectively banishes the people with different abilities to the margines of society.

The aim is to design a space which can be used by anyone, regardless of their physical and/or sensory conditions. In this way the concept of Universal Design was born, emerging from a deep reflection on the binomial "design-disability" which from the 1970s involved the design world into a debate regarding the need to provide adequate solutions for the needs of people who have physical or/and sensory difficulties. Universal Design aimed to be an answer to the complexity of the real world. It is not a closed, but an open, developing system, which considers possible options within a process of dialectical confrontation with usage. This is a system of performance requirements for satisfying objective and "equal" needs for everyone with a subsequent identification of requirements directly related to "genius loci".

From Universal Design to Inclusive Design

Roland Mace developed the concept of Universal Design and used this expression for the first time in 1985. Mace described a concept which re-established a fundamental objective of a good design practice: responding to the needs of the largest number of possible users. His approach highlighted a tension within the objective of evaluation, which should not consider only the dimensional requirements. He challenged the designers to think beyond compliance with the codes and to focus on the special needs of specific users aiming to find solutions which address the needs of various occupants. Universal Design defines the user in a broad way and does not focus only on people with disabilities. It suggests that all the building components and spaces should be accessible and usable by people in the optimum way. It does not imply that everything will be completely usable by everyone: the term refers more to the methodological approach than to a strict and dogmatic proposition.

In 1997 the seven design principles according to Universal Design logic were proposed:

1. *Equitable use* (equal, non discriminatory usage)
   The design is useful and available to people with different abilities.
2. *Flexibility in use*

The design is adaptable for a wide range of needs and individual abilities.

3. *Simple and Intuitive Use*
   The use of the design is easy to understand, regardless of the user's experience, his/her knowledge, language or level of concentration.
4. *Perceptible Information*
   The design effectively communicates necessary information to the user, regardless of the environmental conditions or his/her sensory capacity.
5. *Tolerance for error*
   The design minimises the risks and negative consequences of accidental or non-intentional actions.
6. *Low Physical Effort*
   The design can be used in an effective way, comfortably and with a minimum of force.
7. *Size and Space for Approach and Use*
   The design provides ample space for approach, communication, manipulation and use of an object regardless of the physical size, posture or mobility of the user (Mace, 1998).

After a few years, a transition was made from Universal Design to Inclusive Design. This started from the following fundamental assumption: if the social integration of disability were to be achieved, then the physical environment in which this could occur should be "inclusive". After the first international convention on this topic, organised by UKIID (United Kingdom Institute for Inclusive Design) in London in 2000, a greater sensibility towards the problem and a gradual involvement of other European Union countries have been achieved. This led to the Stockholm Declaration in 2004 in which, for the first time, the definition of Inclusive Design was provided as "design for human diversity, social inclusion and equality" (Stockholm Declaration of EIDD - 9 May 2004).

THE RE-USE AS A CONSERVATION INSTRUMENT

The role of a building re-use is already established within building sector activities notwithstanding a profound social and cultural revolution which has imposed significant changes in the approach to re-use interventions. In other words, there was a transition from a mere conservation of technical-material-structural aspects towards a wider perspective of conservation of the values expressed by a single building structure. In this process the cultural horizons have been widened, completed and integrated. A re-use project has to be developed on the basis of profound technical and scientific knowledge of the constituent components of a building and on the analysis of their values in order to use their potential to meet the needs of users. To achieve this goal, a design intervention should be planned as a balanced synthesis of the dychotomic relationship between conservation, transformation and use. An appropriate function should be planned, completely compatible with the historical-technological nature of the building and flexible in terms of contemporary lifestyle requirements (Guida et al., 2003a).

In this way a function itself becomes a means of conservation and a conservation instrument of the highest quality. This outcome can be demonstrated by the various fates of similar monuments which had different histories of use: some buildings are well preserved because they have been constantly used, others are in bad condition because they were abandoned to deteriorate. The idea of re-use has radically changed – far from being a strict conservation action, it is understood as a bespoke action, particular for each place which embraces the future with its own cultural acquisitions from the past.

Moreover, a radical change occurred in the attitude towards the normative instruments which now aim to address needs/requirements without being binding/limiting while taking into account a critical assessment of the cultural values of each building. Such a procedure, through a wider flexibility and a less restrictive approach, allows the exploitation of existing architectural heritage and the re-use of its qualities for an integrated and comprehensive conservation of a monument. It enables revitalisation through the re-use related to its previous or new function (Pagliuca et al., 2007).

INNOVATION IN THE RE-USE OF SASSI IN MATERA

The ancient and remote town of Matera, a small town in the southern part of Italy, offers the visitor an unexpected sight. It seems a "timeless" city positioned on a steep hill, where groups of houses branch out starting from the top and moving downwards in concentric circles thus forming the "*Sassi*". This important built heritage, abandoned for over 60 years, is nowdays undergoing slow, but careful, interventions to recover this cultural heritage under the sponsorship of UNESCO from 1993. The impact of modern life on such a delicate ecosystem as that of the ancient Rioni Sassi di Matera can sometimes assume distructive aspects. Numerous studies and research projects undertaken in more or less recent times have concluded that there is a need to re-use the *Sassi* for different needs of the community, always with a full respect of the morphological character of each building unit. The task is far from being easy. On one hand, care should be taken of the typical characteristics of *Sassi*, the small units dispersed within the city walls, along galleries and terraces which have been cut in the rocky hillside, and in many alleys and streets. On the other hand, the enormous size of the whole *Sassi* complex emphasises the methodological problems of an intervention on existing structures and the operational challenges of embedding new technological systems in support of various functions within each building structure.

However, the work on the ground shows a shortage of guidance so much so that in many cases the problems of re-use have been tackled by modifying the methods established for interventions on new buildings, or by re-applying tested functional and/or technological solutions which have not been calibrated for insertion in particularly significant contexts such as the Sassi of Matera. Quite often re-use has resulted in the adjustment of building units through a forced transformation and the introduction of new components and functions which have altered the original typological and morphological features, taking the completed projects far away from the initially proposed theories. Therefore, a coherent action for re-use is much more than the moment of selection of effective methods for meeting the required needs. It becomes a detailed study of the needs expressed by usage and of the possible alternatives for meeting them in harmony with the existing architectural characteristics. A coherent system can be determined through a study of the relationships of a building, its new use, the users' needs, the technological equipment consequently required and the preservation of existing values. It is a system of relationships from which technically and culturaly acceptable solutions emerge, solutions that fully respect the values expressed by each architectural structure. The considerations discussed testify that the quality of an intervention in terms of its functional, architectural, material and structural aspects lies in a "quality" of selections/solutions and in a "quality of relationship" of the intervention with the built heritage. Therefore, the objective is not to transform a building structure but to conserve it by harmonzing the contemporary performance requirements with the building's authenticity and original structural language. The selected systems have to be flexible to allow further potential re-use of spaces and structures, especially if it would be difficult to re-insert them later in the life-cycle of a building (Guida et al., 2003b).

To live and re-house by “re-using the past” becomes a systematic proposal for a methodological and design approach which does not remove restoration principles but fully embraces the new concepts of Universal Design. To revive the environments rich with artistic and social history means nothing less than to feel a “renaissance”of the functions embedded in the context, revisited with incremental changes and a contemporary lifestyle.

CASE STUDIES

The methodology used in the research is that of empirical research, i.e. a direct study *“in situ”*, where the designer is an experimenter and a researcher at the same time. This methodological approach was used on particularly representative case studies, the Locanda di San Martino and the Hotel Sant’Angelo, two heterogeneous complexes but at the same time homogeneous in terms of architectural forms and peculiarities, which have allowed the validation of the above proposed considerations. Their complexity allowed only a limited number of possible design solutions. The final solution represents the most appropriate one as a synthesis and a "compromise" between the performance required and the limits imposed by built heritage. The problem of “functional adjustment” of the former residential units to a new reality of living by mediating between prescriptive norms and exemptions dictated by the reality becomes a challenge for the integration of functions, the compliance with the standards and the performance optimisation of re-used spaces. Abandoned houses, linking spaces and infrustructures, deteriorated, often non-existant, nowdays become hotels and residencies of a high visual quality and comfort. In these examples the topic of “universal use”, as in other famous and significant contexts such as Venice, becomes not only a “design theme” but a universal social action. The accessibility for and the use by everyone can not be any more and only “normatively” linked to the adequate endowment from an organisation and/or the general public, but belongs to the domain of the city infrustructure policy. The morphological and urban configuration of the *sassi* in Matera, as well as of the city of Venice, “naturally” deny concepts of “suitability” for use as they have natural “architectural barriers”. This becomes a stimulus for research undertaken by the designer to find suitable and “reconcilable” solutions within these contexts, but which only partially contribute to the solution of all the problems linked to the design of spaces and functions “for everyone”. The latter theme becomes the principal objective of the research. Its is a starting point for the use of methodological approaches and technical solutions on a real site intervention.

Locanda di San Martino (http://www.locandadisanmartino.it)

The Locanda di S.Martino (See Figure 1) is a hotel planned as a “centre for cultural holiday and study” that provides ordinary hotel services but is also an international reference centre for scholars from all over the world. The hotel, which has around 53 beds, appears very articulated due to a particular and specific organisation of spaces. Its main characteristic is that the layout allows a definition of the room and suite types by sub-dividing spaces into more rooms. A number of additional beds can be provided by transforming living spaces, adding the equipment and offering communal services. The objective of the intervention, along with the full respect for the original environment, was to create flexible and usable spaces even for people with reduced and/or impeded mobile or/and sensory capacity. This was the aim notwithstanding the fact that this performance requirement had to clash with the existing typological layout which does not always permit the incorporation of technological support services. The horizontal and vertical connection of different units is provided directly or through re-organisation of space distrubution and by inserting technological services. With full respect for Mace's principles as quoted above, the whole structure is planned in a way which minimises the use of physical force. For example, the reception is the Inn's central node of spatial organisation from which a mechanised vertical connection links three of the five levels of the structure. In addition, the structure has a system of signs that are easily seen and read, and are related to the organisation of the whole building. They are always integrated in a way which respects formal and traditional customs.

Figure 1. The Locanda di S.Martino, a double room and a lift

Hotel Sant'Angelo (http://hotelsantangelosassi.it)

The same rigorous intervention methodology, although facing apparently different problems, was applied on the project for the re-use and conversion of another area, this time located in Sasso Caveoso, to plan Hotel S. Angelo (See Figure 2). In this case again, the structure has the same technical and technological characteristics as the Locanda di San Martino. Its horizontal layout was developed on "galleries" by using existing urban circulation routes which become a true and typical outdoor communication space. It should be noted that, in spite of significant articulated spatial forms, the spaces are all laterally linked on two main levels. They are superimposed on each other as retracted levels. Each unit is a singular space with unique and identifiable characteristics. This type of structure has significantly simplified the insertion of a heating grid and wiring for services. The aggregated ensemble typology, which is distinctive for the morphological articulation of the Sassi of Matera, is found in this area. Urban spaces (urban rooms) and "neighbourhoods" (an ensemble around a "courtyard") alternate and unite to form a structure which recreates a real and historical residential context. Difficulties, related to the suitability of such a reality, are even stronger here. The structure has functional "equipment" completed as needed and made on the site as a bespoke component. With a careful "management" of their operational performance, they should provide a service which otherwise could not be obtained by a functional adjustment of a "technical" solution.

Figure 2. The Hotel S.Angelo, a triple room and the entrance

CONCLUSIONS

The case studies clearly show how much the typological-morphological complexity of these residential units is only apparently an unsolvable problem. They really become usable through the re-definition of arrangements and functions of spaces and by “considerate” insertion of technological systems.
The research intention was to show how the principles which are apparently dichotomic in relation to architectural heritage become the instruments that guarantee the vital continuity of a patrimony which would otherwise be abandoned and degraded. The usability of these historical environments, which are listed as UNESCO’s World Heritage Monuments, is directly linked to the beauty of the places. However, their adaptability has to be the priority for all public organisations and private interests in order that they really become “a patrimony for everyone”.

REFERENCES

Grammenos, F. and Russel, P. (1997), “Building Adaptability: A view from Future”, Proceedings of the Second International Conference: Buildings and the Environment, June 9-12, Paris, Vol. 2, pp. 19-26.

Guida, A., De Tommasi, G. and Napoli, F. (2003a) “ L'edilizia seriale dei centri storici di Puglia. Casi di studio di Bisceglie e Molfetta: schede di progetto - Qualità prestazionali per il recupero dell’edilizia storica. Una proposta metodologica per un codice di pratica”, Adda Editore Snc, Bari.

Guida, A., Fatiguso, F. and Mecca, I. (2003b), “Setting of the restoration project for durability”, in Brebbia, C. A. (Ed.) Structural Studies, Repairs and Maintenance of Heritage Architecture, Vol. VIII, pp. 705-714.

ICOMOS (1998), Declaration of ICOMOS marking the 50th anniversary of the Universal Declaration of Human Rights, www.international.icomos.org/e_stocdec.htm.

Mace, R. (1998), “Universal Design in Housing”, Assistive Technology, Vol. 10, No. 1.

Spinelli, L. (2006), “Ergonomia, usabilità, accessibilità”, Gruppo Editoriale Infomedia, Pisa.

A. Pagliuca, A. Guida, F. Fatiguso (2007), “The “Integrated Refurbishment” as a fruition system of cultural heritage”– in proceedings of the World Association for the protection of Tangible and Intangible Cultural Heritage “The Fifth International Conference on Science and Technology in Archaeology and Conservation” – July 7-12, 2007, Baeza-Granada, Spain.

FACILITIES MANAGEMENT AND BUILT ENVIRONMENT CONSERVATION: COMPETENCES AND ISSUES

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ABSTRACT

Most building conservation practitioners perceive projects as finishing upon handover of the conserved building to the client, without necessarily giving much thought to the continuing management of the heritage asset for the rest of its lifetime. Since the key objective of conservation is to prolong the life of historic assets by giving them a sustainable new use, this narrow focus is unfortunate. Equally facilities managers are often constrained by the particular features of historic buildings and the regulatory environment in which they must function. This paper explores the competences which are needed by those responsible for the conservation and management of historic buildings and describes work done to establish an agreed framework of educational support for conservation practitioners to raise their competence level. Features of the framework have potential benefits for facilities managers. Five educational support units, based on the ICOMOS (International Council on Monuments and Sites) training and education guidelines have been converted, under the leadership of Heriot-Watt University, into an on-line format suitable for use by the practitioner at his or her desk. The paper describes the rationale behind the competence framework, gives a brief outline of the on-line content and its philosophy, and suggests how the principles embodied could be adopted by facilities managers in their work within the historic environment. It concludes that, while facilities managers are unlikely to participate in any of the built environment conservation accreditation schemes, those responsible for historic buildings need to be aware of the special needs of the historic environment.

KEYWORDS: building conservation, ICOMOS guidelines, education, professional accreditation

INTRODUCTION

In the words of ICOMOS (1993) the object of built environment conservation is:

“to prolong the life of cultural heritage and, if possible, to clarify the artistic and historical messages therein without the loss of authenticity and meaning. It is a cultural, artistic, technical and craft activity based on humanistic and scientific studies and systematic research.”

Thus it includes engineering structures, landscapes, townscapes and monuments, as well as historic buildings, and explicitly aims to prolong the life of historic assets by giving them a sustainable new use. While conservation uses the same technical skills as are developed by studying the “new-build” built environment, it has developed its own ethics and philosophy for dealing with the heritage of what already exists - the key principles of integrity, authenticity, reversibility and minimum intervention.

In the UK, education in this field is almost entirely a postgraduate activity. Apart from single modules in some undergraduate degrees most graduates enter practice ignorant of conservation philosophy and practice. They may develop an interest in conservation and build up skills and experience through practice, supported by established postgraduate courses at a number of universities. However, the increasing trend towards requiring accreditation of professional practitioners demands a more structured approach and this paper describes a framework which has been developed to support professionals as they prepare portfolios of their work for assessment. The framework is targeted at professionals of any discipline and the competences described will be relevant to facilities managers. As far as we know, this approach is unique in Europe.

BACKGROUND

The UK government has committed itself to improving the quality of design and architecture and recognises the part played by historic buildings. For example the Policy on Architecture for Scotland (Scottish Executive, 2001) has, as one objective, "to promote the value and benefits of good architecture...[and] work...to commission and publish research on matters relating to building conservation and traditional materials". Another objective is "to foster excellence in design, acknowledge and celebrate achievement in the field of architecture and the built environment, and promote Scottish architecture at home and abroad". This will be met by working to "promote the imaginative re-use of old buildings and develop the skills necessary for their conservation, repair and maintenance." (Scottish Executive, 2001). Similar sentiments underpin the work of the UK Commission on Architecture and the Built Environment (CABE, 2006).

The value of the built heritage is being increasingly recognised, even though it can be difficult to quantify such value (Allison et al, 1996). Cultural tourism is a major contributor to the economies of most northern countries: tourists are attracted by the historic built environment and they expect to see conserved buildings and structures in appropriate and well-maintained settings. Culture and heritage are key contributors to a sense of national identity: people need to identify their origins, and buildings, through their associations with particular historical events, are essential aids in the education process. The quality of life of the inhabitants of any area is enhanced by the enlightened conservation and imaginative re-use of old buildings: run-down districts can be given new life and communities re-invigorated by conservation and restoration work (English Heritage, 2000).

Conservation is a major component of the built environment industry, contributing to the repair and maintenance sector's turnover of about £28 billion in the UK. This is not matched by educational provision, which focuses on the issues of new-build work, and this in turn leads to variable levels of practitioner competence. To address this Historic Scotland, English Heritage and the Heritage Lottery Fund now all require, as a condition of grant assistance, that conservation projects be led by an accredited practitioner. All grant assisted projects require a conservation plan, which must include a management plan for the sustainable use of the building after project completion and handover of the conserved building to the client. Thus, although they are unlikely to lead a conservation project, facilities managers have a clear interest in these long-term management arrangements.

PRACTITIONER ACCREDITATION SCHEMES

Against this background several schemes have been set up in recent years - by the Royal Institution of Chartered Surveyors, Architects Accredited in Building Conservation (under the Royal Institution of British Architects, the Royal Incorporation of Architects in Scotland, Royal Irish Architects Institute (Ireland and Ulster), the UK Institute of Conservation and the Conservation Accreditation Register for Engineers - and about 300 professionals have been accredited in the UK. The Edinburgh Group, a pan-professional forum convened by Historic

Scotland, has been working towards a common accreditation approach since 2001 (Maxwell et al, 2004), which requires candidates to demonstrate their competence and experience through a portfolio of projects of different types. It has been recognized throughout this process that educational support, in the form of Continuing Professional Development (CPD), would be needed to help practitioners develop their skills and present their portfolios for assessment. This was felt to be the only way to effect the improvement in the ability and competence of individual professionals which the accreditation initiative set out to achieve.

A set of competences were presented to the Edinburgh Group in 2001, from which an educational framework was prepared, which in turn has been developed into a set of distance-learning materials for use by practitioners at their desks. The aim is to present the material in a way that challenges participants' understanding of why conservationists do what they do. It starts from the premise that participants are already experienced and knowledgeable in conservation practice and therefore does not duplicate the already existing body of accessible information. However, self-assessment questions force them to examine their perceptions and values. It gives guidance to help them assemble the portfolio of evidence which will demonstrate their competence to those responsible to assessing their application for accreditation through any of the professional schemes. The rationale and framework are described next.

RATIONALE

The international ICOMOS Training and Education Guidelines (ICOMOS, 1993) (see Table 1) are the key reference points established from the conservation policies and charters (Bell, 1997, BSI, 1998, Historic Scotland, 1998). The Guidelines were originally conceived as a training framework but are a useful basis for identifying the functions relevant to conservation professionals, stating that conservation works should only be entrusted to persons competent in these specialist activities. The guidelines refer to ensembles (groups of buildings) and cultural heritage sites defined as such by the World Heritage Convention of 1972, as well as monuments. They include historic buildings, historic areas and towns, archaeological sites and their contents, as well as cultural and historic landscapes.

The 14 clauses in paragraph 5 of the ICOMOS Guidelines are arguably quite complex and certainly make an interlocking set of desiderata. Individual practitioners have experienced difficulty in understanding or interpreting some of them and one aim of this work was to provide a simplifying basis for such professionals. Additionally, the lack of a formal order within the guidelines makes the direct translation into a course curriculum difficult.

Table 1 The ICOMOS training and education guidelines (14 clauses)

Clause	Conservation works should only be entrusted to persons competent in these specialist activities. Education and training should produce from a range of professionals, conservationists who are able to:
a	read a monument, ensemble or site and identify its emotional, cultural and use significance
b	understand the history and technology of a monument, ensemble or site, in order to define their identity, plan for their conservation and interpret the results of this research
c	understand the setting of a monument, ensemble or site, its context and surroundings, in relation to other buildings, gardens or landscapes
d	find and absorb all available sources of information relevant to the monument, ensemble or site being studied
e	understand and analyse the behaviour of monuments, ensembles or sites as complex systems
f	diagnose intrinsic and extrinsic causes of decay as a basis for appropriate action
g	inspect and make reports intelligible to non-specialist readers of monuments, ensembles or sites illustrated by graphic means such as sketches and photographs
h	know, understand and apply UNESCO conventions and recommendations, and ICOMOS and other recognized Charters, regulations and guidelines
i	make balanced judgements based on shared ethical principles, and accept responsibility for the long term welfare of cultural heritage
j	recognize when advice must be sought and define the areas of need of study by different specialists, e.g. wall paintings, sculptures and objects of artistic and cultural value, and/or studies of materials and systems
k	give expert advice on maintenance strategies, management policies and the policy framework for environmental protection and the preservation of monuments and their contents and sites
l	document the works executed and make same accessible
m	work in multi-disciplinary groups using sound methods
n	work with inhabitants, administrators and planners to resolve conflicts and to develop conservation strategies appropriate to local needs, abilities and resources.

Bell (2001) provided such a simplifying basis, based upon a consideration of the conservation process in terms of seven sequential stages:

(i) investigation and assessment of the cultural significance of a site;

(ii) investigation and assessment of its physical condition;

(iii) conservation planning and the definition of issues;

(iv) resolution of social and economic issues;

(v) resolution of technical issues;

(vi) implementation of the action plan;

(vii) management of a site of cultural significance.

By dealing with the definition of issues together with their resolution and recognising that the last two are both related to management of the site over its lifetime, it became possible for her to propose the five unit framework that is described next.

SUMMARY OF FRAMEWORK

Stirling and Bölling (2002) developed Bell's content to assist individuals identify where they lack knowledge or expertise and expounded the framework to inform the provision of appropriate professional development and training. The framework recognises that the competences are additional to basic professional qualifications and is divided into five units, each with a clear statement of the aims, competences required and examples of the sort of evidence that practitioners would expect to provide for assessment. Every unit includes the explicit requirement that practitioners show knowledge and understanding of conservation principles and ethics and the impact they have on their work.

Unit 1 Cultural significance

The success of every conservation project depends on understanding a site's cultural significance. By identifying a site's qualities, what needs to be protected against decay, intervention or removal becomes clear and working within a common code of ethics prevents applying contemporary social, political or individual bias to what needs to be preserved. The unit aims to explain the concepts on which the significance of a building or site is based and to provide tools to investigate and assess the components of this significance, whether historical, cultural, social or emotional.

Practitioners should be able to identify, survey, assess and analyse sources relating to the historical, cultural, social or emotional significance of a site, and record it as appropriate. From this they will be able to identify vulnerable aspects of a site and define a philosophical approach to its conservation, from which a conservation plan will emerge.

Unit 2 Architectural qualities and value

Architectural quality is a major component in the assessed value of most historic buildings and areas. Since any intervention will affect appearance and thus value no project work should be undertaken without fully understanding its impact on existing architectural quality. The unit aims to ensure that practitioners are able to identify architectural quality and value and therefore design interventions that meet the requirements of the brief without reducing the existing architectural quality.

Practitioners should be able to identify, survey and understand the architectural quality of any structure in terms of its formal concept, spatial relationships, massing, form and proportion, influence of light, colour and texture, detailing, and use of materials. From this they will be able to identify existing qualities and vulnerable areas and define a conservation philosophy. They should be able to appraise alternative solutions and choose those which satisfy the technical, functional and economic requirements of the brief with minimum impact on existing quality. The level of intervention may range from basic repairs to full projects where re-use, alteration, adaptation, addition, landscaping, public access needs, safety requirements and the introduction of modern services may be required.

Unit 3 Investigation, materials and technology

The special qualities of cultural sites restrict the choice of investigative and repair methods for historic buildings. Further, construction that does not conform to present day standards is not necessarily defective and no detailing should be changed without serious consideration. Clearly, those materials that have deteriorated through environmental processes may need replacement, but the reasons for the deterioration must be understood and addressed. This unit aims to ensure that practitioners have the skills to carry out a condition survey, investigate defects and make balanced decisions on the options for action within sites of cultural significance.

Practitioners should be able to select and use appropriate survey methods, employing specialists as necessary and backed up by the contribution of documentary evidence, to identify defective material, structure and construction and the causes of decay and its likely rate of spread. From this they will be able to identify vulnerable areas and define a conservation philosophy. They should be able to appraise and select from alternative solutions to deal with the problems presented and preserve the significance of the site or building.

Unit 4 Social and financial issues

This unit covers a broad range of social, financial and other activities associated with the use, evaluation and management of sites of cultural significance. Function, use, ownership, property valuation, public attitudes and external factors such as vibration, mining subsidence, atmospheric pollution, vandalism and theft, all need to be investigated and their impact assessed before conservation plans can be drawn up. Legislative controls and the existence of potential new users, together with the availability of project funding and sustainable income sources for the building after conservation, may all restrict the options available to the practitioner. This unit aims to ensure that practitioners can make balanced and defensible decisions on options for action and develop these in such a way as to resolve the social and economic issues that threaten the building or site. Practitioners should be able to deploy or call upon specialists in all the above areas.

Unit 5 Implementation and management of conservation works

Significant problems created by the site's sensitivity influence the way the work should proceed and dictate the use of the most suitable contract, contractor or directly employed labour. This unit aims to ensure that practitioners involved in the financial and managerial aspects of implementing a conservation plan or project can do so without damaging or compromising the cultural significance of a site, and can install measures to ensure its future survival.

Practitioners must be aware of the special needs of conservation projects in identifying the standard of work required and suitably expert contractors, in selecting appropriate means of procurement, cost planning and control, and in the management and supervision of works in progress to assure success. They must also be able to develop and implement short and long term maintenance plans, provide for the sustainable management of tourism and be able to participate in continuing monitoring and review of the site's overall condition, significance and conservation.

DISCUSSION

The framework has been developed into a set of educational support materials in a web-based format. The website (www.understandingconservation.org) went live in March 2007 and has subsequently been receiving about 600 visits per month. It contains support material, text, illustrations, links to other sites, and is supported by self-assessment questions and other challenging exercises. As well as a note-taking facility, it will be possible for candidates for accreditation to log-in and build up their personal portfolio but this will require the accreditation schemes to activate the links to their online forms.

The mapping of these five units on to the ICOMOS guidelines is summarised in Table 2 and this confirms that all of the guidelines are covered by the competences. The framework recognises that professionals already possess a body of knowledge and skills as a result of their own discipline but that conservation requires those knowledge and skills to be applied in a context which is ethically and philosophically different from new build.

Table 2 Matching of units to ICOMOS guidelines

ICOMOS clause	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Unit 1	X	X	X	X			X	X	X	X		X	X	
Unit 2			X		X			X				X	X	
Unit 3		X		X	X	X		X		X		X	X	
Unit 4	X		X	X		X		X	X	X			X	X
Unit 5					X			X	X		X		X	X

Most professional groups likely to be leading conservation projects are concerned with all five units so the framework provides a universally applicable set of competences. The most obvious role of facilities managers in the historic environment is in managing buildings which must be financially viable within the constraints of legislation or other regulations aimed at protecting the built heritage. This requires management which understands the philosophical issues of why a building should be conserved, why it is significant and why that significance is vulnerable during the day-to-day operation of the building. A less obvious role of facilities managers is to use their skills in managing buildings to work with designers of conservation projects to ensure that the conserved building delivers what the client expects. In other words to feed knowledge and understanding gained through objective evaluation of building performance into the design process.

Thus the mainstream expertise of facilities managers will bear on ICOMOS clauses e, i and k, which are covered by unit 5 of the framework. They will be able to contribute to the architectural interventions in the historic environment and bear on ICOMOS clauses c, e and h, covered by unit 2, and work within the philosophical environment covered by unit 1. The framework of competences is clearly relevant to facilities managers working in historic buildings.

CONCLUSION

A common set of competences for professionals working in built environment conservation has been identified. Support materials for professionals to improve their competence and work towards accreditation have been set up on a website, and this is expected to help assure the supply of accredited professionals and improve the overall quality of conservation work in the UK. Facilities management professionals are likely to find the competences helpful in understanding the philosophical and practical issues faced by conservation professionals.

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REFERENCES

Bell, D (2001), Research into structured support for CPD development for accreditation in architectural conservation. Unpublished report, Commissioned from Edinburgh College of Art by Historic Scotland.

ICOMOS (1993), Guidelines for education and training for the conservation of monuments, ensembles and sites (1993).

Scottish Executive (2001), A policy on architecture for Scotland, Edinburgh.

CABE (2006), Corporate strategy 2006-2009. Commission on Architecture and the Built Environment, London, www.cabe.org.uk/default.aspx?contentitemid=1325 (accessed 7/1/08)

Allison, G, Ball, S, Cheshire, P, Evans, A, Stabler, M (1996), The value of conservation? London, English Heritage.

English Heritage, The power of place, London, English Heritage (2000).

Maxwell, I, Heath, D, Russell, P (2004), Accreditation in historic building conservation: The work of the Edinburgh Group, Journal of Architectural Conservation, 10, 36-48.

Bell, D (1997), The Historic Scotland guide to international conservation charters, Historic Scotland.

BSI (1998), BS7193:1998 Guide to the principles of the conservation of historic buildings, British Standards Institution.

Historic Scotland (1998), Memorandum of guidance on listed buildings and conservation areas, Edinburgh, Historic Scotland.

Stirling, JS, Bölling, C (2002), A framework description of competence for a shared approach to built environment conservation accreditation schemes in the UK, Unpublished report, commissioned from Heriot-Watt University and Edinburgh College of Art by Historic Scotland.

FACILITIES MANAGEMENT IN HERITAGE BUILDINGS: STAKEHOLDER ATTITUDES

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ABSTRACT

Many public organisations – schools, hospitals, local authorities, central government departments, universities – carry out their functions in historic buildings. This paper explores the tensions that exist between, on the one hand, the organizations seeking to perform efficiently in the modern world and, on the other, the guardians of the built heritage whose aim is to manage the historic environment in such a way as to prevent its degradation and the loss of significance and the character that the public value. It considers a Scottish department with a geographically widely dispersed estate of prominent buildings, in daily use by the public. A high proportion of its buildings is listed as being of architectural and cultural significance, and therefore proposals to improve efficiency and service to the public by carrying out alterations and improvements are scrutinised by Historic Scotland. By means of a questionnaire survey carried out at all levels within the organization, this research sought to establish the attitudes and perceptions of staff to the role of Historic Scotland in managing the historic environment in which the department operates. On the whole, staff have a negative view of listing and see it as a constraint on operations. This is an important challenge for facilities managers responsible for historic buildings.

KEYWORDS: stakeholder management, attitudinal studies, public buildings, historic buildings

INTRODUCTION

Many public organisations operate in historic buildings and have to balance efficiency and heritage. By means of a questionnaire survey carried out at all levels within the Scottish Courts Service, this research sought to establish the attitudes of staff to the historic built environment in which the department operates. After a brief introduction to building conservation and listing, this paper describes the features of court buildings, discusses the results of the survey and draws lessons for the role of facilities managers responsible for historic buildings.

BUILDING CONSERVATION

The movement to conserve the historic environment has grown over 150 years, through a series of conservation charters, to set up regulatory frameworks in most countries which aim to protect buildings of historic and cultural significance, recognized as contributing to quality of life and a sense of place for the population. Typical features of these regulatory frameworks are (Earl, 2003): (i) an assessment of what is valuable, leading to a "List" of buildings requiring protection; (ii) a mechanism of alerting the competent authorities to possible threats to important buildings, leading to a requirement for submitting notices of application for works to be authorized; (iii) a consent process, which scrutinises the works proposed and permits harmless or beneficial works, or alternatively suggests modifications to ameliorate the work; and (iv) a system of enforcing decisions through appropriate punishments.

Scottish legislation provides protection for a building through inclusion in the Statutory List of Buildings of Special Architectural or Historic Interest under the Town and Country Planning (Scotland) Act 1972. (As amended by the Planning (Listed buildings and conservation Areas) (Scotland) Act of 1997). Buildings may be "listed" under this Act because of their (i) age and rarity, (ii) architectural interest, and (iii) close historical associations. In Scotland, buildings may be listed in categories A, B or C, which represent decreasing levels of merit from those of international importance (A) because of their architecture and history, style or type. The consent process is managed by local authority planning departments, with expert advice from Historic Scotland, a government agency whose remit is to safeguard Scotland's historic environment, including its stock of heritage buildings.

COURT BUILDINGS

The Scottish courts service, (SCS) is a government agency responsible for the operation of the Sheriff and supreme courts in Scotland, and will shortly take over responsibility for the District courts system. Scottish Courthouses were mostly built in the 19th century. Some were built between 1812 and 1835 and others in the 1870s and 80s. Many of the first batch also got extensions during the second phase of building. In the 1970s the estate was reviewed and some small rural courts and a few obsolete larger courts were closed. Following new-built replacements, there are now 49 Sheriff Courthouses, High Court Buildings at Glasgow, Edinburgh and Aberdeen and a supreme courts complex in Edinburgh, together with some leased property. All these have been largely refurbished and re-equipped. The entire estate is connected in a WAN (Wide-Area computer Network) and each building has been fully wired into a LAN (Local Area Network). This provides a framework for the development of Electronic Service Delivery across the estate. Some work has been pro-active, aimed at improving the ability of the estate to deliver service, but much reactive work has been required in response to statutory requirements, such as fire safety, health and safety at work, and disability legislation. As a result there are a number of fire enclosures, stair lifts, hoists, and ramps. Many of these changes have only been achieved as compromises between best practice, the law and the practicalities of the building. The functions required of courthouses are complex with cells, courtrooms, witness rooms, jury rooms, interview rooms and offices. Ideally there should be separation of circulation routes between public, witnesses, jurors, sheriffs and court staff and officers and accused.

44 buildings (83% of the SCS estate) are listed, and the implications of this listing are that once a building has been listed it may not be demolished or altered so as to affect its character, without listed building consent having been granted by the planning authority. Listing protects not only the exterior but also extends to historical internal fittings and fixtures. There is thus a regulatory framework which underpins the involvement of Historic Scotland, as guardians of the historic environment, in the assessing of and advising upon any alterations to SCS buildings, which may be proposed in order to improve their functional performance or to comply with new regulations, such as health and safety, disability discrimination and fire safety. This involvement could be seen as a constraint on SCS operations and be viewed adversely by the staff. This was the starting point for this research.

AIMS AND OBJECTIVES

The aim of the research is to collect information on the SCS estate, the people who work in it and their attitudes to listing and its associated regulatory requirements by testing the hypothesis that “listing of the Scottish Courts estate is viewed by staff as a constraint on the service’s operations.” The objectives of the data collection exercise are to provide a range of information that will enable valid generalisations to be made about the impact of listing on the staff of the service and lead to conclusions and recommendations for a better fit to SCS business needs.

METHODOLOGY

Of possible research methods to survey these attitudes, one-to-one interviews were rejected as being too time-consuming and potentially biased because the interviewer would be personally known to many interviewees. Postal questionnaires were rejected because their well-known low response rate would pose problems with certain grades of staff containing very small numbers and therefore at risk of being under-represented in the responses. An anonymous electronic questionnaire was chosen because of its objectivity and ease of data entry, combined with flexibility in terms of time for completion, as staff would not have to clear diary time for interviews. GlobalSCAPE® software was used, as this is the only one permitted by the IT department, and was set up to host a survey customised to the target population. Respondents were alerted by a personalised e-mail and responses submitted to a web-site, which provides a built-in database and reporting tool to process the replies (GlobalSCAPE, 2007).

A survey designed to elicit staff attitudes to historic listing within the SCS estate was constructed. It sought to identify where respondents were located and whether their building is listed, their grade, function, gender and age. It asked a range of questions about listing designed to gather data about attitudes and in particular the attitudes of those staff with building management responsibilities. The sample collected data by grade in order to make it easier to identify and elicit the views of different groups within the staff.

RESULTS

Validity of the sample

SCS has a total staff complement of 1295. 300 responses were received, of which only 182 could be analysed within the limited IT run time available. Not all grades responded, but there were responses from the lowest grades (SGB2) up to grade 6 (Head of Unit). Not all groups within the Agency responded. No members of the judiciary and very few of the most senior staff did so. This is unfortunate because such groups have a disproportionately higher impact on policy and operations. For that reason greater weight should be given to the responses of those grade 6 and 7 officers who did respond (grade 6 is higher than a grade 7).

Figures 1-3 show the age, gender and length of service profiles of the sample. These distributions were compared to records held by the SCS human resources division to ensure that the sample is representative of the population. The average age of staff is 43, compared to the peaks of the two distributions in the bands 36-45 or 46-55. 62% of the staff are female, compared to the gender distribution which shows 53% female, and a general skewing towards higher proportions of female staff in the junior grades and with relatively short lengths of service. The sample average length of service (11-20 years) closely matches the population average of 13 years. The mismatch between age and length of service in SGB grades is because they are often retired part-time workers. Therefore, with these minor criticisms, the sample is considered to be representative of the overall staff population.

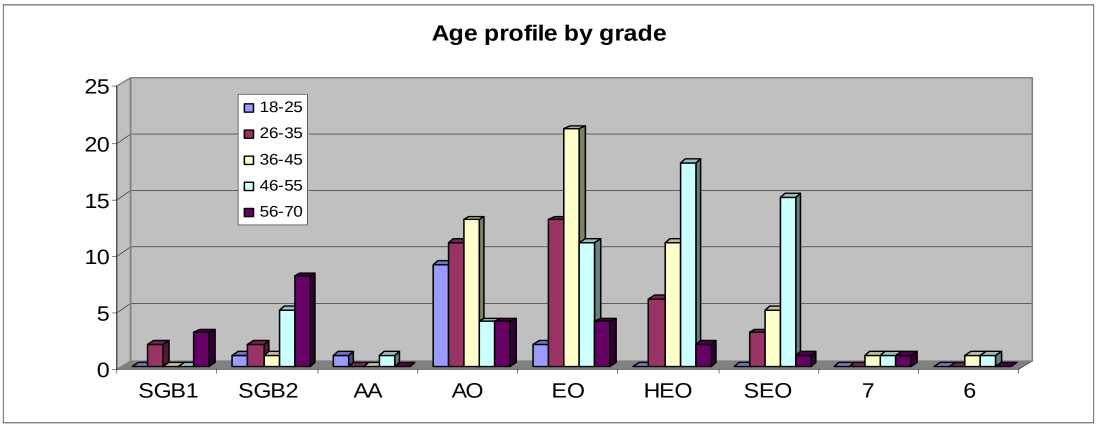

Figure 1. Age profile of sample population

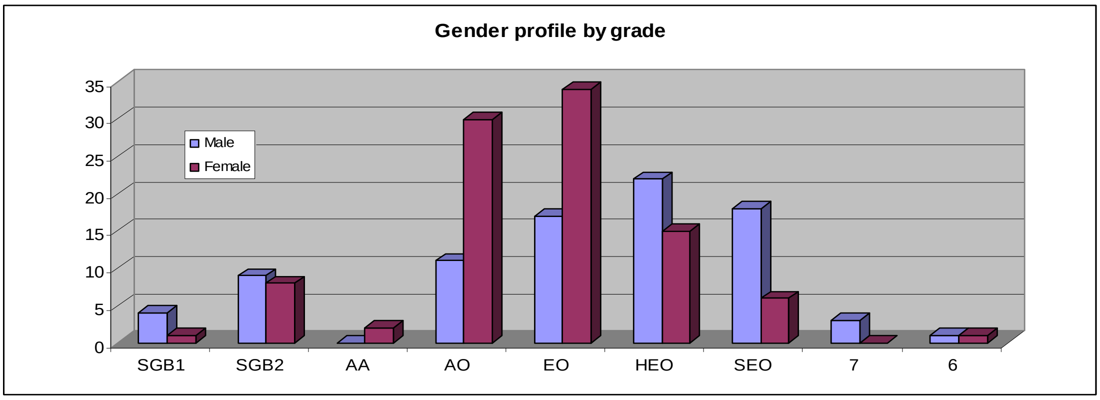

Figure 2. Gender distribution of sample population

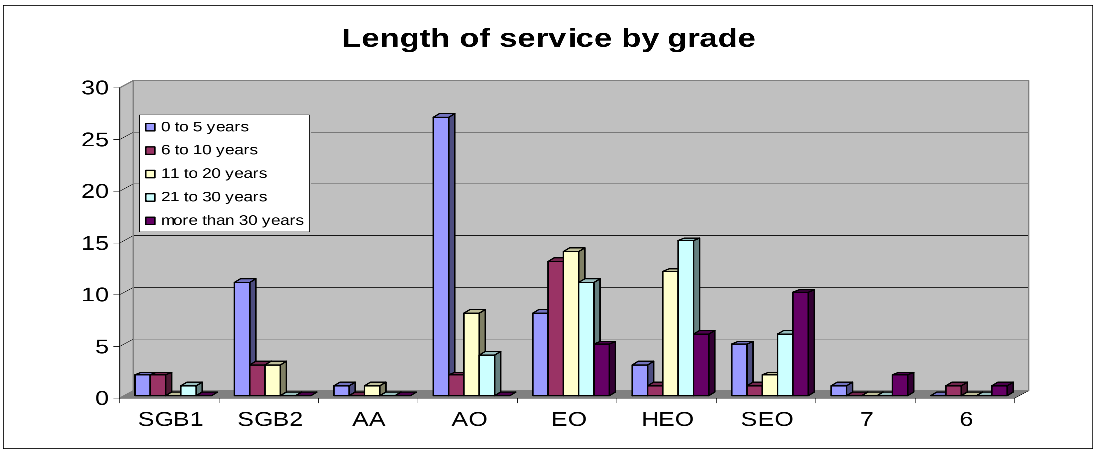

Figure 3. Length of service of sample population

One sub-group of respondents was of particular interest for this research - those officers with building management responsibility, either as Sheriff Clerk, accommodation officer or their assistants. Detailed scrutiny of the distributions indicates that building management responsibility is significantly a province of older, more senior male members of staff, predominantly HEO and SEO grade with long service. When these officers retire, they are more likely to be replaced with females, who are in the majority in the lower grades. Consequently, while the attitudes expressed may differ between age, gender and length of service, those currently expressed by older, longer serving males may be replaced over time by those currently expressed by younger, shorter serving females.

Relevance of listing

When asked to respond to the statement that listing as a historic building is not relevant to the core activities of the courts service, the views of each grade are shown in Figures 4 and 5 for males and females respectively. Most staff feel that listing is relevant and disagreement with the statement generally increases down the grades, and with males more than females.

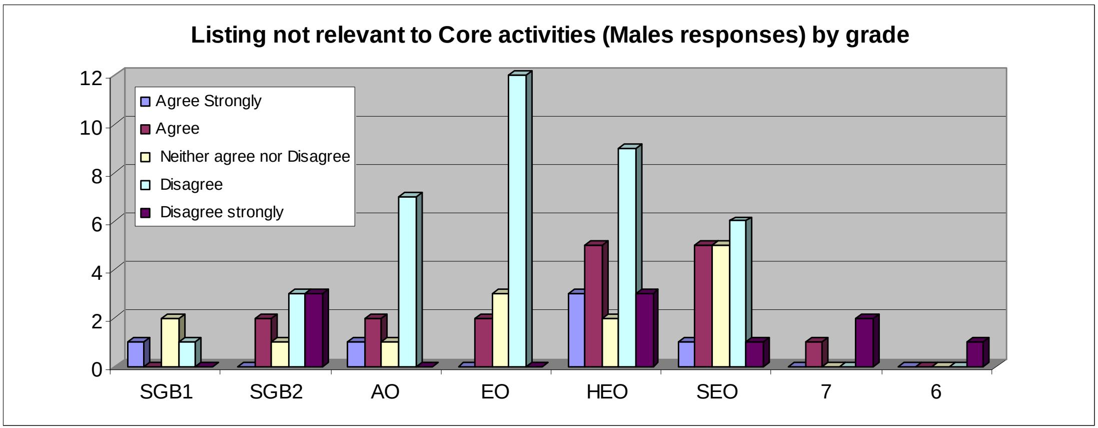

Figure 4. The relevance of listing - males

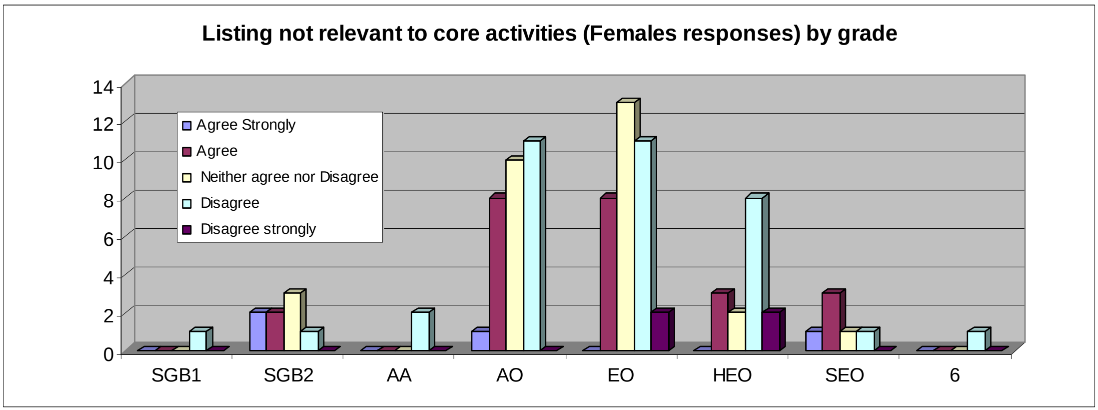

Figure 5. The relevance of listing - females

Listing as a constraint

When asked to respond to the statement that listing as a historic building is a constraint on the operations of the courts service, the views of each grade are shown in Figures 6 and 7 for males and females respectively. A majority of staff in all grades see listing as a constraint, with the balance tending towards unanimity at the senior end. There is no difference between males and females.

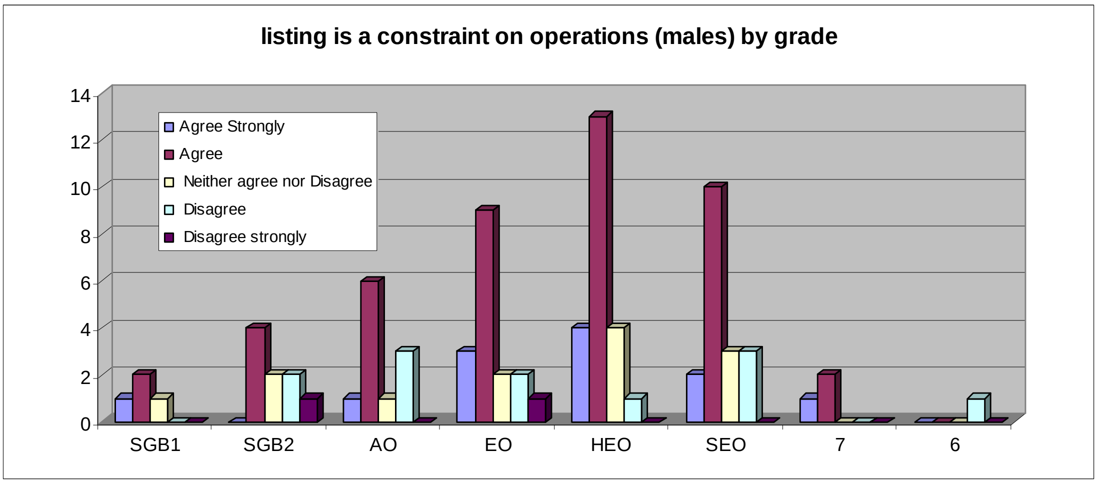

Figure 6. Listing as a constraint on operations - males

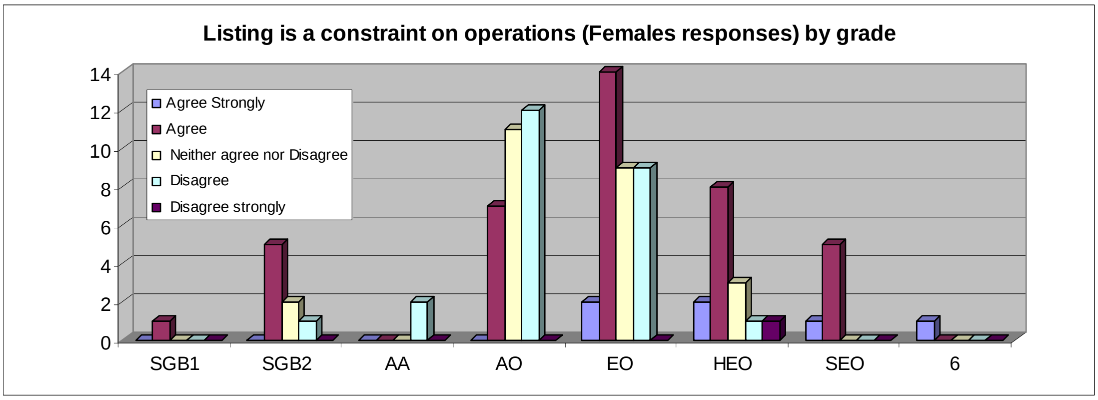

Figure 7. Listing as a constraint on operations - females

Listing in relation to core service responsibilities

When asked to respond to the statement that the duties imposed on the courts service by listing are equally important to the courts service as its core business targets and objectives, the views of each grade are shown in Figures 8 and 9 for males and females respectively. A majority of staff in all grades have no opinion, with the remainder equally split between support and no support for the statement, with one major exception: the senior male staff oppose the statement vigorously.

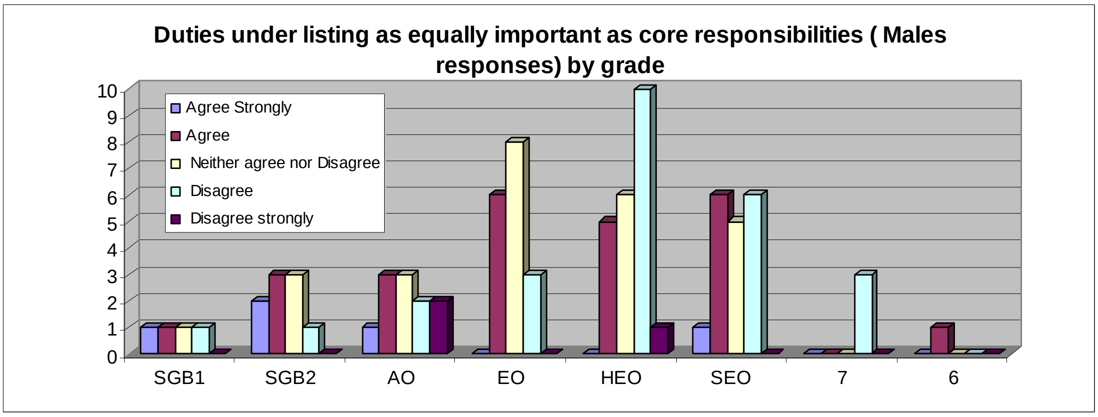

Figure 8. Responsibilities under listing compared to the core business - males

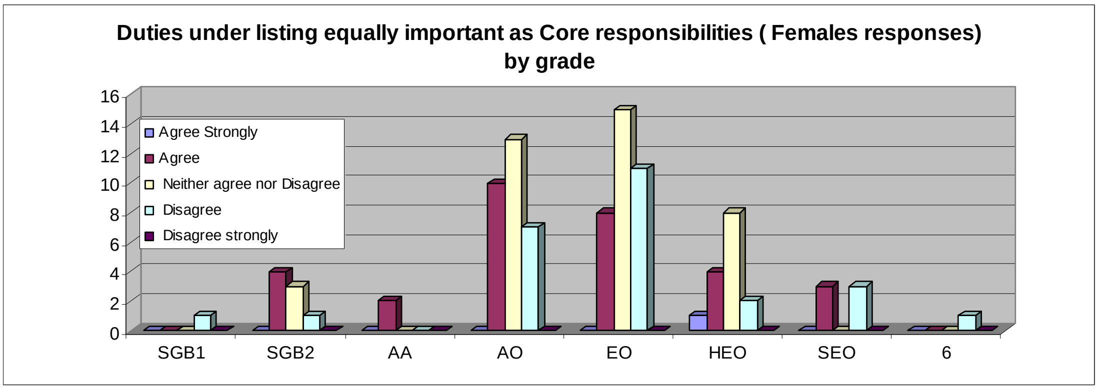

Figure 9. Responsibilities under listing compared to the core business - females

Other comments

Respondents were given the chance to add any other comments in a free-form statement. Of 28 comments capable of analysis, 9 were positive and 19 negative. The following examples are typical attitudes to listing.

Positive comments

“Working in an historic building is a real privilege”, “Any burden caused by listing is far outweighed by the benefits”, “I enjoy working in an historic building and feel it my duty to make sure it is treated with the care it deserves”, “Listed buildings are an important part of our heritage. SCS has a responsibility to comply with the requirements of listing”, “The atmosphere of a listed building enhances the status of SCS and adds to the “gravitas” of the work carried on there”.

Negative comments

“We have to put up with outdated uncomfortable buildings that aren't fit for purpose”, “Listing imposes restrictions which adversely affect good Health & Safety practice and good occupational health”, “Listed buildings tend not to lend themselves to the requirements of a modern court”, “Development is restricted”, “A necessary evil”, “Working in a listed building imposes certain restraints on working practices”, “Building is beautiful, but not fit for purpose”, “These buildings were the courts of the past, but we need to move on to create courts for the future", "Historic buildings may lend dignity to proceedings, but they are no longer practical, efficient or cost-effective locations to house court business".

DISCUSSION

The questionnaire results, supported by the free-form comments, tend to suggest that the hypothesis that listing is viewed negatively by the staff of the Scottish Courts Service is true and that the issues of daily operation of the service largely outweigh the dignity conferred by the historic surroundings in which that operation tales place. The courts service would be well advised to consider these attitudes in developing its estates strategy and its approach to facilities management. In this regard the attitude of the Irish service to its buildings may be noted: "The administration of justice is a solemn act of government … [which] should take place in dignified, suitable and fully equipped buildings." (Government of Ireland, 1996). Clearly, such a position is considered to be important to policymakers and public, and probably reflects a majority view in Scotland, but the challenge to those who have strategic responsibility for buildings and the facilities managers who manage them on a daily basis is to reflect this message to the staff who work in them. Evidently some staff are proud to work in historic buildings and this pride needs to be exploited to convince the other staff. Undoubtedly similar attitudes to those presented here are likely to be found in other fields of employment where historic buildings are in use, and will present similar challenges.

CONCLUSION

Based on a representative questionnaire survey of the staff of the Scottish Courts Service, there is a strong view that listed status acts as a negative constraint on the operational performance of court buildings.

ACKNOWLEDGEMENTS

We gratefully acknowledge the time and effort of staff in the Scottish Courts Service taken in answering the questionnaire. This paper is based on a research dissertation submitted as part of the degree of MSc Facilities Management, Heriot-Watt University.

REFERENCES

Earl, J. (2003), Building Conservation Philosophy, Donhead, Shaftesbury, UK.

GlobalSCAPE (2007), www.globalscape.com (accessed December 20th 2007)

Government of Ireland, (1996), Management and Financing of the Courts, www.courts.ie/Courts.ie/Library3.nsf/(WebFiles)/E33B888C196A85A980256DA6003459DA/$FILE/courts1.pdf (accessed January 7th 2008).

INTERVENTIONS IN BUILT HERITAGE: MANAGING WHICH RISKS AND FOR WHOM

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ABSTRACT

This paper aims to illustrate the fundamental dichotomy involving interventions in built heritage. On one side, the influential factors; and on the other side, the resultant risks. Both researchers have decided to join the knowledge acquainted in the last years of research and present to their field of expertise an essential state-of-the-art on which are presented the risks that normally require management when intervening in built heritage, as well as, the respective beneficiaries.

This literature survey allowed the researchers to verify that even if most frequently risk management is directly related to 'financial losses' and 'human being losses', there are also other fundamental losses which deserve equal attention. Those are 'heritage losses' as well as 'material losses'. Further research should be undertaken, so that it is better understood per fundamental factors what and who exactly could contribute to the reduction of uncertainty and probability, together with the risks that normally require management.

KEYWORDS: interventions, built heritage, risk management, cultural values

INTRODUCTION

The built environment is dividable in two groups: built heritage – previous generations; and built newness – current generation. Just as any other tangible property, built heritage is found varied in significance, as well as, in condition. Unlike built newness, built heritage is more often target of interventions in order to bring it into higher rates of significance and/or condition.

The more significant built heritage is often found listed in safeguard institutions, while the less significant is often condemned to indifference. In some countries such as Portugal, periodical activities of preservation, conservation and restoration are still a myth for most unlisted buildings. Consequently, they are the first ones to reach obsolescence and the first ones to be chosen for higher scales of intervention, such as demolition.

Curiously, their condition does not seem to play such a considerable role. Particularly, some features, such as performance and costs, do seem to bring higher risks of demolition in higher interventions. Currently in the Netherlands, lifespan is found playing a fundamental role together with performance, towards energy efficiency. In the UK, however, the role of health and safety as well as energy efficiency is becoming more and more important.

There is one very fundamental aspect to consider in risk management, which often is overlooked; and that is, whom are the risks being managed for exactly, when intervening in built heritage? Often, risks are tendentiously oriented towards the actors and respective achievement of individual aims, rather than towards the buildings and respective impact on the environment.

This paper shall start by defining the eight fundamental factors influencing interventions in built heritage. Next, the relation between risks and uncertainty shall be explained; so that finally the resultant risks which are more frequent found referenced to be managed adequately when intervening in built heritage will be explored. Last, some preliminary conclusions shall be taken, together with few recommendations for further research.

INTERVENTIONS IN BUILT HERITAGE

Before explaining the resultant risks from the eight fundamental factors influencing interventions in built heritage, it is very important to clearly understand their particular role in the whole system (see Figure 1). The eight fundamental factors are respectively, 'object, 'values', 'tools', 'aims', 'actors', 'action', 'time' and 'site' (Pereira Roders, 2007a).

'Object' refers to the building (or buildings) being intervened and respective condition. Such condition regards its performance towards the environment, within its physical (substances; forms, components and/or materials), functional (functions), technical (performances), economic (costs), lifetime (lifespans) and potential (adaptabilities) dimensions (Pereira Roders, 2007b).

The cultural values which are identified in every 'object' and that normally establish the distinction between listed and unlisted buildings, within built heritage, are here referenced as 'values'. Mason (2002) defined a provisional typology for cultural values, considering 'the kinds of value most often associated with heritage sites and conservation issues, but it does not assume that every heritage site has every type of value'.

According to Mason, there were two major groups: the socio-cultural values (historical, cultural-symbolic, social, spiritual-religious and aesthetic) and the economic values [use (market), non-use (non-market), existence, option and bequest]. Pereira Roders (2007b) has chosen to structure them differently. Accordingly, the eight primary cultural values are the social, economic, political, historic, aesthetical, scientific, age and ecological values.

Instead, the 'actors' are all individuals directly or indirectly involved with the 'action' of intervention, shaped by their 'aims'; and consequently, when making use of 'tools' particularly chosen to design or perform the 'action'. 'Actors' has been earlier referenced by Brand (1994) as 'souls'; nevertheless, only as a possible seventh 'layer of change', added to: 'site', 'structure', 'skin', 'services', 'space plan' and 'stuff' (see Figure 2).

Brand (1994) also identified 'site', progressing from Duffy's "several layers of longevity of building components' (1990), mainly focused on the lifespan fragmentation of the building. In this case, Pereira Roders (2007a) defined site as all natural and built environment having directly or indirectly influence on the 'object', excluding the particular 'actors'. Last, 'time' regards the period when the design or perform of the 'action' of intervention is taking place.

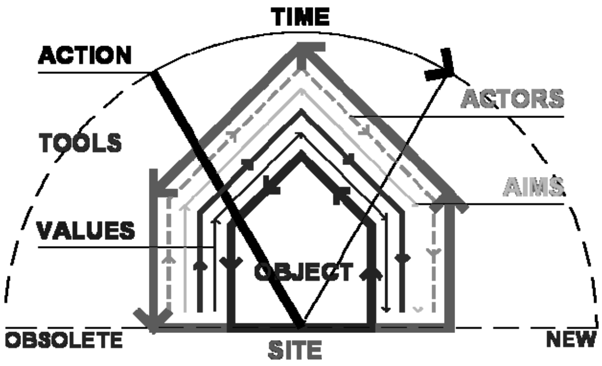

Figure 1. The eight fundamental factors (Pereira Roders, 2007a)

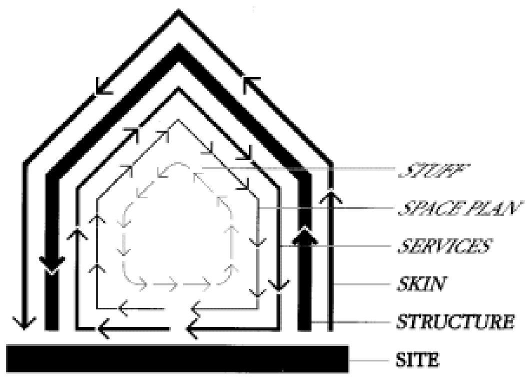

Figure 2. The shearing layers of change (Brand, 1994)

RISK VERSUS UNCERTAINTY

All interventions in the built environment incur risks. According to Douglas (2008), other scales of intervention, than urban reconstruction / building new, incur even more risks. Basically, such raise of risk is related to its increase of uncertainty. Thus, before going through each fundamental factor and understand its intrinsic risks, it is essential to understand what both risk and uncertainty signify.

'Risk' has also been defined as the combination of the possibility of an event and its consequence (BSI 2002). However, Douglas (2008) pointed out the risk has generally a negative connotation and usually involves some form of financial loss. Alternatively, risk should be seen as the chance that an actual outcome will deviate from that forecast or intended, and not exclusive on the economic perspective.

Closely related to 'risk' is 'uncertainty'. The main difference between them is that the former is something that is considered to be reasonably objective in nature and thus quantifiable (e.g. statistical assessments), whilst the latter is more subjective but generally unquantifiable (e.g. subjective probability). Risk always involves an element of uncertainty, but uncertainty does not always involve risk (Douglas, 2006).

Therefore, the more uncertainty, the more risk interventions in built heritage can achieve. Table 1 illustrates the relation between risk and uncertainly, adapted from Raftery (1994), Bowles and Kelly (2005) and Douglas (2006). There, it is also possible to verify that the information available plays a fundamental role to decrease uncertainty and consequently, the risk to be managed when intervening in built heritage.

Table 1. Risk versus Uncertainty

Risk	5 Very High	4 High	3 Reasonable	2 Low	1 Very Low
	Unknown Unknowns		Known Unknowns		Known Knowns
Building-related Information					
Documentary Inventory	no documents (environment, building construction and previous interventions)	partial documents (environment)	partial documents (environnent and construction)	partial documents (environment and previous interventions)	full set of documents (environment, building construction and previous interventions)
Oral Inventory	no oral testimonies (environment, building construction and previous interventions)	partial oral testimonies (environment)	partial oral testimonies (environment and construction)	partial oral testimonies (environment and previous interventions)	full oral testimonies (environment, building construction and previous interventions)
Physical Inventory	no access to outside the building (surroundings)	no access to inside the building	full access to inside the building: superficial inventory (e.g. photos, sketches)	full access to inside the building: partial inventory (e.g. photos, sketches, in-situ measure-ments, notes)	full access to inside the building: detailed inventory (e.g. photos, sketches, in-situ and lab measure-ments, notes)
Uncertainty	5 Very High	4 High	3 Reasonable	2 Low	1 Very Low

RISK MANAGEMENT AND THE DIRECT BENEFICIARIES

According to UK Health & Safety Executive's website, 'risk management is the process by which an organisation reaches decisions on the steps it needs to take to adequately control the risks which it generates or to which it is exposed, and by which it ensures those steps are taken' (HSE, 2007).

Douglas (2008) defined five main constraints affecting interventions in built heritage: 'financial', 'spatial', 'temporal', 'legal' and 'personnel'. Moreover, he considered risk as the result of the 'condition' and/or the emerging 'set of circumstances'. So, Douglas added the 'existing building's condition and performance' to 'basis of estimates or budget costs', 'design and logistics', 'objectives and priorities', 'project organisation'; earlier identified by Ward and Chapman (1999).

Returning to the eight fundamental factors, it is possible to verify few more additions were made to what can be established as the 'risk profile', as well as, identify the most referenced risks related to each fundamental factor that are normally managed when intervening in built heritage and the respective beneficiaries (see Table 2). In some particular cases, there are not only beneficiaries but also injured factors.

Objects

Every "object" is different. Bowles & Kelly (2005) already mentioned that perhaps with the exception of some housing estates, no two buildings have exactly the same orientation, performance, accessibility, etc. Or even if originally they had, probably with time, this homogeneity disappeared during its use period and/or respective interventions.

Douglas (2008) stated that full code compliances might be more difficult to achieve because of physical restraints, probably because full code compliances are normally written for new buildings. There are always many different ways to cope with the full code. Therefore, depending on the actors involved in the intervention (e.g. developers and architects), to comply with the full code might vary from minimal to maximal intervention.

When its condition is condignly assessed, there shall be less room for uncertainties and probabilistic diagnosis, which too often results in a considerable amount of 'resources losses' e.g. time, finances, materials, etc. In fact, from building to building, involved actors can start creating their own 'action patterns', reducing the risk of doing repetitive and time-consuming activities. That would certainly reduce the risks to be managed.

Values

Every "object" is perceived differently. Some are considered exceptional and become listed, other remain unknown and are commonly considered as "valueless" by the current generation. As the cultural values are in constant evolution, there is a serious risk that future generation accuse current generations of being active promoters of 'heritage losses'. In fact, there are no "valueless" buildings.

"Valueless" built heritage were simply not condignly assessed. The ignorance on its lifespan: past and future, makes present generations determine the destiny of such buildings on base of the present. Therefore, a condign assessment shall reveal exactly what is valuable, taking into consideration not only the most common historic and aesthetical values, but also the social, economic, political, scientific, age and ecological values.

Actors

There are many different actors involved with interventions in built heritage. Depending on the building and environment, the risks to manage as well as, the respective actors vary. According to Bowles & Kelly (2005), 'personnel compositions and levels are never the same, and the forms of contract used are often adapted with variations and amended clauses, all of which can militate against standard forms of contract'.

Interventions in built heritage, rather than building new, can be very labour intensive and require skilled workers. Bowles & Kelly (2005) have earlier argued that 'despite being more labour intensive refurbishment contracts may have fewer operatives on site at any one time than a comparable new-build scheme'. Therefore, these interventions require less but skilled workers to accurately implement the envisaged construction activities.

Consultants are both important for both reducing both strategic (e.g. project justification) and tactical (e.g. property location) risks. In fact, the strategic risks are mainly related to the quality of the feasibility and design stage, e.g. funds/financing, definition and justification of a project, the stakeholder interest and building availability. Consequently, the direct actors involved are the clients, consultants, approving authorities, etc.

Aims

The aims are quite fundamental to the risk management. They are the ones that shape the action and make the new existence more or less adequate than the pre-existence of a building target of intervention. In fact, Ward and Chapman (1999) and Douglas (2008) have all referenced the importance to manage the risks related to the uncertainty about objectives and priorities.

Whenever, the 'aims' are unsustained to its building and environment, they can lead 'actors' into very lifespan unconscious 'actions'. Consequently, when intervening in built heritage the risks to be managed regarding several other factors can increase considerably. Inadequate aims can direct or indirectly risk the 'object' target of intervention, its inherent 'values', the involved 'actors' and/or its 'site'.

Actions

The 'actions' of intervention and respective scale are naturally related to the previous fundamental factor, but should also be much related to the building and respective environment. Otherwise, the 'actions' being taken to fulfil the overestimated aims of few involved actors (e.g. client, developers, etc) are lifespan unconscious and consequently, the risk to be considered incompatible to the building and respective environment is much higher.

Often, they reveal two patterns: higher 'actions' of intervention are eminent when there are finances available and lower 'actions' of intervention are eminent when there are less finances available. In fact, Douglas (2008) emphasised that 'funds for refurbishment and other similar work might be more restricted as part of an organisation's cost-cutting exercise. So, they might not represent 'financial losses', but shortage of 'financial' resources.

Tools

Similar to the ‘object’, also the universe of ‘tools’– methods, technologies and substances – available to be used when intervening in built heritage, is wide and varied. However, what normally occurs is that the ‘actors’ and respective ‘aims’ steer the chosen categories of ‘tools’. For example, unsustained ‘actors’ are not expected to choose ‘tools’ that can lead them into sustainable ‘actions’ (Pereira Roders, 2007c).

The risk to manage does not stop if the adequate method is chosen to steer the chosen ‘action’ of intervention. Instead, when following the adequate method, the ‘actors’ can actually end up choosing for inadequate technologies e.g. due to time and financial constraints. Similarly, the chosen substances have three levels of risk profile. The first regards the chosen forms, the second regard the chosen components, and the third regard the chosen materials.

Site

After the ‘actors’, the ‘site’ can be considered as one of the factors which should require more attention when managing the risks of an intervention in built heritage. Not only is the ‘site’ one of the most predictable responsible for the decrease of a building’s condition, as unpredictably can be also responsible for enormous ‘resources and cultural losses’ (e.g. natural catastrophes, etc).

Inversily, depending on the degree of compatibility between the building and the site, the building can either promote or denigrate the site. Buildings can help solving problems, but can also create problems, not only for its involved actors, but also for the ‘site’. Again, when both building and site are assessed condignly before taking any other decision, all most fundamental points of attention shall in due time emerge.

Time

‘Time’ is one of the most important factors to be well managed in order to reduce serious planning risks. It can not only determine the category of ‘tools’ available for being used e.g. informatics in the end of the XX century, as it can influence ‘actors’ choosing for the specific ‘actions’ of intervention. ‘Time’ is also the most probable fundamental factor. Independent of what ‘actors’ might decide, ‘time’ is unstoppable and that can contribute e.g. to considerable delays on the planning, when comparing the actual results with forecasted times.

The reaction of both building and environment to time is far more improbable. Therefore, even if there is lifecycle data to guide all actors involved in the construction industry, one should not take immediate conclusions and consider such data as the imperative truth. These values were reached taking in consideration the worst possible conditions; which is not always the case for every built heritage. Otherwise, the risks to be managed would raise and the contribution of interventions in built heritage to the environment drop.

CONCLUSION

Interventions in built heritage have several risks to be managed as well as different beneficiaries. However, with this literature survey it was possible to verify that to reduce uncertainty and the resultant risks to be managed, more information is required to sustain accurate surveys that shall lead into condignly assessment. The three inventories (documentary, oral and physical) can be fundamental for achieving it.

Moreover, this literature survey allowed the researchers to verify that even if most frequently risk management is directly related to ‘financial losses’ and ‘human being losses’, there are also other fundamental losses which deserve equal attention. Those are ‘heritage losses’ as well as ‘material losses’. Together, they insure that both natural and built environments remain preserved for the future generations, without undervaluing the current generation.

Further research should be taken on risk management when intervening in built heritage, so that it is better understood per fundamental factor what and who exactly could contribute to the reduction of uncertainty and probability, together with the risks that normally require management. Together with all other involved actors (e.g. architects); facility managers can actively contribute to a raise of lifespan consciousness when intervening in built heritage.

REFERENCES

Bowles, G and Kelly, JR (2005) ‘Value and Risk Management’, D19CV9 Course Notes for MSc Construction Management programme, Heriot-Watt University, Edinburgh.

Brand, S. (1994) How buildings learn: What happens after they’re built: Viking Press, New York, p. 13

BSI (2002) ‘Risk Management vocabulary – Guidelines for use in Standards’, Guide 73, British Standards Institution, London

Douglas, J. (2006) Building Adaptation, Butterworth-Heinemann, Oxford, 2nd edition

Douglas, J. (2008) Chapter 2: Risks, in Doran, D. (Ed.) Refurbishment and Repair in Construction, Whittles Publishing, Dunbeath, Caithness, Scotland

Duffy, F. (1990) Measuring building performance, Facilities, v. 8, n. 5, p.17

HSE (2007) Frequently Asked Questions, Health & Safety Executive, London, available at: http://www.hse.gov.uk/risk/faq.htm#riskmanagement

Mason, R. (2002) Assessing Values in Conservation Planning: Methodological Issues and Choices, in Torre, M. (Ed.) Assessing the values of cultural heritage: Research report, Los Angeles: The Getty Conservation Institute, p. 12

Pereira Roders, A. (2007a) RE-ARCHITECTURE basis: Lifespan rehabilitation of built heritage, Technische Universiteit Eindhoven, Eindhoven, Vol. 1

Pereira Roders, A. (2007a) RE-ARCHITECTURE scapus: Lifespan rehabilitation of built heritage, Technische Universiteit Eindhoven, Eindhoven, Vol. 2

Pereira Roders, A. (2007a) RE-ARCHITECTURE capitellum: Lifespan rehabilitation of built heritage, Technische Universiteit Eindhoven, Eindhoven, Vol. 3

Raftery, J (1994) Risk Analysis in Project Management, E&FN Spon, London

Ward and Chapman (1999) Transforming Project Risk Management into Project Uncertainty Management, International Journal of Risk Management, Vol. 21, pp. 97-105

INCREASING SUSTAINABILITY IN CULTURAL HERITAGE: A CASE STUDY OF SCHOOL BUILDINGS

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ABSTRACT

Environmental sustainability and cultural value preservation often appear as conflicting goals whenever regarding historical buildings; in consequence, most Italian cultural heritage institutions seem to deny any possible innovation in this field.
This paper presents an applicative work, that is a first step of a research aimed at producing methods, procedures and tools, for the sustainable rehabilitation of historic buildings. It deals with the rehabilitation design of a school and it shows the case study, the methodology and the main project elements.
The result of this work is an empirical design method, aimed at preserving building identity and improving conditions of use and environmental sustainability. It is based on the search, the analysis and the comparison of different work alternatives and on the possibility of balancing various levels of preservation and/or transformation in relation to different priorities for the various building elements.

KEYWORDS: environmental sustainability, cultural value, schools, rehabilitation.

INTRODUCTION

The environmental preservation is a principle that, even though with some difficulties, has begun to spread in Italy, both in the public awareness and in the law and tax system policies. Particularly complex appears, however, the attempt to conciliate the objectives of the environmental protection with those of the preservation of existing buildings. Although, the strategic role of building retrofit is recognized, in saving natural resources and energy, the existing buildings are believed to be the main cause of energy overuse, leading to the waste of resources and the increase of pollution.

In Italy, this conflict assumes dimensions hardly comparable, because of the quantity and dissemination of historic buildings. The problem has grown even more with the tradition of the historical studies and the restoration theories, that led us early to an extension of the preservation, over the classical monuments and the building image (Bellini, 1986), in accordance with the definition of "Cultural heritage" as “Material testimony that has a civilization value” (Commissione Franceschini, 1967, vol.1)

From this, it follows, the need to try working on existing buildings, to preserve also those elements, usually considered to be little worth, such as, flooring, doors, windows, etc.. The principles of wide preservation, agreeable at a theoretical level, often go into crisis in practice, working on non-monumental buildings. It happens for various reasons, especially: the need to adapt the buildings in use to the ever changing law requirements and users' needs; the freedom of the designer in decision-making about buildings without the protection of the building preservation institutions, etc.. In order to expand the possibility of preservation of traditional buildings, the Italian national law on Cultural Heritage (D. Lgs. 42/2004) automatically lists all public buildings over 50 year old, whose designer is no longer alive. Among the law requirements, that more recently seem to conflict with the goals of cultural heritage preservation, there are, therefore, the international energy-saving requirements

(2002/91/CE EPBD Energy Performance Building Directory). This is a really complex problem, and the national law, at the moment, doesn't solve it but only offers an escape way. In fact, it allows the possibility not to apply the energy-saving requirements to the listed buildings, "in the event of compliance with them, it would have a consequence of an unacceptable alteration on their feature or image, especially of historical or artistic characters." (D.Lgs.192 /2005 ,D.L. 311/2006).

The lack of explicit and official criteria about what is acceptable and what is not (or about how to recognize it in the different situations) has, as a consequence, a general refusal of every works aimed at increasing sustainability, by the building preservation institutions. On the other hand, the energy requirements could further reduce the preservation of interesting elements of the non-listed buildings. There is the need to develop research aimed at supporting the design process for the rehabilitation of sustainable cultural heritage, in a proactive way; so our built environments can, at the same time, preserve their identity and improve the general conditions of life and environmental sustainability.

This paper presents a rehabilitation design of a school, and it shows the case study, the methodology and the main project elements. It was developed as an empirical activity, in research aimed at defining decision-making criteria for the evaluation of technical alternatives, for the sustainable rehabilitation of historic buildings.

THE CASE STUDY

The choice of a school building was stimulated by the fact that schools are extremely rich in terms of significance and value (due to their educational function, architecture and dimensions, etc.). Nevertheless, they are often in decay, non-complying the law requirements, misusing space and with a very low energy efficiency. Schools are, therefore, object of rehabilitation and they will be more and more; so the attention to environmental problems could assume a strategic importance for both quantity and diffusion of school buildings, and for the possibility of increasing the environmental education of children by the direct example, in order to improve their future behaviour. However, at present, the investment in the sustainability of the school buildings is tiny and differently spread throughout the Country. (Legambiente, 2007).

The case study selected is in Milan; it is a complex with a nursery, an elementary school and a professional school for adults, located in two buildings built in the '20s, and enlarged in the '50s. It is listed as a cultural object because it is a public building, more than 50 years old. Now it is in a very bad condition caused by the great decay, due to the absence of maintenance; it has very low fire-safety and comfort (thermal and acoustical) performances; its space is misused for the careless activities location and consequently, there is, at the same time, overcrowding, low utilization, and lack of location for some important user needs. The design for the building rehabilitation was commissioned by the director of the school and it will be presented to the municipal administration, owner of the buildings, which will have to decide about the work that will be carried out next year.

METHODOLOGY

This research was based on theoretical references about important issues related to existing buildings, such as: preservation and restoration (Bellini, 1986); qualification of the process

(ISO 9004, 2000, UNI 2005a, 2005b, Di Battista, Fianchini, 2005, Roders, et al. 2007); building analysis and performance evaluation (Di Battista, Fianchini, 2007)

These references allowed to define some initial hypotheses:

- It is generally better to add than to remove (materials, elements, signs of various times, etc.).
- The global performance of a building results not only by the performances of the technical elements, but also by the functional elements and by the users' behaviour.
- In order to pursue an overall increase of the different values of a building system it would be necessary to attribute different priority levels to each of the goals, related to the various building elements. In this way, it would be consequently possible to balance various levels of preservation and/or transformation, to select between different work alternatives and to evaluate them in terms of lost and benefit.

Subsequently, the following design objectives were selected, for the empirical activity:

- Global improvement of use-performances, related to the current users' needs
- Environment preservation
- Conservation and enhancement of cultural value
- Technical and Economic Feasibility
- Reliability and effectiveness of building management.

Later the information and the data on the buildings, on the users and on the activities were gathered and integrated. Some design topic goals were selected, such as: adjusting building layout, in order to fit the dimension and the location of various spaces to the needs and the activities of the various groups of users, to improve the circulation, to increase the flexibility; conforming to the law requirements (on fire prevention, on disable accessibility, on users' safety); improving thermal, acoustical and energy-saving performances; improving the conditions of use of the courtyard, and its relations with the surroundings. Then the most important **s**patial and technical elements and equipments were selected, and various project alternatives were considered and evaluated in relation to the level of the objectives satisfaction, by quantitative and/or qualitative criteria.

ELEMENTS OF REHABILITATION DESIGN

This part presents some examples of the project solutions and shows the comparison between the different technical alternatives, on the basis of their levels of objectives satisfaction (positive / negative / neutral).

Table 1: Legend of satisfaction levels of the objectives

Positive	Negative	Neutral
+	--	=

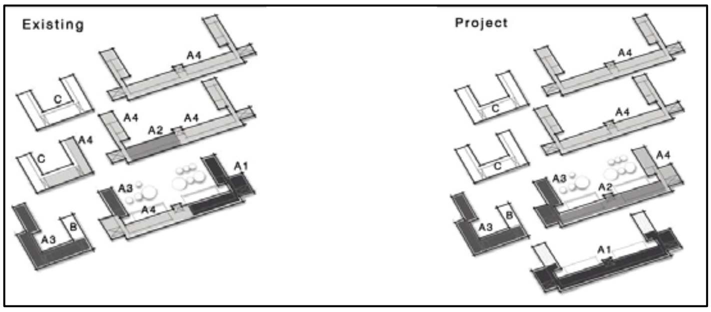
Functional Elements

✓ ***Building lay-out***

<u>*Evaluation methods*</u>: space mapping, building activities mapping; users inquiry; behaviours observation. - <u>*Diagnosis*</u>: inadequate spatial relationships of the activities (closeness

/distance); low variety of space dimensions and flexibility; disorganisation of the users' movements; overcrowding or under utilization of space. - <u>*Design solution and benefits:*</u> the lay-out design decreases the commixture of the various activities and users, by providing for different functional areas, with internal routes and separated equipment; it increases the dimensional variety of spaces, makes the area in the basement usable and makes the school completely accessible to disables; etc. This solution improves the way of use of the users, reduces waste of space and energy, makes the building more flexible and able to satisfy the ever changing needs.

Figure 1. Comparison between existing lay-out and project A: Primary school (A1 refectory, A2 direction and administration, A3 gym, A4 education); B: Nursery; C: Professional school



Technical Elements

✓ ***External masonry***

<u>*Evaluation methods*</u>: facade mapping, surveying, rapid performance evaluation (M.A.P.P.- Method for prediagnostic score evaluation, Di Battista, Fianchini 2007, pp.23-29) and energy performance calculus (UNI EN ISO 13790) - <u>*Diagnosis performance*</u>: decay of materials, risk of falling elements, low thermal insulation. - <u>*Alternatives of intervention*</u>: 1. External coat; 2. Internal coat; 3. Internal coat only on the northern side (solution adopted).

Table 2: Comparison between alternatives of intervention for external masonry

External masonry	External coat	Internal coat	Internal coat only on the northern side
Improvement of use-performance	+	+	+
Environment preservation	+	+	+
Cultural value	--	+	+
Feasibility	--	--	+
Management	=	=	=

<u>*Design solution and benefits:*</u> the intervention on external masonry consists in the installation of internal coat on the northern side to reduce energy dispersions in the most cold areas, to improve comfort in classrooms, while preserving the image of the complex.

✓ ***External Windows***

<u>*Evaluation methods*</u>: elements mapping for types and orientation, sample survey, global performance evaluation (MAPP) and energy performance calculus (UNI EN ISO 13790). - <u>*Diagnosis performance*</u>: damaged materials, closing systems malfunction, dangerous glasses, low thermal insulation. – <u>*Alternatives of intervention:*</u> 1. Improving the elements; 2.

Realizing double frames; 3. Replacing the elements (solution adopted).

Table 3: Comparison between alternatives of intervention for external window

External Windows	Improving elements	Realizing double frames	Replacing elements
Improvement of use-performance	--	--	+
Environment preservation	--	+	+
Cultural value	+	+	--
Feasibility	+	--	+
Management	=	--	=

Design solution and benefits: the solution for external windows consists in the replacement of existing elements with new ones. Both type and materials of new windows are designed to match the existing ones, maintaining the image of the complex. Installation of new elements allows a general improvement of using conditions aiming to the improvement of security performance and thermal- hygrometric comfort, thanks to the combined action of the new frames with the new mechanical ventilation system. The improvement of energy performance of new windows, combined with the choice of a natural material, contributes to environment preservation.

✓ ***Coverage***

Evaluation methods: energy performance observation and calculation (UNI EN ISO 13790) - *Diagnosis performance*: low thermal insulation. - *Alternatives of intervention:* 1. Insulation at the extrados of the attic insole; 2. Insulation at the intrados of the attic insole (solution adopted).

Table 4: Comparison between alternatives of intervention for coverage

Coverage	Insulation at the exstrados	Insulation at the intrados
Improvement of use-performance	=	=
Environment preservation	+	+
Cultural value	=	=
Feasibility	+	+
Management	--	=

Design solution and benefits: the intervention on the coverage consists in the installation of an insulating layer at the intrados of the attic insole, which allows the attic to be inspected, and reduces energy losses while improving acoustics of the below classrooms. The latter aspect increased by the combined action pf the insulating layer with the holes of modular panels of the ceiling.

✓ ***Ceilings***

Evaluation methods: direct observation and calculation acoustic performance (Sabine's equation) - *Diagnosis performance*: damage materials, low sound absorption. *Design solution and benefits:* the intervention on ceilings consists in the installation of a modular false ceiling which reduces the volume of environments, improves acoustic performance and allows to place the plants under the ceiling. The heating system, integrated with the same false ceiling, is composed of radiant perforated panels for widespread ventilation, while the mechanical ventilation system is placed between the panels and the floor. The use of perforated panels also improves sound absorption performance, by means of the combination of perforated panels with insulating material posed on the intrados.

✓ ***Ground insole***

Evaluation methods: direct observation - *Diagnosis performance*: poor thermic and hygrometric capacity followed by bad indoor conditions and humidity infiltrations. *Design solution and benefits:* the intervention on the ground insole aims to improve the performance of the element, together with an overall improvement of the conditions of well-being and use of the recovered basement. The solution consists in the creation of a loose aired, aimed to increase the internal comfort and to allow the passage of equipments, and consequently to improve the conditions of the use of the basement. In the package of floor are housed both radiant system for the distribution of heating and an insulating layer to improve the thermal insulation on the ground and efficiency of the heating.

✓ ***Internal Windows***

Evaluation methods: elements mapping for types and sample survey - *Diagnosis performance*: Damaged materials, closing systems malfunction, dangerous glasses, low noise insulation. *Alternatives of intervention*: 1. Improving the elements (solution adopted); 2. Replacing elements.

Table 5: Comparison between alternatives of intervention for internal windows

Internal Windows	Improving elements	Replacing elements
Improvement of use-performance	+	+
Environment preservation	+	--
Cultural value	+	--
Feasibility	+	+
Management	=	+

Design solution and benefits: The improvement of the elements by sealing the frames and replacing the existing panes with safety glasses enables to improve conditions of use as entails an immediate increase in the soundproof windows, reducing air infiltration as well as an improving security conditions for its use. The recovery of elements makes it possible to contain the waste of natural resources, fundamental value for environment preservation. From the cultural value point of view the solution allows the memorial building techniques, inherent in the original frames, to be maintained.

✓ ***Heating system***

Evaluation methods: assessment of consumption by the analysis of the historic reported of the last 5 years, inspection with technicians. - *Diagnosis performance:* low efficiency of production system and of distribution and regulation one. *Alternatives of intervention*: 1. maintenance of existing plant; 2. replacement of existing plant with an high efficiency plant, integrated with renewable sources (geothermal heat pump integrated with photovoltaic plant) + replacement of distribution and emission system with a low temperature system for increase efficiency of production system + increased efficiency of control system by positioning new thermal probes.

Table 6: Comparison between alternatives of intervention on heating system

Heating system	maintenance existing plant	replacement of production system	cutting plants	replacement of emission and distribution system
Improvement of use-performance	=	+	+	+
Environment preservation	--	+	+	+
Cultural value	=	=	=	=
Feasibility	=	+	+	+
Management	=	+	+	+

Design solution and benefits: the intervention on the heating system consists in replacing the existing plant with a geothermal heat pump. With this solution, the primary energy used from the plant will become electricity. If electricity is produced through the installation of photovoltaic plant, it will be totally clean, thanks to the exploitation of renewable energy. At the last, the other interventions are: firstly, the replacement of emission and distribution system, with the installation of a floor radiant system at the basement floor, and a radiant ceiling for the other floors; and secondly, cutting plants through a division building in compatible areas in activities and timetables.

Table 7: Comparison between all design solutions adopted for make a qualitative assessment of the level of satisfaction of the project

Solution adopted	stairs	external masonry	external windows	coverage	ground insole	internal windows	ceilings	heating system	ventilation system
Improvement of use-performance	+	+	+	=	+	+	+	+	+
Environment preservation	=	+	+	+	+	+	+	+	+
Cultural value	+	+	--	=	=	+	=	=	=
Feasibility	=	+	+	+	+	+	+	+	+
Management	=	=	=	=	=	=	+	+	+

CONCLUSION

The work on the case study allowed us to carry out the empirical development of the method supporting the sustainable rehabilitation design of cultural heritage, and, at the same time, to verify its outcomes in progress.

The introduced rehabilitation design of the school seems to satisfy the initial objective of improving the performances and avoiding the identity loss of the buildings. That was thanks to this methodological approach, which stimulated the search for solutions capable of satisfying the most number of goals, by the analysis and comparison of various work alternatives. Moreover, in the cases where it was not possible to pursue all the goals at the highest level, it allowed to select the works in relation to the different priorities for each element, so the satisfaction levels of the various goals could have been balanced in the global project. It is the case, for example, of the decision of moderating the thermal resistance improvement of the external walls, in order not to disfigure the facades; this limitation has been compensated by the replacement of the external windows (which could not be preserved because they would be too dangerous for users). The loss of the external windows was compensated, at the same time, by preserving the similar windows placed in the internal space, which could be made safe; and so on.

Regarding the general issue on the sustainable rehabilitation of cultural heritage, this work has been a useful methodological test. In fact, the objective of the application on the case study was not the production of project models to be automatically reproduced on similar buildings, but to support conscious decisions in the different cases. However, it is only a first step of research that requires further development, to move from the experimental level to a more precise theoretical elaboration, oriented to a generalization of the method.

In particular, in this work, the evaluation criteria and the goal priorities for the various building elements have been set up in a synthetic way; following research developments should focus on their analytical definition with the aim at laying the bases for a procedural standard, for the qualification and control of design for the sustainable rehabilitation of cultural heritage. In fact, in order to spread these principles in the work practice, it seems absolutely necessary to provide operators (designers, property owners and public administrators) the methodological and procedural tools for their application.

REFERENCES

Bellini A., (1986), "Teorie del restauro e conservazione architettonica", In Bellini, A. (Ed), Tecniche della conservazione, Milano

Commissione Franceschini, (1967) Per la salvezza dei beni culturali in Italia, 3 vol., Roma

Di Battista V., Fianchini M., (2005) "Interventi sul costruito e qualificazione del progetto", in Violano A. (ed), La qualità nel progetto di Architettura, Firenze, pp.137-144

Di Battista V., Fianchini M., (ed) (2005), Procedure preliminari all'intervento sul costruito, Firenze

Legambiente, (2007), Ecosistema scuola, Roma

Roders A.P., Post J., Erkelens P. , "Re[Valuating]- Architecture", in CIB W70, Changing user demands on buildings, Trondhaim, pp.94-104

Decreto Legislativo 22 gennaio 2004, n. 42 Codice dei beni culturali e del paesaggio

Decreto Legislativo 19 agosto 2005, n. 192 Attuazione della direttiva 2002/91/CE relativa al rendimento energetico nell'edilizia

ISO 9004 (2000) Quality management systems - Guidelines for performance improvements

UNI 11150-1/2/3/4 (2005a), Building construction - Qualification and control of building design for building rehabilitation

UNI 11151(2005b), Building process. Definition of the process steps of renovation of existing buildings

UNI EN ISO 13790 (2005),Thermal performance of buildings - Calculation of energy use for space heating

MODERNIZATION OF CONCERT HALLS TO CONTEMPORARY REQUIREMENTS

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ABSTRACT

There are three significant reasons for the modernization of concert halls: their ageing, necessity of sound correction and adjustment to new requirements. Nowadays it is greatly important to adjust such halls to other purposes than performing classical music. It is important to enable multimedia transmission. This necessitates special rooms, equipment, new acoustic parameters and a brilliant sound. In order to achieve these goals two types of methods are in use - natural and electroacoustic . The former assume introducing additional reflecting or diffusing acoustic panels and modern absorbing materials into the space of a concert hall, as well as re-modeling some of interior elements. The latter base upon applying carefully designed systems of microphones, loudspeakers and electronics in the interior which improve natural sound. This process of modernization will be presented using subjectively chosen examples of concert halls built during 19th and 20th century.

KEYWORDS: modernization, concert halls,

INTRODUCTION

The main subject of this paper is an adaptation of concert halls to contemporary requirements. Ways of performing, listening and transmitting are constantly evolving as a result of using new technologies and materials. Moreover, the audience becomes increasingly demanding, as far as quality of sound, aesthetic of space, accessibility for disabled users and their convenience are concerned. While these remarks are obvious for currently built objects, they are not common for concert halls built in 19th and 20th century. Many of those buildings are well known for their splendid acoustics and historical value. So while updating them to nowadays demands it seems crucial that their virtues are preserved, since many of them are part of national and world's heritage.

During the last few years a considerable number of concert halls have been successfully renovated. A closer examination of some of the cases may prove very helpful in creating a clear scheme for a modernization process which would take into account causes, methods and effects. Two major methods of introducing acoustic and architectural changes into the hall will be discussed. Examples of such halls built during 19th and 20th century have been subjectively selected for the present discussion in order to illustrate the process of improvements aimed at creating a richer and healthier environment for listening to music.

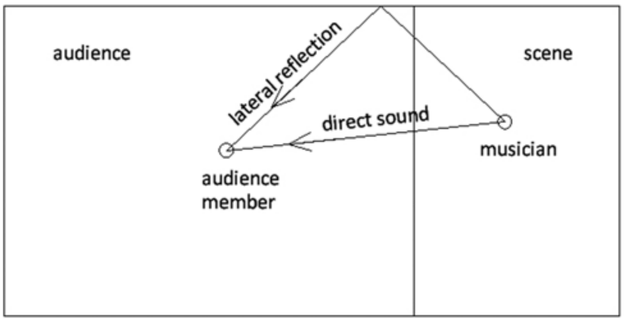
The purpose of modernization

There are three significant reasons for renovation of concert halls: their ageing, necessity of sound correction and the need for adjustment to new requirements. A similar list of reasons can be found in Nakamura, H. (2002). The acoustician from Nagata Acoustics remarks: “The building or facility itself needs renovations due to aging. The client desires to upgrade the acoustical performance. Claims or complaints about the acoustics require redress.”

Ageing is a natural process that all buildings must undergo, since in a continuously functioning object its construction, finishing and furniture are in a constant use. In Europe concert halls renovation process is incessant, while in the United States a great deal of concert halls have been modernized only recently. The same process is being currently experienced in Japan.

Corrections of sound in historical concert halls aim at adding lacking volume, warmth and aliveness, also strengthening speech, which is illegible in long reverberation halls. Especially 19th but some of 20th century concert halls significantly differ from modern ones. They were built with materials and construction parameters available at that time. This usually meant narrow and long shoe-box shaped interiors with balconies and too many rows. It resulted in specific acoustical situation and lack of comfort. Moreover acoustics as a science that we know today started to form its basis in the second half of 20th century. Nevertheless there are also some advantages in the old shoe-box shaped halls: a strong mixture of direct sound with lateral reflection (Figure1), a clear sound, a good balance both on stage and in the audience area, visual and architectural aesthetics. The disadvantages however are: a weak sound on balconies and at the rear of audience, large human-body absorbance, flutter echo (cf. Barron, 1993, p.26), too little space between rows, narrow seats and lack of fresh air.

Figure 1. Sound propagation in shoe-box shaped concert hall



Fitting concert halls with new features and qualities meets the need for enabling more varied performances than only symphonic music concerts, moreover new transmitting systems and better quality of sound. One of the most important features of a good concert hall is its best attainable sound quality. Generally either natural or electro-acoustic methods are applied to achieve this purpose. The former assume introducing additional reflecting or diffusing acoustic panels and modern absorbing materials into the space of a concert hall, as well as re-modeling some of interior elements. The latter base upon applying carefully designed systems of microphones, loudspeakers and electronics in the interior which improve natural sound. In some buildings both kinds of methods are engaged simultaneously.

Other aspects of concert halls modernization, like introducing pipe organs, adding new rooms, adjusting to fire requirements, facilities for disabled users, air conditioning, aesthetic update, will be illustrated with further examples and discussed succinctly, as they are not the main subject of the paper.

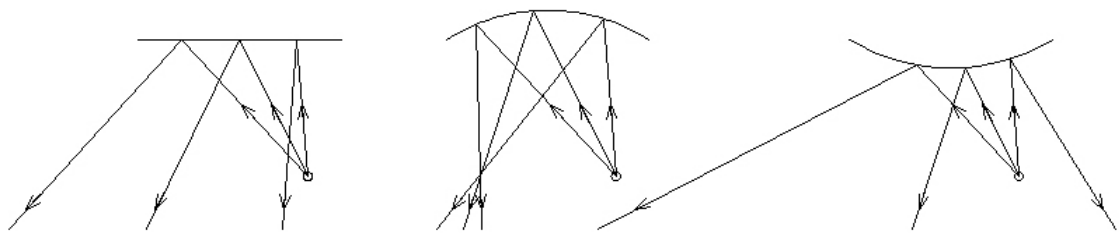
Methods of concert halls modernization

Natural

There are two methods of correcting sound in a natural way. The first one assumes improvement of existing elements, like walls, ceiling, stage and audience area. The second one is based on introducing new elements like acoustic panels, diffusers or other acoustically active materials into the music chamber. Besides the two, a third method could be considered based on the removal of some finishing of the interior. In most cases, however, it can be classified as a variant of the first method. An example of this can be heavy curtains and carpets, very decorative and popular in the past, but significantly absorbent and causing reduction of reverberation time, spaciousness and aliveness. Another case is stucco, which is a decorative element in widespread use in old concert halls. It usually acts as a diffuser but in excessive quantity or incorrectly placed it causes lack of balance. We face a similar problem in case of concave ceiling sections which were used for construction and for the ornamental capacity while in fact caused formations of clusters of sound waves (Figure 2), and lack of sound's energy in other parts of the interior. The same refers to walls located on wrong angles or covered with incorrect materials. Concluding, before conducting acoustical-lifting it is highly important to examine the existing spatial and material state of a music hall or an opera house.

Figure 2. Panel's shapes and wave reflection patterns, a) flat, b) concave, c) convex

a b c



The second natural method mentioned above lies in the introduction of new elements. It is acoustic panels allowing to modify the angle and to direct the reflection of sound waves, their scattering and the amount of absorbed energy, that is in common use in this case. So if loudness at the rear of the audience is too little, sound can be directed there. When musicians do not hear each other well on stage, cross reflections may be generated, etc (Figure 2). Apart from that, in order to achieve a more mixed sound and consequently a subjective feeling of warmth and richness – envelopment diffusers, absorbents and mixed systems can be added. They usually consist of paneling or membranes and are easy to fix on walls or on a ceiling.

Sometimes a more advanced, but still natural, reconstruction is required like architectural re-modeling of the auditorium profile or a ceiling's section. Yamagata Prefectural Community Hall (Yamagata City, Japan, built in 1962 modernized in 2005, by Nagata Acoustics) whose modernization required complete rebuilding of the shape of the ceiling, would be a good example here. The main problem with the hall was strong sound-wave absorption. Currently a new ceiling, made of well-reflecting fiber-reinforced gypsum boards and gypsum boards, placed at desired angles, directs reflections towards the audience and stage. This improved on-stage-hearing and sound quality in the audience area. Some changes of materials are also introduced in other parts of the hall, in order to reduce sound-absorbing elements to a considerable degree. Thanks to these procedures halls reverberation time has been raised to 1,5 sec, which is the correct value for multi-purpose venues.

A similar modernization was carried out in Marlboro Festival Auditorium, (Marlboro, Vermont, USA, built in 1962, modernized by Nagata Acoustics) the hall that had faced the problem of significant difference of reverberation time depending on empty or full audience area and the problem of balance. Japan acousticians removed a large canopy above stage, which was supposed to reflect sound waves, while in fact it lessened the volume of the hall. Moreover shell was installed at the back of the stage, to direct reflections back to the musicians. In this way, balance problem was fixed and disadvantageous difference of reverberation time between empty and full concert hall was successfully reduced.

But not only reduction and rebuilding is an effective way of introducing changes in 19th and 20th century halls. In Boettcher Concert Hall (Denver, Colorado, USA, built in 1978) 'acoustical draperies' were recently added, which had been hung on all four walls. They can be rolled up or down, which changes the reverberation time of the interior. In this simple way the hall is now adjusted to various kinds of performing.

To conclude, natural methods of concert halls modernization provides architects and acousticians with innumerable devices to change and repair spatial and acoustical qualities of music chambers. Unfortunately, it involves vast construction changes which usually generates expenses. Second type of methods can be applied as an alternative, of course as long as it will be accepted.

Electroacoustics

Electroacoustics is widely discussed in a concert hall design especially when the room is considered to be a participant in creating the orchestra's sound. The reverberation time, loudness, spaciousness, warmth, richness are the features of venue itself and have major influence on what we eventually hear. Musicians, performers and hall authorities consider the moral aspects of changing the natural features by using digital equipment. Acousticians argue that since they change the above mentioned parameters by using angle of walls, ceilings, materials for construction and finishing and special acoustic elements anyway, there is no reason why modern technologies should not be applied in the same. It is mostly necessary in modern multi-purpose halls, where different parameters are required depending on the kind of activity taking place there.

The definition of modern electroacoustic framed during an interview with JaffeHolden acoustics (Laney, J.L. 1997) is as follows: "Electronic architecture is the modification of the acoustic fields in performance spaces through the use of audio technology. It is not a PA system with a close-miked orchestra and a reverb unit patched into the main outputs of a mixing console. It is a means of simulating sound reflection patterns with the use of critically placed microphones and loudspeakers supported by carefully tuned electronics and digital processing."

Various kinds of loudspeakers are in use in electroacoustics, which results in varied visual appearance of interiors. An architect should be very careful in placing them and must consider if he should or should not try to mask them from audience view. For example, column loudspeakers are large and visible, so it is advisable to adjust them to the aesthetic vision of the hall space, while ceiling loudspeakers can be successfully hidden behind an acoustically invisible mesh. Various systems of movable panels are offered, allowing to lower loudspeakers when necessary. JaffeHolden came up with a new and interesting idea. They meant a special form of proscenium arch (cf. Cruice, V. 1992) with an aluminum construction supporting the loudspeaker system. The whole construction and the loudspeakers are covered with a special material. It allows sound propagation, but can be adjusted to the outlook of the hall. Needles to say, all such constructions and systems must be accessible for hall technicians. It is important, not only in case of the innovation in question, but in all electroacoustical solutions, to maintain the proper work of the system in order to keep its high performance as long as possible. This leads us to disadvantages of electroacoustic methods, i.e. necessity of maintaining and replacing some of the parts. Moreover, the system will become old after a long time and will have to be rebuilt, which is usually possible, or replaced.

Laurie Auditorium (Figure 3), (San Antonio, Texas, USA, built in 1972) at the Trinity University is a good example of a successful use of electroacoustic solutions. The interior can accommodate from 2479 up to 2709 listeners. It is based on a fan-shaped plan which is very good considering sight-lines but less advantageous for acoustic reasons. Modernization of Laurie Auditorium did not include any changes in hall's design, but an old acoustic shell was removed and electroacoustic changes were introduced. Thanks to the new system the hall had gone through change and is now receiving great reviews on its acoustics.

Figure 3. Laurie Auditorium of Trinity University – modernized interior. Photo provided with permission of Laurie Auditorium

Another illustration is the Circle Theatre (Figure 4), (Indianapolis, USA, built in 1916, modernized in 1984) which has too little volume for its requirements and was said do "sound dry"[1]. For symphonic music 300 volume-to-seat ratio is required while there the value was 165. With regard to some preservation requirements and external limitations the music chamber could not be expanded. Therefore acousticians installed loudspeakers and microphones different from formally used and placed them in some of the old locations but with new functions. The main floor loudspeakers were meant to give warmth to the characteristic for the hall and were placed inside the moat. In this way sound takes time and space to develop itself before reaching the ears of the audience. The acousticians placed subwoofers over the balcony, which were hidden behind decorative grilles. Moreover, sub-loudspeakers were placed under the balconies also hidden from people's sight by special cans. As for the main floor, there loudspeakers were designed with a function of replacing

[1] Tom Aldridge (Laney, J.L. 1997)

primary, early and reverberant energy field. They were also hidden in former organ lofts and covered with decorative elements. As for balconies, the same function was fulfilled by ceiling loudspeakers. The system is controlled by a special unit, allowing to adjust spatial enhancement algorithms, delay, level, length, frequency with connection to reverberation. Touch screen panels are used to control the power, microphones and adjusted to creating various acoustical environments.

Figure 4. Hilbert Circle Theatre. Photo provided with permission of Indianapolis Symphony Orchestra

Other aspects

The intention of the present paper is to present various aspects and methods of classical music chambers modernization. It would be inappropriate not to mention other aspects of the process. Modernization is also connected with introduction of new evacuation rules, additional rooms and facilities, adjustments and upgrading in changing demands of aesthetics and fire-protection requirements. While introducing innovations, it is important not to lose character and quality of the old space. Original producers and materials should be looked up and brought to remodel interiors and exteriors. If this is no longer possible, they should be replaced with similar ones. To give an example, while updating Auditorium of Poznan University (Figure 5), (Poznan, Poland built in 1909 modernized in 2006) the authorities decided, that there was not enough lighting in the hall. Lacking light-points were newly-created, basing on original chandeliers design. The lighting required for conferences was hidden behind architectural elements. This modernization was followed by further activities of this kind perform in the proper and correct way. It should be stressed that old concert halls must be equipped in air conditioning. It should be well isolated and as silent as possible. An aesthetic aspect is also an extremely important issue. In Poznan inlets of air-conditioning system were hidden behind decorative grilles (Figure 6). In this way a modern distort was successfully avoided in hall's historical appearance.

Figure 5. Auditorium of Poznan University – modernized interior

Figure 6. Auditorium of Poznan University - decorative grill

CONCLUSIONS

Modernization of concert halls of 19th and 20th century, caused by ageing and necessity of changes and improvements, is a vast enterprise involving close cooperation of architects, acousticians and investors.

There are two significant methods to introduce acoustical changes into the music chambers: natural and electroacoustical. Choosing the right method depends on external and internal limitations, preservation requirements, as well as eventual effect that should be achieved. Opinions of musicians, authorities and the social point of view must be taken into account. Using both methods may enable changing parameters of a hall in innumerous ways.

It is important that even a small change in a concert hall (e.g. installing new lighting equipment) effects the sound and general impression of music and sound quality. Apart from that in some cases large-scale remodeling of the interiors may be acceptable and desired. All activities should be well planned and optimized, because halls usually work the whole year through.

After first stage of their work – design and second – realization, designers should continue with third stage – building usage, modernization and demolition.

All changes in concert halls of 19th and 20th century should be introduced very carefully, taking into account their functional and historical aspects, as they are part of world's heritage.

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REFERENCES

Barron, M. (1993), Auditorium Acoustics and Architectural Design, London

Beranek, L. (1996), Concert and Opera House. How they sound, United States

"Boettcher Concert Hall. Technical Information" (2007), available at : http://www.denvergov.org/Boettcher_Concert_Hall/TechnicalInformation/tabid/379043/Default.aspx

Cruice, V. (1992), "Taking the Bite Out of a Music Hall's Sound", available at: http://query.nytimes.com/gst/fullpage.html?res=9E0CEEDF123DF933A0575BC0A964958260

Ikeda, S. (2002), "Renovations and Acoustical Design - Part 3: Noise Abatement Renovations", Nagata Acoustics News 02-6 (No.174), available at: http://www.nagata.co.jp/news/news0206-e.htm

Komoda, M. (2002), "Renovations and Acoustical Design - Part 4: Sound System Renovations", Nagata Acoustics News 02-8 (No.176), available at: http://nagata.co.jp/news/news0208-e.htm

Laney, J.L. (1997), interview with JaffeHolden Scarborough Acoustics in Norwalk, "The electronic acoustician Using electronic architecture creates warmth, atmosphere and a more satisfying orchestral experience", available at: http://digitalcontentproducer.com/mag/avinstall_electronic_acoustician_using/

Lord, P. and Templeton, D. (1986), The Architecture of Sound. Designing Places of Assembly, the Architectural Press, London

Nakamura, H. (2002), "Renovations and Acoustical Design. Part 1: Encourage the Inclusion of Acoustical Design in Renovation Plans", Nagata Acoustics News 02-2 (No.170), available at http://nagata.co.jp/news/news0202-e.htm

"Poznan. University under the name of Adam Mickiewicz – Auditorium. Organ prospect /The fist Academy Building/. Conservatory documentation", elaborated by Tomczuk, K.P. (2006)

Toyota, Y. (2005a), "Marlboro Music Festival Auditorium Gets an Acoustical Renovation", Nagata Acoustics News 05-10 (No.214), available at: http://nagata.co.jp/news/news0510-e.htm

Uchida, M. (2006), "Yamagata Prefectural Community Hall Renovation Project - Asbestos Abatement, Seismic Retrofit and Acoustical Improvements", Nagata Acoustics News 06-05 (No.221) , available at: http://www.nagata.co.jp/news/news0605-e.htm

THE GOVERNANCE OF ITALIAN CULTURAL HERITAGE PROPERTIES: THE ENHANCEMENT PROCESS

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ABSTRACT

The Italian Government is changing its management strategy for cultural heritage properties: sale gives way to long term licenses for use. The finance act for the year 2007 allows the State, for the first time, to grant concession of public buildings with cultural value to private entities, for a longer time than average and up to 50 years. This choice aims to gain private investments that will increase the value of the public heritage buildings. Before granting concession of public buildings to private entities, the Public Administration has to be able to foresee the effects of the transformations planned by private concessionaire, and it should guide the private investments to the building safeguard. The present study aims to design a model for the sustainable preservation of the cultural heritage buildings granted in concession, and to guarantee safety, authenticity and compatibility in the choice of new uses suggested by the concessionaires.

KEYWORDS: cultural heritage properties, enhancement, concession to private entities, reuse, compatibility

INTRODUCTION

The Italian model of cultural heritage management is based on laws considered to be the most effective in Europe for building conservation (Settis, 2002). Recently in Italy the management policy for cultural heritage buildings has changed greatly. The recent finance acts and laws concerning historical and artistic assets allow the State to sell its cultural heritage buildings to private citizens or organizations, in order to improve the public budget. Despite the fact that such laws appear to be in contrast with the objectives of conservation and of the enhancement of historical-artistic heritage buildings, these laws do also impose the census and assessment of the effective cultural interest and the definition of the measures to be adopted in order to protect the interests of society for public cultural assets sold to private entities. The Regional Superintendencies for Architectural Heritage, on the basis of the characteristics of the buildings, deliberate on the authorization for sale and, based on the context, they establish the permitted functions for the future use of each building. The new uses should not compromise the cultural value of the buildings and should guarantee that the community continue to benefit from them. If the directions relative to the reuse are not respected this entails the cancellation of the purchasing contract for the goods.

The difficulty in the decisions about new use allocations caused serious delays in the work of the Superintendency. These bodies, lacking adequate tools for assessment, in many cases do not apply the legal procedures, leaving the purchasers full freedom of choice in choosing to institute new functions: the control checks are postponed until the compatibility check of the reuse projects formulated by the new owners (Pinto and De Medici, 2006). Such a system exposes the purchasers of a public building with cultural value to considerable risk: the new owner can discover, only after having made the purchase, that the Superintendency does not consider the new function that he/she intends to institute in the acquired building to be compatible. Such circumstances, together with the relevant increase in the cost of real estate that has occurred in Italy in the last few years, has contributed to hindering the sale process of cultural assets. More generally, the privatization system, applied to many sectors of the Italian economy, does not seem to have delivered up until now the promised results. The observation of such a failure requires the search for a turn-around which leads to a thorough requalification of the public sector, with the involvement of private investors. In this process the Public Administration must maintain its role of first importance in the management of the activities which are not only market activities, establishing a relationship of partnership with the private entities from which both groups can benefit.

Public Administration is progressively abandoning the path of the sale of its own real estate assets, experimenting with a new management strategy: the concession of the buildings for use to private entities for long periods of time. The 2007 finance law, in fact, allows for the first time the entrusting of public buildings with cultural value to private entities, extending the time limit of the concession up to 50 years. Such a choice is aimed at incentivating the enhancement of public assets through private investments. In this scenario, the rules which accompany the authorization for sale or for concession in use constitute an opportunity not only for the conservation of cultural assets, but also for the development of the urban and territorial context, activating socio-economic requalifications on a wider scale. The new management model that Italy is about to undertake requires control methods and tools able to guarantee that the enhancement actions will produce a worthwhile pattern of good results while avoiding putting the conservation of cultural heritage into jeopardy. The Public Administration, in fact, will have to be able to evaluate the effects of the transformation that the private managers will want to carry out in order to reuse the buildings received in concession, directing private investment in their improvement and maintenance.

METHODOLOGY

The present contribution proposes a model for the control of the choices of building reuse, founded on the principle of *sustainable conservation* of the cultural heritage buildings entrusted in concession, with the objective of guaranteeing safety, conservation of cultural values and compatibility in the choice of new uses indicated by the private managers. The new functions for cultural heritage buildings must be selected on the basis of a compatibility evaluation with the building and with the dynamics of the area, in relation to the planning tools of the Public Administration. This measure guarantees a greater protection of the asset, but requires, at the same time, suitable tools for the identification of compatible use allocations, which the Superintendencies do not currently have at their disposal. In the majority of the reuse interventions carried out by private entities, in fact, the choice of use allocations derives from objectives of deriving maximum profit from the property, which do not propose checks or attention to more general interests. This implies a weak commitment to the conservation of the pre-existing building identity and of the relevant transformations of the building, in order to guarantee its adaptation to the demands of the new users. Therefore, the protection of the private interest causes the loss, quantitative and qualitative, of the information that the historical buildings contain and that determine their cultural value.

The proposed method (Figure 1) allows the identification of new use allocations compatible with the existing buildings through successive phases of assessment and comparison of information. Each phase corresponds to one step of the decision process, involving different "actors" and requires different information in regards to the type and the level of elaboration.

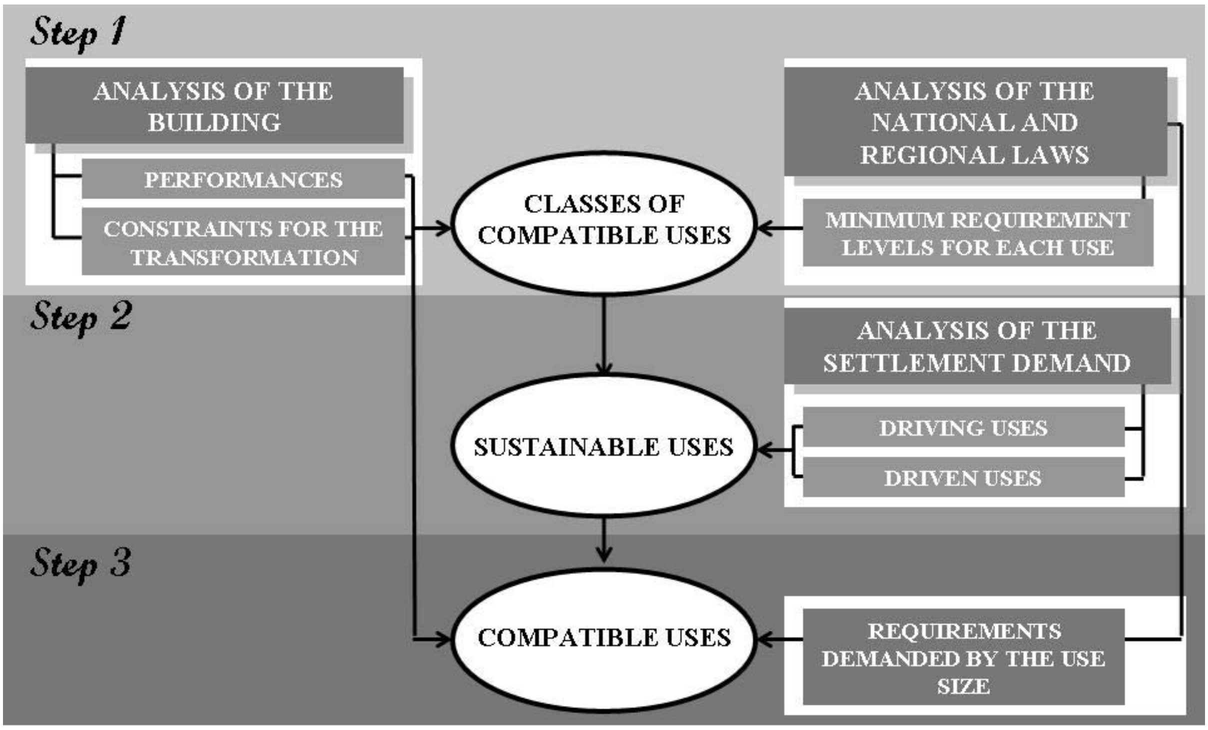


Figure 1. Method for the choice of new use allocations compatible with existing buildings

The first decision phase consists of checking the respondency between the building characteristics and the demands set by each of the categories of use allocation that can be instituted in it. Such a check compares information relative to the services that the building is able to offer in use with the minimum user and safety requirements imposed by mandatory laws for the categories of use allocation. This entails the checking of the required transformations of the property in view of the new activities to be instituted, evaluating the balance between conservation and modification choices. In fact, the reuse project will subsequently be able to transform the building, improving inadequate services or adding those that are absent. The transformations will, however, still have to take into account the constraints determined by the willingness to protect the cultural value of the property. For this reason already in the first decision phase the constraints to the transformation have to be identified, with the objective of verifying the possibility of adaptation of the building in order to accommodate new activities. The first decision phase is indispensable in supporting the choices for reuse in the process from authorization to the conferment in concession of public cultural assets to private operators.

The second phase has as its objective the identification of, in the area of the categories of use allocation held to be compatible, new activities to institute in the building in relation to the development directives of its context. This requires an analysis of the installation needs (required by new activities to be introduced in the area in question) which does not neglect social and economic needs. The choice of new use allocations must, in fact, take into consideration the demands of all the social components involved, seeking new balances for the instituted system, in line with a policy of sustainable development (Caterina and De Joanna, 2007). The analysis of the installation request must take place in the planning phase, with the aim of identifying new uses which guarantee the economic sustainability of the intervention choices (*driving uses)* (Fusco Girard and Nijkamp, 1997). The study of the case must also take note of the needs of local communities and of the potential users, who can request the institution of activities that, although not able to sustain themselves independently (*driven uses*), are indispensable in ensuring the social sustainability of enhancement interventions. The scenarios of reuse outlined subsequently to such a phase of research are the result of mediation between the objectives and the values expressed by public and private subjects involved in actions of enhancement.

The third phase allows the verification of compatibility of the new sustainable activities to be instituted, defining their dimensions. The bodies of information to be compared, as in the first decision-making phase, are on the one hand the services guaranteed by the building and its transformation constraints, and on the other hand the needs required by the possible uses. However, the data to be collected must be more detailed and the respondency to needs different from those examined in the first phase must be verified. The application of evaluation methods to results gained, moreover, allows the definition of an order of preference among the compatible use allocations, on the basis of criteria that can be agreed upon between the clients, the local community, rural and urban society and the potential users.

A CASE STUDY: VILLA TOLOMEI

The current study, through the analysis of conducted experiments, outlines the information/decision-making system and the relative methods of evaluation to adopt in order to recuperate the construction through its adaptation to new activities. The proposed evaluation method allows the construction of a "system of values" which characterizes each building, identifying the constraints to respect and the resources to enhance, in order that the transfer of the property guarantee an increase in its useful life cycle, optimizing the return on its cultural, social and economic values. The project of gaining knowledge of the property must be drawn up according to phases of subsequent elaboration, in relation to the demands of each phase of the decision-making process. The choice of new categories of use compatible with the transformation constraints must be made while taking into account the strategies of the owner institution and the financial resources available. In this phase, therefore, it is not the carrying out of research in all fields that is necessary, but instead the acquisition of information aimed at the verification of compatibility, in relation to the requirements of the use dictated by the legal limitations. The subsequent elaboration of the reuse project, which foresees the comparison of various intervention solutions for the pre-selected function, will require more elaborate research, aimed at verifying the compatibility of the project alternatives formulated.

The method drawn up for the selection of new uses compatible with existing buildings was tested on the case study of Villa Tolomei, a building situated in the district of Florence, Public Property of the Italian State. The procedure of conferment in concession to a private body is in process for this building. In the case of Villa Tolomei, the commission has already identified the use allocation category to be instituted, the residential category, without however specifying the characteristics and the user profiles foreseen (the building could become, according to the proposal that will be selected at the end of the tender announced by the Agency of the State, a private residence, a retirement home, a hotel, a university residence, etc.). With an exemplificatory aim, in Figure 2 and Figure 3 the information necessary to the first decision-making phase is reproduced.

PUBLIC LICENCE TO BUILDING REUSE FOR ENHANCEMENT

VILLA TOLOMEI **Marignolle, FIRENZE**

GENERAL DATA

LOCATION: building located between the Marignolle Hill and the Bellosguardo Hill, south-western Firenze

AGE OF CONSTRUCTION: XIV Century, with significant transformations in the XVIII Century

PRIMAL FUNCTION: dwelling place of many patrician family (Bonciani, Tolomei, Cusani-Visconti) until 1956

PRESENT FUNCTION: none

OWNER: Italian State

CONSERVATION LAWS WICH CONCERN THE BUILDING:
- Constraint Decree for the building: Decree of the 20/04/1977, ex L. 1089/39
- Constraint Decree for the historical park: art. 49, NTA, ex L. 1497/39
- Legislative Decree 42/2004 – Code for the Cultural Heritage and the Landscape

ACCESS: by a gateway beside the street of Santa Maria a Marignolle, through a tree-lined road or a secondary road

PERCEPTIVE-CULTURAL DATA

OUTSIDE:
- simple and regular volume
- symmetry of the façades
- plastered walls, stonework decorations and gable on the main façade
- hexagonal turret with terrace-roofing (built on in later time)
- pavilion roof, with Tuscan imbrex and clay tiles
- wooden windows and doors, with iron grates

INSIDE:
- wooden floors
- mosaic pavement in the living room and in the dining room
- caisson ceilings decorated with fresco painting and stucco
- wall paintings painted in the XVIII and XIX Centuries
- plastered walls
- narrow stairs

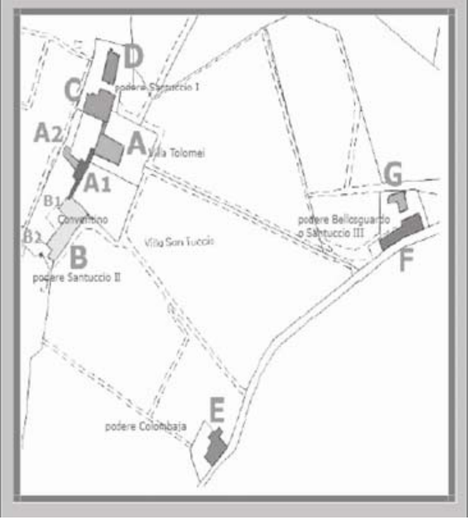


Figure 2. File Card of Villa Tolomei (photographs and drawings are taken from the Information Memorandum attached to the Call for Tenders for the leasing of the building, available on the web site: www.agenziademanio.com)

PUBLIC LICENCE TO BUILDING REUSE FOR ENHANCEMENT

VILLA TOLOMEI — **Marignolle, FIRENZE**

MORPHOLOGICAL-DIMENSIONAL DATA

NUMBER OF ROOMS: 30

USEFUL SURFACE:
Ground floor: 340 m²
First floor: 340 m²
Total Surface: 630 m³
Aboveground volume: 2950 m³
Underground volume: 325 m³

SHAPE: rectangular plan, regular-shaped volume

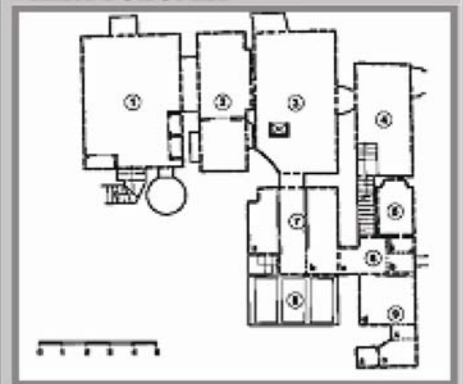
MATERIAL-CONSTRUCTIVE DATA:

- **bearing structure:** stonework masonry
- **vertical interior partitioning:** stonework masonry
- **roofing:** pavilion roof, with Tuscan imbrex and clay tiles
- **vertical closure:** wooden windows and doors, with iron grates
- **finishing:** mosaic pavement in the living room and in the dining room, caisson ceilings decorated with fresco painting and stucco, wall paintings, exterior and interior plastered walls
- **plants**: plumbing, sanitary, wiring and heating systems installed in the early ‘50

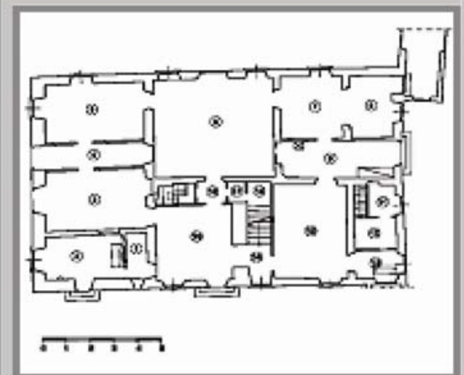
MAINTENANCE STATE:

- **underground floor:**
  - **bearing structure:** rising damp, producing decay of the plaster (detachment, swelling, falling off)
- **ground floor and first floor:**
  - **bearing structure:** breackages on the wall between the chapel and the vestry, seepage due to water leakage spring from the bathroom’s pipes
  - **horizontal partition:** breackages on the floor
  - **finishing:** breackages of the false ceiling, due to the installation of plants, partial falling off of the false ceiling, due to seepage from the roofing, breackages on the floor

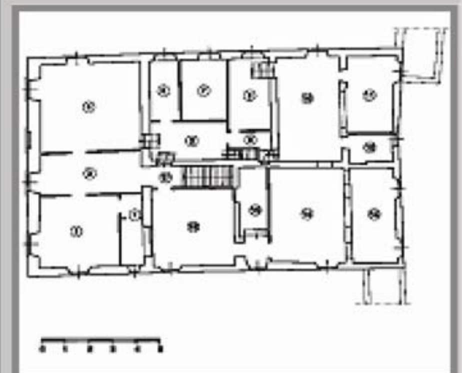
VILLA TOLOMEI



Underground floor



Ground floor



First floor

Figure 3. File Card of Villa Tolomei (photographs and drawings are taken from the Information Memorandum attached to the Call for Tenders for the leasing of the building, available on the web site: www.agenziademanio.com)

This information is divided according to the following categories: general data, morphological-dimensional data, material-constructive data and perceptive-cultural data.

The proposed method foresees that, in the first decision-making phase, the information relative to the building be obtained from the commission (Public Institution), making use of a survey file which will have to be provided to the Superintendency in order to verify whether or not the minimum requirements are met. The result of this check will allow the establishment of an order of priorities of the compatible use allocation categories, not only based on the degree to which the requirements of each compatible use category are met, but also in relation to the recognized constraints on the transformation. In fact, the knowledge of these constraints allows the checking of the adaptation possibilities of the building, in order to increase the levels of present services or to introduce new services.

In the second phase, the results of the previous comparison are used by the private bodies which intend to receive the property in concession. These private bodies, with the aim of verifying the advisability of the investment that they are preparing to make, gather the information necessary to identify the *driving functions* to be instituted in the building. Their reuse proposals will, however, have to pass once again under examination of the commission, which is interested in verifying that the interests of the community are protected following the conferment in concession, and of the Superintendency, involved in the protection of the cultural asset. Therefore, the verification will have to provide proof not only of the economic sustainability of the reuse intervention, evaluating the effects of the institution of *driving functions*, but also of its social sustainability, taking into account the requests of *driven functions.*

Finally, in the third phase, on the basis of the result of the previous control phases, the Superintendency will have to set out an order of preference in the reuse solutions of the private bodies, once again comparing the services and constraints of the building with the requirements relative to each hypothesis for reuse. In particular, the controls to be carried out will have to take into account the number of estimated users for each new function, in order to verify the dimensional compatibility between the existing building and the proposed new use allocations.

CONCLUSION

The reuse of buildings that are part of the cultural heritage and are given in concession must guarantee the conservation of the building's existing identity, preserving its figurative and material quality, without renouncing the response to demands determined by its new function. In this process certain variables weigh heavily, variables determined not only by the behaviour of the building in its use, but also by factors which are present on a wider scale (territorial, urban, zone), and which involve the users (Pinto, 2004). In these cases the ability to support the decisions of Public Institutions who are owners of heritage buildings, who are currently proposing policies of long term concession of cultural assets, is fundamental. Such policies present high levels of uncertainty and can compromise the conservation of buildings with historical-artistic value. However, the starting up of the concession process requires the definition of evaluation procedures which allow conscious intervention choices on behalf of the administrators, not only on the basis of the institution application, but also based on the limitations and the potentials of the buildings to be reused. The design solutions proposed by those to whom the buildings are given in concession to reuse must guarantee the protection of the identity of the building and enhance the building resources, the quality of which must be preserved, improved, and integrated with respect to the constraints present in them.

The quality of the intervention choices, which converge to guarantee the more general aims of urban and rural quality, constitute a priority objective in building reuse. The knowledge of the properties to be reused assumes a strategical role in guaranteeing the quality of the intervention. The analysis and the elaboration of the available information is, therefore, aimed at evaluating and proposing decision-making criteria, according to the objectives of the protection of cultural heritage and of the optimization of the use of available resources.

The Public Administration is called on to act out a strategic action in order to optimize resources: the selection, between possible alternatives, of allocations that are best able to activate the enhancement process both for the individual building which is the object of the transformations, as well as for its context. This action must combine multiple factors according to a systematic logic, in a complex context of compatibility and sustainability dictated also by the guidelines of territory development and by the planning strategies of the Public Administration. In this perspective, cultural assets are considered a resource to be protected and enhanced, creating the conditions so that these assets can not only express their intrinsic values, but that they can also spark off worthy processes of building and environmental requalification on a larger scale. For this reason, the governing of the transformations by the Public Administration constitutes the only way of guaranteeing the coherency of the actions carried out on the ground with strategic development choices.

REFERENCES

Fusco Girard, L. and Nijkamp, P. (1997), Le valutazioni per lo sviluppo sostenibile della città e del territorio, Franco Angeli, Milano.

Caterina, G. and De Joanna, P. (Eds.) (2007), Il Real Albergo de' Poveri di Napoli. La conoscenza del costruito per una strategia di riuso, Liguori, Napoli.

Pinto, M.R. (2004), Il riuso edilizio. Procedure, metodi ed esperienze, UTET Libreria, Torino.

Pinto, M.R. and De Medici, S. (2006), “The sale of the public Italian cultural heritage: the compatibility evaluation for the reuse to restrict the intervention of the new owners”, in Haugen, T. I., Moum, A. and Bröchner, J. (Eds.), Changing user demands on buildings. Needs for lifecycle planning and management, The Norvegian University of Science and Technology (NTNU), Trondheim, pp. 55-64.

Settis, S. (2002), Italia S.p.A. L’assalto al patrimonio culturale, Einaudi, Torino.

ALTERNATIVE USES FOR REDUNDANT CHURCHES

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ABSTRACT

Throughout the Western World, church buildings are being declared redundant, converted or demolished in increasing numbers. In the Nordic countries, public funding has protected churches from redundancy, but the pressure on the National Churches to undergo structural changes is increasing. The Norwegian Association of Church Employers (KA) has followed the development in the international arena with great interest. Considering the debate that is approaching in Norway, varying techniques and experiences from other counties have been studied in order to generate guidelines for preferred future uses for churches threatened with redundancy. The central principal is to find solutions for uses that respect both the original form and function of the church building. By assessing different projects, a priority list outlining various options has been developed in order to assist congregations, local planning authorities and heritage organisations in their evaluation processes.

KEYWORDS: Redundant churches, new uses, social planning

INTRODUCTION

Throughout the Western World, churches are continuously being abandoned, converted or demolished and there are no signs of this trend diminishing. This is mainly attributed to a decline in the religious activity of Christian communities, typical to both North America and Europe. The decline that began in the early sixties threatened the existence of many small congregations, resulting in mergers, which in turn has resulted in the need for buildings more suited to the size and needs of the new congregations. Many old churches are therefore considered either too large or unsuitable for modern day requirements and pronounced redundant. (Norisset et al., 2006)

At the same time that religious practices have evolved, it has become apparent that churches not only represent a religious heritage, but also equally importantly a cultural heritage. Churches, due to their architectural form, location and often their sheer size, contribute to creating a local identity and character, and are often an integral part of the “genius loci” – the distinctive atmosphere of a place. As the problems concerning the future of churches have become clearer, social planners and other specialists have begun to take an active interest in the plight of these buildings. Canada and the Netherlands are currently in the forefront of research into this topic. Studies carried out are the result of a cooperative effort between researchers and relevant religious and government authorities.

Similar changes in patterns of religious activity are also apparent in the Nordic countries (Iceland, Denmark, Sweden, Finland and Norway). This especially affects churches in isolated rural communities threatened by population demise and churches located in city centres where the population centre has expanded to the suburbs. However, these changes in demographics have not had equal consequences to the church buildings. This is because the churches in the Nordic countries are national institutions. The churches are guaranteed financial support through public funding. Despite the fact that many churches are no longer in regular use and pressure on the Church to undergo structural changes is increasing, very few churches have been made redundant. In most cases, Free Church communities and voluntary religious organisations experience this pressure first, and force them to adapt in a greater degree than the more established National Churches.

In most cases, the National Churches have been shielded from these changes, although there are lots of instances where local church communities are experiencing pressure to reform. The Norwegian Association of Church Employers (KA), representing Norway's church owners, has initiated a variety of projects directed towards improving management and development of the "public churches". KA believes in active participation in the debate on the future of the churches and contributes to the development of different methods and guidelines for how congregations, historical authorities and social planners can address the questions connected to the future use of existing church buildings.

A SHORT SUMMARY OF TODAY'S SITUATION

In the autumn of 2005 researchers, architects, historians and church managers attended a conference in Montreal to discuss the status and situation for church buildings throughout the Western World. The proceedings are published in "What future for which churches?" (Morriset et al., 2006). Although the church authorities, the management and administration structures and the economic resources and funding varied greatly, it was surprising how many similarities that exist in regards to the problems and challenges met by.

The conference revealed that in most countries there are ongoing discussions relating to questions of ownership, financing, and of what can and should be done with redundant churches. Most countries have a system of registering or listing of churches that are worthy of preservation. However, due to the different management structures, the consequences of listing vary greatly. Although maintenance funding varies – from public to private – different authorities were concerned with protecting cultural values and contributing in varying degrees to funding. But public funding usually covers only a small proportion of the costs, and it has been necessary in many places to initiate local awareness campaigns intended to mobilise the local community and voluntary organisations to help in funding and work based projects. Despite these efforts, there is still not enough funding to maintain the necessary level required for long-term protection. Everywhere organisations are looking for appropriate solutions. This has encouraged the founding of different networks both on the national and international level.

The state of Quebec in Canada has attempted to address the problems with redundant churches by adopting an active approach. Canada is perhaps one of the world's most multicultural societies; this has resulted in the need for many different types of Christian churches. These churches have a strong visual influence on the cities. Increasingly these monumental buildings have been closed, either because they do not meet the congregations' current requirements, or because they have been redundant. Authorities have held the following opinion: "Churches are an important ingredient in the local identity. One does not require a religious affinity with a church in order to regard it "ones church". When a church has been declared redundant, it is not only the religious heritage that is threatened, but also the cultural heritage for the surrounding community, and for that sake the national heritage." The Managing Director for sustainable development in Quebec, Serge Viau, expresses the following point of view: "All churches deserve to be preserved, despite it is too optimistic to believe that it will be possible" (private conference notes).

Table 1 lists some of the alternative uses for churches. Since the end of the 1960's, in England alone, nearly 1700 of the Church of England's 16 000 churches are no longer in use for church activities. This is equal to the total number of churches in Norway. The reasons behind this relate to lack of maintenance funding, establishment of other Christian denominations and that it has become easier to sell church property. This has resulted in a diverse range of alternative uses such as housing, discotheques, pubs, and gyms (Kural, 2007). Cases are to be found in Germany, the Netherlands, Canada and the USA. In New York, the property prices are so high that it has become a threat to poor congregations that are tempted to sell their old churches for private/commercial use.

Table 1. Examples of alternative uses for redundant churches. Sources: Morriset et al. (2006) and Kural (2007).

1. Health studio	15. Laboratory	31. Pub
2. Public archives	16. Hotel	32. Festival centre
3. Community centre	17. Art Gallery	33. Culture workshop
4. Day centre for refugees or homeless people	18. Concert hall	34. Deaconate centre
	19. Circus school	35. Museum
5. Hospice for alcoholics	20. Columbarium (graves)	36. Shops, supermarket
6. Handball hall	21. Library	37. Conference hall
7. Sports hall, gymnasium	22. Jazz club, music theatre	38. Local centre, market place
8. Small business premises	23. Children's activity centre	39. Theatre
9. Storage	24. Open Church	40. Functions
10. Monument, place of interest	25. Educational facilities	41. Women's centre
11. Ceremonial facilities, funeral chapel	26. Shopping centre in the basement	42. Mosque
	27. Offices	43. Military quarters
12. Dance club, disco	28. Apartments	44. School
13. Church for other faiths	29. Homes for the elderly	45. Therapy centre
14. Combination. A minor part continues to be used as a church	30. Café and restaurant	46. Fitness centre, sauna, swimming pool

In Netherlands, Pollmann (1995) concludes that, in 1995, few conversions of churches were entirely successful. His compatriot van Leeuwen (2006) is of the same opinion, stating, "The best function of a historic church is of course its original function, but, if destruction has to be avoided, demolition being irreversible, much may be allowed." Kiley (2004), who has made a careful study of the phenomenon of vacated churches in US, confirms, "The best use for a church is a church." But, he says, when conversion is necessary, "Two types of strategies have proven most successful: those that reuse the singular volume of space, and those that reuse the quality of construction and unique character of the space."

In the Church of England, churches may be declared redundant under procedures laid down in Church legislation known as "The Pastoral Measure 1983". The Redundant Churches Committee settles the future of churches closed for regular public worship. A guidance note for local planning authorities states that: "A church, even if not of major historic or architectural quality, may be the most significant building in its locality, a familiar and important feature of the landscape. Churches make up the most significant single group of the nation's historic buildings and the process for settling the future of redundant churches recognises the interests of both the Church of England and the wider community" (Code of Recommended Practice, 2006). But even if the redundancy procedures are quite strict, there are no restrictions on alternative uses, exept that it should be "suitable".

FACTORS THAT REQUIRE ANALYSIS WHEN CHANGING THE FUNCTION OF A CHURCH

As mentioned, a change to a church's function poses many questions. We will consider these problems from three different points of view, namely a dogmatic/theological angel, a cultural and social angel and a technical-economical angel.

Dogmatic/theological considerations

In the Nordic countries, the Lutheran church is dominant. Martin Luther perceived churches not as holy of their own accord. In his Church Thesis from 1522 he writes, "There is no other reason to construct churches than as a place where Christians can assemble, pray, listen to sermons and receive communion. When these reasons are no longer valid, churches should be demolished just as other buildings are demolished when there is no further use for them."

Today we have adopted a different approach to buildings from the past, although theology has remained unchanged. Martin Luther's opinion is however not a universal one, many other Christian communities consider churches for many different reasons to be holy. Even if these communities do not appear to have formalised their views, they do practice varying principles and traditions:

1. *The Orthodox Church* regards their church buildings as holy, a form of the Holy Spirit materialised. Orthodox churches must be utilised as churches or be razed to the ground. Some disused churches are sold to other Christian denominations. In these cases the sacred contents are removed and gifts are returned to the donator.

2. *Catholics* see the Eucharist as the source and summit of the Christian life, and believe that the bread and wine brought to the altar are transformed through the power of the Holy Spirit into the true body and the true blood of Christ. It is therefore important that all items used during the performance of the Eucharist, such as the altar, the tabernacle and its contents, should be removed before the church can be used for other purposes.

3. *The Lutheran Church* does not consider the church building in itself to be sacred, although the consecration ritual refers to the church as "dedicated and consecrated in Gods honour and to the edifying of the congregation."

4. *Reformation churches* (Baptist, Pentecostal etc.) regard the congregation as sacred and not the church building. The church is considered as an object used by the congregation for practical purposes.

Often when a church is taken out of use, a ceremony is held. Many of the different Christian churches have their own liturgies for such occasions. Among them is the Catholic Church that has developed a set of rituals used for the deconsecrating of churches. Similar rituals have also been used for redundant Lutheran churches.

Cultural and social considerations

Despite the fact that a Christian community no longer consider a redundant church as a religious building, the general public continues to perceive it as so based on its architectural, historical and cultural significance.

A study carried out in Sweden during the 1990's showed that the public's interest in the local church as a significant building was the same for those that attended church and those that did not. The results of the study were presented under the title "Don't touch our church!" (Bromander, 1998). In another study, Clarence Nilsson, who had held the position of dean in the Uppsala Cathedral, made the conclusion: "Redundant churches don't exist if our emotions decide" (The Central Board of the Swedish Church, 1992).

Seen from a cultural and social perspective, a church building may play many roles in different arenas. It is possible to identify at least four different groups that all feel a responsibility or ownership for the church buildings:

1. *The active members of the congregation* regard their church as a gathering place and a spiritual home. They are concerned with the church work and are interested in using the church for a wide range of activities.

2. *The public Christian community* regards the church as a liturgical framework, a place for celebrating important religious events such as Easter and Christmas as well as for the practice of rituals such as christenings, confirmations, marriages and funerals.

3. *The local community* regards its church as an important landmark and symbol of the community. The church symbolises identity, history, culture, tradition and often a sense of belonging. Churches are often constructed in central or visually important locations, which have resulted that they often play an important role in the physical layout and development of a town.

4. Finally, a church may be considered a part of *the national cultural heritage*. Churches provide valuable information about architecture, art and workmanship as well as giving important facts and information about daily life and people's religious life during 1000 years of our history.

How should we navigate between these different considerations? Who should decide and who should pay? These questions lead to complex discussions and possible conflicts that in turn pose many unanswered questions.

Technical and economical considerations

In addition to religious, social and cultural issues, it is also important to discover if there are any technical, economical or planning restraints that may limit the choice of alternative uses.

When assessing a building's adaptability and suitability for different uses, one needs to differentiate between the following factors:

1. *Generality* – For which purposes can the building be used?

2. *Flexibility* – Can the internal structure and layout be adapted to suit different uses?

3. *Elasticity* - Is it possible to extend, rebuild or section off the building to cater for a range of different uses?

Churches are often buildings of high quality both when it comes to workmanship and design. Nevertheless, they are also buildings that are specially created as houses of worship, which inevitably means they receive low scores on the adaptation scale. This reduces both their suitability for adaptation and range of choices for alternative uses. However, by selecting a suitable use combined with appropriate changes to the building's layout and form, it is possible to find solutions. There exist many good examples where a church's identity actually enhances its new use or purpose. In many cases, it is preferable that changes are of a reversible nature so that if a need arises in the future, the building can be returned to its original use. This has also made room for creative and innovative solutions. Unfortunately, experience has shown that projects of high quality also come at a relatively high price. These projects are seldom profitable based on a cost/benefit analysis. The argument for defending such a high price tag must be the fact that these projects are at the same time preserving cultural heritage and community values.

When considering economic aspects, it is important to distinguish between churches located in central places and churches in rural areas. Churches that are centrally located often have a high property value. This can have both positive and negative consequences. In some cases, it can be the driving force to demolish or convert it and in others, a means to provide income that can be used for renovations and maintenance. Churches situated in areas with low property values and limited possibilities for alternative income, usually have a limited range of options. Another factor is that isolated churches in country areas often have adjacent cemeteries that do not make finding suitable alternatives any easier.

METHODS AND PRINCIPLES FOR ALTERNATIVE USES FOR CHURCHES

Some general principles

The material available is not detailed or homogenous enough to make accurate comparisons. However, the various case studies display a lot of concurrent experiences that give grounds for some general conclusions. The most important conclusion is that traditional churches have been designed specifically with a single function in mind. A design that has such strong connections to religious, cultural and social elements often means that, as a rule, the best solution is to ensure that the building is continued use as a church. If this is not an alternative that can be considered, the most successful is to find use for the building that is of a public nature. This ensures that the local community still has access to the building and helps to maintain a feeling of ownership. Elements of the architecture that are of a religious nature should be protected as much as possible. Projects that are the least successful from an architectural and social perspective are those where churches have been converted for private use such as for offices or apartments. These often demand radical changes to a church's form and characteristics and can be seen as an attack on community values.

In other words, the goal is to find solutions that work in the best way possible *with* the building, solutions that respect the original form and function of the building, that preferably reuse the singular volume of space and are reversible.

Guidelines for evaluating possible alternative uses for existing churches

Due to the uniqueness of church buildings, it is necessary to consider all facets of prior to considering alternative use possibilities. It is necessary to examine the building and its limitations, as each building is unique. Layout, design and materials may limit different types of uses. From an historical and antiquarian perspective, continued use of a church for the purpose is intended to be the best solution. This places demands on both the congregation and antiquarian authorities to co-operate in finding solutions. If a church for example were so historically important that changes would be unacceptable, then a sensible solution would be to preserve it as a museum and only permit it to be used on special occasions. In some situations, local authorities may want to incorporate the church into a larger planning project or in other ways decide what future role the building will have for the local community.

Experiences from the case studies and available literature allow us to deduce some tentative guidelines over which alternative uses are the most respectful and successful for redundant churches. These guidelines are intended to assist congregations, public and urban planners, local authorities and heritage organisations in evaluating possible future use alternatives. The priority list is shown in table 2.

Table 2. Priority list for alternative uses of redundant churches

Priority	Category	Explanation and examples
1.	Church use	Continue primarily with current use
2.	Church use	Cultural and social activities carried out by the congregation
3.	Church use	Transfer to another Christian community for use as a House of Worship
4.	Civic use	Public cultural activities (Library, concerts, exhibitions)
5.	Civic use	Public offices/social services/sporting activities
6.	Private use public access	/Commercial activities (Art gallery, restaurant, boutique, health centre)
7.	Private use	Private activities (Offices, workshops, business, housing)
8.	Demolition	-

CONCLUSION

Throughout the Western World, church buildings are becoming redundant. Churches are a highly specialised form of architecture and are representative of our religious, cultural and social history. Church buildings in both form and function have important religious, social and cultural connotations connected to them. The act of abandoning or demolishing churches effects not only its congregation, but also the local community and in some cases society. Congregations, antiquarian authorities and local councils need to co-operate in order to find suitable solutions that can ensure both preservation and future use of church buildings. As a rule, the best solution is to maintain the original use. However, where this is not a viable alternative, it is best that the churches can be put to public use in a way that ensures that the local community maintains their feeling of ownership. It is also important that when adapting the building's form to its new function that the religious architecture of the church is preserved as much as possible in its original form. Perhaps the most important consideration is to avoid those solutions that that can be regarded as a form of privatisation or those that require changes that will alter the character of the building or are of an irreversible nature. The aim is to find solutions that work *with* the building, not against it, solutions that preserve the character and identity of the building and its original form and function. Based on case studies and available literature, these principles have been incorporated into a priority list that is intended to assist congregations, local planning authorities and heritage organisations in their evaluation processes.

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REFERENCES

Bromander, J. (1998) Rör inte vår kyrka! (Don't touch our church!), Tro & tanke 1998:7, Uppsala

Code of Recommended Practice (2006), Appendix 15C "Redundant Churches in the Church of England, A Guidance Note for Local Planning Authorities" available at http://www.cofe.anglican.org/about/churchcommissioners/pastoral/pastadmin/code/pm1983code.doc

Kiley, C.J. (2004) Convert! The Adaptive Reuse of Churches, Master's Thesis, Urban Studies and Planning, Massachusetts Institute of Technology.

Kural, R. (2006) "Mere liv i kirkerne! Vil idræts- og kulturaktiviteter i vore kirker kunne give dem en ny renæssance?" ("More Life in our Churches! Can sporting and cultural activities provide them with a new renaissance?") available at http://www.idrottsforum.org/articles/kural/kural070516.html

Norisset, L.K., Noppen, L. and Coomans, T. (Ed.) (2006) Quel avenir pour quelles églises? What Future for Which Churches?, Presses de l'Université du Québec, Québec, pp. 19-35.

Pollmann, T. (1995) Herbestemming van kerken. Een ontnuchterend relaas (Conversion of Churches. A Sobering Story), 's. Gravenhaage, RMDZ/SDU, 1995.

Svenska kyrkans sentralstyrelse (1992) Fädernas kyrkor – till varje pris? (Church of the Fathers – at any Price?) Diskussionsbetänkande avgivet av 1990 års kyrkobyggnadsutredning, Stockholm.

Van Leeuwen, A.J.C. (2006) "Believing in Churches. Church Buildings in The Netherlands. Conservation and new functions" in Norisset, L.K. et al. (Ed.) Quel avenir pour quelles églises? What Future for Which Churches?, Presses de l'Université du Québec, Québec, pp. 257-268.

BRAZILIAN 16TH THROUGH THE BEGINNING OF 20TH CENTURIES BUILDINGS AS HOUSING FOR THE TWENTY FIRST CENTURY

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ABSTRACT

Brazilian cities and their buildings are connected to the Portuguese cultural and political model from the 16th through the beginning of 20th centuries. Colonial cities were distributed along the coast of Brazil. These urban nuclei had a small perimeter supporting a large number of people with few open spaces which effectively provided protection. The urban lots were narrow and long, and the building was located in front of the street and on its boundaries. In relation to the cultural, architectural and urban heritage, the country presented, over the last 50 years, one of the highest urbanization rates in the world.

The occupation of these urban centers, focusing on housing production, has the advantage of seizing the local and regional installed urban infrastructure, which reduces the cost of interventions for public authorities, environmental impacts and increases social inclusion.

This paper explores the revitalization process of urban areas in Brazilian cities and presents the approaches to revitalizing old centers as a political challenge, and as a complex process to harmonize the work of different institutions. It describes a case study listing the agents that interfere in the decision-making process for a public funding housing Project for the city of Rio de Janeiro, emphasizing aspects which may contribute to the quality and management improvement of property rehabilitation projects for social housing.

KEYWORDS: Urban revitalization, project management, social housing, building rehabilitation

INTRODUCTION

Brazil today, presents different social realities spread throughout the entire territory. Due to this diversity, local, state and federal governments seek solutions to develop their territories which benefit all social classes. One of the solutions offered by the public authorities is the revitalization of old urban centers through building rehabilitation. This provides social housing for the resident population in the area. After public authorities have defined their strategies, this solution can be treated as an opportunity for social inclusion.

This paper presents a review of urban revitalization and building rehabilitation trends in Brazil, and addresses aspects of the project relating to rehabilitation of old buildings to produce social housing as the main aspect of social and economic recovery, as well as the preservation of historical heritage of old urban centers. It concludes pointing out the need for sustained actions on the part of architects in the 21st century, based on the tenets of recovery, conservation and rehabilitation.

A BRIEF HISTORY OF REVITALIZATION OF URBAN CENTRAL AREAS IN BRAZIL

In 1937 the Brazilian federal government instituted SPHAN - National Artistic and Historic Heritage Service (Serviço de Patrimônio Histórico e Artístico Nacional), for the purpose of reinforcing national identity and contributing to the construction and protection of Brazil's artistic and historic heritage. The main – and still current – means of preserving Brazilian heritage – the historical monument status was instituted by Decree Law number. 25 dated November 30, 1937. As stated by Fonseca (1997), the "historical monument status was instituted as a realistic compromise between the individual's right to property and the defense of public interest as far as the preservation of cultural heritage was concerned" (FONSECA, 1997, p.115).

During the 1950's and 1960's, the Brazilian development process underwent changes which clashed with the conservation policy, as pointed out by the referred author:

> [...] this new development model led to repercussions not only at the symbolic level – to the extent that this ideology was opposite to continuity and tradition – but also at the social and economic levels – due to an intense migration to the state capitals and increased value of urban land. There was acute tension at SPHAN, especially with regards to the conservation of historic towns and historic centers (Ibid, p.159).

During the 1970's, following a series of alterations , the heritage department's actions manners and guidelines changed and it was renamed IPHAN – National Artistic and Historic Heritage Institute (Instituto do Patrimônio Histórico e Artístico Nacional). According to Medeiros (2004) , these changes in its guidelines were necessary because, in the new economic and cultural stance on heritage and urban assemblies, the historical status and conservation of an isolated monument were substituted by the historical status and conservation of urban building groups Still according to the authors, "the new economic and cultural perspective that prevailed during the 1990's introduced the notion that economic value generated by cultural heritage would also be subordinated to the new social lifestyles and, consequently, to the ' usage value' of the cultural asset" (MEDEIROS, 2004, p.16). It is considered that, under this perspective, conservation introduced the notion that the old building must be adapted to the new social usage demands. Hence, the new urban intervention criteria of revitalization and rehabilitation join the older notions of restoration and conservation.

During the 1980's, BNH – Brazil's National Housing Bank - (Banco Nacional da Habitação)[1] financed a pilot Project aimed mainly at recovering property for housing purposes, with a major participation of the local community. Olinda's Pilot Project, an

[1] The Brazil's National Housing Bank was created by the Federal Government in 1964 for the purpose of concentrating actions geared towards producing social interest housing for social classes not covered by the housing industry. It was active until 1986, inclusively conducting research on building technology and materials which are used as reference to date. All of BNH's records, as well as part of its tasks, were transferred to Federal Economic Bank (CAIXA) when the former was deactivated.

important housing heritage conservation initiative was incepted in 1985 as an experimental activity within the scope of the Historic Nuclei Revitalization Program (Programa de Revitalização de Núcleos Históricos). According to Bosi (1986), the purpose of this program was "[...] to preserve the Brazilian cultural heritage with the respect, support and cooperation of resident population, in a joint planning and implementation process "(BOSI, 1986, p. 134).

In 2000 Federal Economic Bank (Caixa Econômica Federal – CAIXA) implemented the PRSH Historic Site Revitalization Program (Programa de Revitalização de Sítios Históricos) and the Ministry of Culture created the National Artistic and Historic Heritage Conservation Program (Programa de Preservação do Patrimônio Histórico e Artístico Nacional). Taking the Olinda Revitalization Project as a point of reference, PRSH was intended to recover the tenet that housing would promote urban rehabilitation. The Monumenta[2] Program, which combined recovery and conservation of historical heritage and social and economic development was also implemented through the Ministry of Culture.

Still in early 2000, the trend towards rehabilitation as an alternative for inclusive and sustainable urban development led to an increased interest in policies conducted by other countries. Hence, the Brazilian MRE - Ministry of Foreign Relations (Ministério das Relações Exteriores) and CAIXA incepted negotiations with representatives of the French government to set up a Technical Cooperation program, incorporating the experience drawn from the French joint venture with the Rio de Janeiro City Hall for the Rehabilitation of the Morro da Conceição, which took place between 1998 and 2000 (PROGRAMA CIDADE BRASIL, 2006). After a Protocol was formalized, the French cooperation was named "Brazilian City Program" (Programa Cidade Brasil) and provided technical cooperation supporting projects, in many Brazilian's cities.

The Brazilian Federal Government instituted the PRAUC - Central Urban Area Rehabilitation Program (Programa de Reabilitação de Áreas Urbanas Centrais) in 2004 based on the cooperation program experience with the French government. The purpose of the PRAUC is to coordinate the rehabilitation actions in an integrated manner, ensuring compatibility between the particular needs of each site and the government projects, promoting an associated operation of the financing credits to fund the recovery of the built premises and to encourage a culture of refurbishing and reusing real estate, which is still incipient in Brazil (ROLNIK et BALBIM, 2006, p.3).

REVITALIZATION OF URBAN CENTERS BASED ON THE ASSUMPTION OF HOUSING USAGE – CURRENT SCENARIO

The degraded construction environment of Brazilian towns is one of the consequences of the spiralling urbanization, specially as of the 1960's, due mainly to the economic lure of industrialization, which concentrated job positions in major cities, causing a development surge that public policies could not control. As a consequence of this intense urbanization process, there was a collapse of public city management.

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[2] MINISTÉRIO DA CULTURA, MONUMENTA Program, 2007. Available at: www.monumenta.gov.br . Accessed in June 2007.

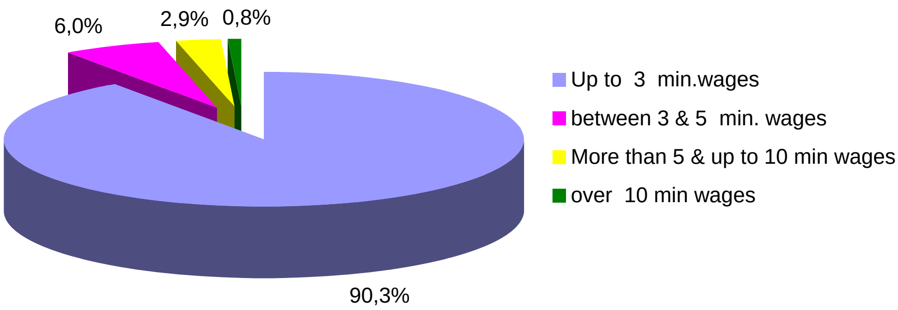
During the 1950's, 36% of the Brazilian population lived in urban areas. By 2000 this percentage had increased to 81%[3]. The projection for the current century is an intense urbanization trend, where over 80% of the entire Brazilian population living in towns, as a consequence of territorial expansion process without adequate planning, confirmed by the social-spatial segregation and the expansion of urban boundaries.

The preference for building in peripheral areas of major cities, mostly extensive and unoccupied, where the cost of land is cheap and it is possible to achieve larger scale constructions, has stimulated a land expansion trend towards the outskirts of the towns. This expansion of urban boundaries, associated with the economic expansion vectors has caused a sub-utilization of the urban centers, as far as the housing availability and use of the existing local infra-structure are concerned.

It is considered that there are two basic aspects to the analysis of housing issues in central urban areas , directing the Federal Government's public: in first place, the **sustainability of the interventions** in the constructed environments, preservation of local cultural and social structure; and secondly, the opportunity to **revive idle real estate** (vacant buildings) reinstating the social and economic dynamics of these urban centers.

Housing is a major challenge in Brazil. The housing deficit is equivalent to 6,4 million domiciles, according to estimates made by João Pinheiro Foundation (2006), and is concentrated in the up-to-five minimum wages[4] social strata, corresponding to 96,3%, see Chart 1.

Chart 1: Urban housing deficit based on family earnings, in minimum wages - 2005



Source: Housing Deficit in Brazil 2005 / Fundação João Pinheiro. Centro de Estatística e Informações. Belo Horizonte, December 2006.

Concentration of deficit, primarily, in the up-to-three minimum wage bracket, equivalent to 90,3%, confirms the need for public support to meet the housing needs of this group, which will most unlikely be met by the private housing market.

3 INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. National Domicile Sampling Research. PNAD:IBGE, Rio de Janeiro, 2005. Available: www.ibge.gov.br. Researched June 2007.
4 Equivalent, in Dec. 2007, to approximately US$ 500,00 (five hundred US dollars).

Still according to João Pinheiro Foundation (2006), the Brazilian housing deficit is characterized by:

a) precarious housing (improvised and rustic domiciles);
b) co-habitation (families living in the same home); and,
c) the excessive burden posed by rent (families with earnings of up to three minimum wages spending over 30% of their earnings on rent).

Table 1: Characterization of housing deficit

component	urban		rural		total	
	units	%	units	%	units	%
Family cohabitation	3.850.058	60	639.081	43	4.489.139	57
Precarious housing	706.763	11	849.474	57	1.556.237	20
Rent as excessive financial burden	1.857.323	29			1.857.323	24
Total	6.414.144	100	1.488.555	100	7.902.699	100

Source: Housing Deficit in Brazil 2005 / João Pinheiro Foundation. Statistics Information Centre. Belo Horizonte, December 2006.

In the urban area, family cohabitation in 3.850.058 units is the major cause of the deficit estimates, equivalent to 60% of the estimated deficit, which indicates how precarious the existing housing is in Brazil. Secondly, equally worrisome, is the excessive financial burden posed by rent, in 1.857.323 domiciles, equivalent to 29%. The precarious housing component applicable to 706.763 units, is equivalent to 11% of the deficit. Table 1 illustrates these findings.

The 2000 Brazilian demographic census assessed 54,2 million private domiciles, of which 44,3 million were located in urban areas, and 9.9 million in rural areas. Of the total private urban domiciles, 4,6 million, or 10,4%, were unoccupied, i.e., are vacant houses. From a strictly quantitative analysis standpoint, one could conclude that the 4.6 million vacant urban domiciles in 2000 would be sufficient to cover 72% of the national urban deficit in 2005. However, it is unknown which is the type of these domiciles and the reason why they remain vacant, despite the housing needs in these areas.

PROJECT MANAGEMENT PROCESS OF REHABILITATION: A CASE OF STUDY

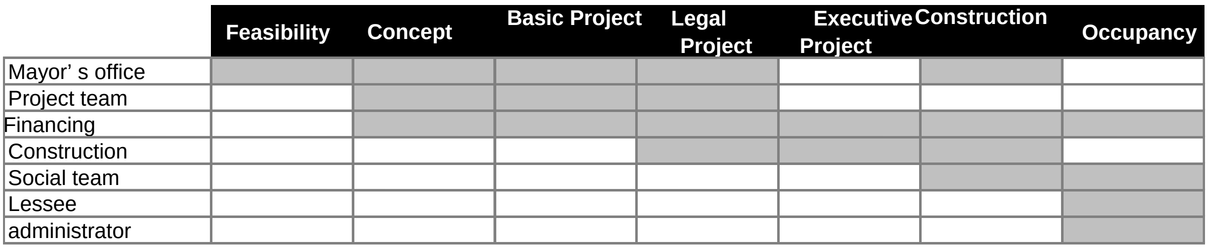
The Rio de Janeiro Mayor's Office instituted the "New Alternative Program" which carries out the rehabilitation, recovery and construction of property in urban voids, which have infrastructure and are located in the center of Rio de Janeiro. The area has urban and service infrastructure and is the Program's main focus. It also harmonizes the municipal, urban and heritage regulations, within the scope of rehabilitation and recovery projects, to render such projects feasible.

In order to ensure financial feasibility to projects within this Program, the Rio de Janeiro mayor's office is supported by the federal government Ministry of Cities' Residential Lease

Program (“Programa de Arrendamento Residencial” PAR), which is financed by the Residential Lease Fund (FAR – Fundo de Arrendamento Residencial) and implemented by CAIXA, which, for its turn, receives the applications and releases the funds to be used in each town.

In order to understand how one produces housing by using unoccupied urban property, the process was analyzed, focusing on the development phases and interfaces with the intervening agents. To illustrate this analysis, Chart 02 shows the production process, which is subdivided into several stages: feasibility, concept, basic project, legal project, executive project, implementation of the construction and occupancy. The following intervening agents are listed in this analysis: Rio de Janeiro mayor’s office – promoting agent, Project team, CAIXA – financing agent, Construction company, social team, lessee, administrator

Chart 2: Intervention of agents in each stage of the social housing production process in rehabilitated property.



Source: Adapted by CLAPER,(2008, p. 85)

As shown in the summary chart above, the design team responsible for the architectural concept does not take part in the development of the executive design. This has proven to be unsatisfactory, since the Builder quite often fails to grasp details of the design, and is placed in the predicament of making construction-related decisions without having any support from the team that originally designed the Project.

The executive design was under the Constructor’s responsibility, and underwent direct interference from the public utility companies, municipal approval and licensing authorities, and from the authorities responsible for inspecting and approving the installations as far as fire-safety was concerned

Finally, the lessee, the party with most interest in the enterprise, only participates in the final stages of the enterprise, when it is no longer possible to neither adapt the design nor change the adopted technical specifications, which may give rise to lessees’ non-satisfaction with the finished product (property) and consequently, their default of payments.

FINAL COMMENTS

The architectural projects for real estate that will undergo refurbishing seek to incorporate solutions that would adapt the older constructions to the current housing requirements. The major challenge as far as public funded housing is concerned is to provide new approaches to configure the buildings to meet these requirements with the intervention of several players such as the financing and promoting agencies, the heritage bodies and the users.

Rehabilitation of central urban areas for housing purposes requires a civil construction segment for which existing techniques and technologies are scarce , intervention in pre-existing buildings does not follow the same production process as in new buildings. Refurbishment, on this scale, entails a reorganization of the civil construction industrial process, going as far as the production of consumables, equipment and qualification of labour itself.

In this new segment, the construction logic is different from the one that applies to new buildings. The old buildings are already in a given stage of their life cycle, have a specific morphology, and have already undergone several interventions along the course of their useful life, and therefore, require adequate construction materials and procedures.

It should be stressed that the social housing in historical heritage towns is costly in comparison to new housing, due to several aspects: choice of building technique, specialized labor, purchase cost of the property, value of the land, and necessary logistics for building in the central areas of towns. Furthermore, the extent of rationalization, and consequently the productivity in enterprises of this nature are not high. This cost, however, may be offset by using the existing infrastructure in urban centers, which also becomes revitalized

Aside from the political initiatives and joint ventures between the public and private sector to develop this new civil construction segment, from a technological and technical view point, the process to rehabilitate a building requires a methodological stance whereby the plans would be coherent with the building's life cycle, intended use, building techniques and technologies, and the cultural and historical value that it represents.

Another major point is the enactment of flexible legislation that would allow for the speedy regularization of the real estate legal status, thus providing celerity to the use of the property and promoting the joint ventures between the private and public sectors to develop a new segment of civil construction.

The social function of rehabilitation in urban centers, where the driving force for inclusion is the production of housing, the complex requirements involved in the development of plans for rehabilitated buildings, the expansion of a civil construction segment aimed at rehabilitation are tents for sustained action, in the broadest sense, by a new generation of architects that will carry out their activities during the 21st century.

REFERENCES:

Bosi, V. (1986),Núcleos Históricos: recuperação e revitalização; a experiência de Olinda. In: REVISTA DO PATRIMÔNIO HISTÓRICO E ARTÍSITICO NACIONAL, n 21, p. 134-145.

Claper, J.R. (2008), Reabilitação de Edifícios para a Habitação Social: uma abordagem da gestão do conhecimento no processo de projeto. Thesis (Master's Degree in Architecture), Universidade Federal do Rio de Janeiro, Rio de Janeiro. 81-117.

Fonseca, M.C.L. (1997), O Patrimônio em processo: trajetória da política de preservação no Brasil, Rio de Janeiro, UFRJ: IPHAN.

Fundação João Pinheiro.(2006), Déficit Habitacional no Brasil 2005. Fundação João Pinheiro, Centro de Estatística e Informações:Belo Horizonte, 200p.

Maricato, E. (2001), Brasil, cidades: alternativas para a crise urbana. Rio de Janeiro: Vozes,.

______. (2005), Cidades Brasileiras: Um Balanço. Carta Maior, São Paulo, Disponível em: www.cartamaior.com.br . Acesso em: janeiro de 2007. p. 1-3.

Medeiros, A. E. A. (2004), Intervenções Modernistas e Pós-Modernistas em Sítios Históricos. In: REVISTA ELETRÔNICA PARANOÁ, vol 6, p.1- 21. Disponível em www.unb.br/fau/pos_graduacao/paranoa/paranoa.htm

Ministério das Cidades.(2004), Política Nacional de Desenvolvimento Urbano. Cadernos MCidades Desenvolvimento Urbano, n1, 7p.

Moreira, C.C. (2003), Avaliação dos Estudos de Viabilidade de Reabilitação de Imóveis de Uso Habitacional em Sítios Históricos: Recife, São Luís e Belém. Relatório Final, Caixa Econômica Federal. Rio de Janeiro. 101p.

Programa Cidade Brasil. (2006), As Ações de Reabilitação dos Centros Urbanos do Programa Cidade Brasil. In: REUNIÃO TÉCNICA NACIONAL – CAIXA & EMBAIXADA DA FRANÇA, 2006, Rio de Janeiro. Anais ... Rio de Janeiro: Cooperação Francesa/CAIXA, 1 CD.

Rolnik, R. e Balbim, R. (2006), Programa Nacional de Reabilitação de Áreas Centrais. In:SEMINÁRIO DE HABITAÇÃO E REABILITAÇÃO DE ÁREAS CENTRAIS, 2006, Rio de Janeiro, Anais ..., Rio de Janeiro 1 CD.

Silva, H. M. M. B. (2006), Relatório Consolidado. Relatório, Programa das Nações Unidas para o Desenvolvimento, PNUD, Brasília. 41p.

MAINTENANCE ON MEASURE FOR THE MONUMENTAL HERITAGE

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ABSTRACT

According to the to the European guidelines of the knowledge based society, rethinking the heritage management calls in cause the reorganisation of the activities of control, inspection, participation, through the redesign of tools and procedures. The paper deals with a heritage management model based on the integration between technologies for monitoring built environment in real time, sharing information and controlling decisions, accessing to degradated elements. Promoting the widening of the decisional approaches that subtend the maintenance participation for the monumental heritage, the paper introduces the idea of exceeding the traditional transfer of scientific disciplinary approaches from the industrial field, based on a corrective and episodic action, in order to assert a "case by case" approach. Taking into account the heritage identity characters, the paper faces with procedural difficulties due to the monumental sites complexity and the absence of information in matter of reliability and durability. Therefore, the study introduces a critical rethinking of the monumental heritage in terms of logistics, procedures of control, instrumentations, assuming the patrimony as a sort of maintenance permanent yard.

KEY WORDS: **technological transferability, information control, monitoring, immediate access tools**

MAINTENANCE ON MEASURE: AIMS, CULTURAL REFERENCES, RESEARCH METHODOLOGY

During the last twenty years, telecommunications, computer science average and electronics, thanks to the digital technology, have begun to converge, radically changing the operative context where companies and operators used to move, and coming to the definition of integrated services systems. The Information and Communication Technology continuous progress has involved many productive fields, associated by the search of flexibility and efficiency. Referring to built heritage protection, technological innovations, till now, have been relegated only to activities connected with the decisions taking, the lawsuits organization, the costs optimization. Assuming as scientific basis Ruskin's idea of "continuous care"[1] for monumental heritage, a multidisciplinary research group[2] has been investigating the opportunities of applying new technologies integrating the traditionally separated management procedures related to information- decision- intervention. The research has been pursuing the creation of a structured relation between the diagnostic and the conservation process actors with the maintenance technicians supported by heritage knowledge plans, monitoring technologies, yard tools.
Widening scientific competences and technologies to monumental heritage life cycle control, has been at the basis for the prefiguration of a maintenance plan on demand and a new idea of monitoring procedures. Moving from a new scientific approach to built heritage management,

[1] In 1849 Ruskin wrote: "The principle of modern times.....is to neglect buildings first and to restore them afterwards. Take proper care of your monuments and you will not need to restore them."
[2] The paper refers to a research experience on built patrimony maintenance tools and strategies, relised within the Università degli Studi di Napoli, Architecture Faculty and the Research Consortium Corited, Consorzio Nazionale di Ricerca e Formazione sulla Tecnologia per la Costruzione e la Salvaguardia delle Strutture Edilizie since 1998
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conceived as an “ex ante” strategy, the research investigated and validated appropriate technologies, apt to support the degradation survey and the maintenance operations re-organisation.
Referring to the maintenance culture, the search has been facing the scientific approaches’ evolutions, taking into account the slow passages from an industrial vision to evolute principles devoted to built patrimony. Starting from the idea of maintenance advanced at the beginning of the '90s, within the Italian National Agency of Unification (UNI), as the combination of technical and administrative actions, the cultural approach has been extended to the character of service, signed by an organizational and procedural order[3]. Monumental heritage maintenance has been conceived as a system of activities that are exercised from organizations with the aim of integrating structured information, technical know-how, strategic abilities and management qualities[4]. A unitary control and forecast strategy able to guarantee performances levels in a satisfactory relationship with requirements is the cultural approach to the concept of maintenance on demand, pursued by the research team. This issue has been related to the European Communitarian Politics for the next decade, promoting scientific innovation through "... new methods of production, supplying and distribution; the introduction of changes in the management, the organization and the conditions of job, in the qualifications of the workers ". According to the European guidelines of the knowledge based society, rethinking the heritage management calls in cause the reorganisation of the activities of control, inspection, participation, through the redesign of tools and procedures
Within these cultural references, the proposal of heritage management technologies has been conceived as a processes’ transfer. Assuming heritage as a permanent yard in terms of maintenance, elements’ efficiency and durability has been remitted to state conditions monitoring on measure planning. Hardware and software technological transferability from the industrial production to heritage rehabilitation has been investigated with special attention for the “non-structured” characters that sign built environment, rethinking about working procedures, operators, working times. On a methodological point of view, the research has been following an experimental approach, being structured in three phases:

- Phase 1 - current state of maintenance processes in practice and research, and the impact of new tool on the traditional processes. This phase had an exploratory character and dealt with the definition of a maintenance coordination service;
- Phase 2 - monitoring nets for built heritage state conditions diagnosis. This phase was carried out with the help of a pilot site, the ancient tower of Conca dei Marini, where several monitoring tools were tested in order to verify the possibility of integrating data;
- Phase 3 – immediate access technologies for maintenance yards. This phase lead to the outlining of yard requirements, their transposition into segmented design scenarios, and final realisation of a maintenance yard prototype.

MONUMENTAL HERITAGE COORDINATION SERVICES

According to the Italian Code of the Cultural Assets and Landscape (D.L. 22.1.2004), a monuments management model has been proposed, working on the requirements of built heritage identity and functionality preservation. The maintenance coordination service has

[3] Such passage is explained in the Dlgs. 157/1995 in performance of Directive 92/50/CEE in matter of public contracts and in the Norm UNI EN ISO 9001 of 2000

[4] In the Italianl panorama, the Norm UNI 10604 (Criteria of planning, management and control of the services of maintenance of pieces for real estate) of 1996, refers to the field of the building the objective of the maintenance of real estate, maintaining the patrimonial value and the performances within acceptable limits for all the life cycles

been conceived as a flexible structure able to manage on demand the information and decision processes related to built patrimony. Its specificity relies in the integration between built system knowledge maps - defined for each specific monument decomposing it into technical elements and devices - the specific monitoring of sensitive elements supported by a not invasive sensor net. A decision system integrates the degradation relief technologies with the decision taking procedures and launches the maintenance interventions with the help of immediate access tools.

Taking into account the monumental heritage characters of identity, the search faces maintenance procedural difficulties, tied to the elements complexity and the absence of information in terms of reliability and durability. The search introduces a critical reproposition for heritage interested by maintenance, in terms of logistics, procedures of control, tools, based on the idea that monuments can be assumed as permanent yards, thanks to the installation of sensors multilevel for the acquisition and the transmission of data related to the state conditions.

The service is conceived like a cross-sectional structure between the Agencies for heritage protection (Ministry, Regions, Supervising, Common...), strategic occasion of centralization of human resources, financial institutions, and materials. The coordination service is able to integrate structured information, technical know-how, strategic and management abilities and to guarantee prefixed quality. The determination of dialogue and concertation modalities between heritage management and protection Agencies is assumed as the priority request that informs the service. The service is involved in the acquisition of the out coming data from the sensors local net, and in the elaboration of the maintenance plan on measure for each singular element on the basis of the monitored data. The service is able to:

- put to point a process of monitoring and diagnostic, recording all the sensitive data necessary in order to acquire a degree of meaningful acquaintance of the state of conservation of the good;
- acquire and elaborate the information emitted from the system of sensors distributed, in real time;
- manage through data banks integrated the situated information on heritage;
- identify the risks evolution emerged from the monitoring;
- characterize the priorities and the modalities of the maintenance participation to short and medium period;
- activate protocols of communication between protection agencies, so as to avoid conflicts.

MONITORING TECHNOLOGIES

Monitoring and diagnosing heritage state conditions, is assumed as a fundamental activity for the maintenance processes. The possibility of adopting not invasive technologies is at the basis of the research experience that has been prefiguring the opportunities of widening the maintenance market.

In the field of monumental diagnostics and measurement, technologies are currently used for very sophisticated investigation that was until a few years ago entirely unknown. There are still huge problems on management of information and methods to apply to this new generation of techniques and tools. While in the fields of measurement of the industrial production, particularly in the aerospace, automotive and energy, there are now solid consolidated criteria and methods, in the area of monumental buildings these technologies are still used in a trial and not very efficient way. In details, the research has been working with non-invasive diagnostics sensors, integrating laser technologies, with optical fibers sensors,

uncooled thermal sensors, thermocameras, and georadars. These have been chosen for their attitude in monitoring structures and materials at a distance and without the need to take samples. These technologies not only provide non-destructive test, but also guarantee the absolute lack of contact with built objects. The possibility of creating a monitoring net has been investigated with the aim of structuring a not invasive relief map, according to protocol guides defined for the specific situations of degradation. The research team has been facing problems related to heterogeneous data management collected by different technician with very several criteria, in different moments. Information organisation and correlation has been faced with the help of "multi-channel" technologies.
A pilot case study has been assumed in Conca dei Marini (Figure 1), with the aim of matching together the scientific results of different technologies and coming to not invasive monitoring protocols.

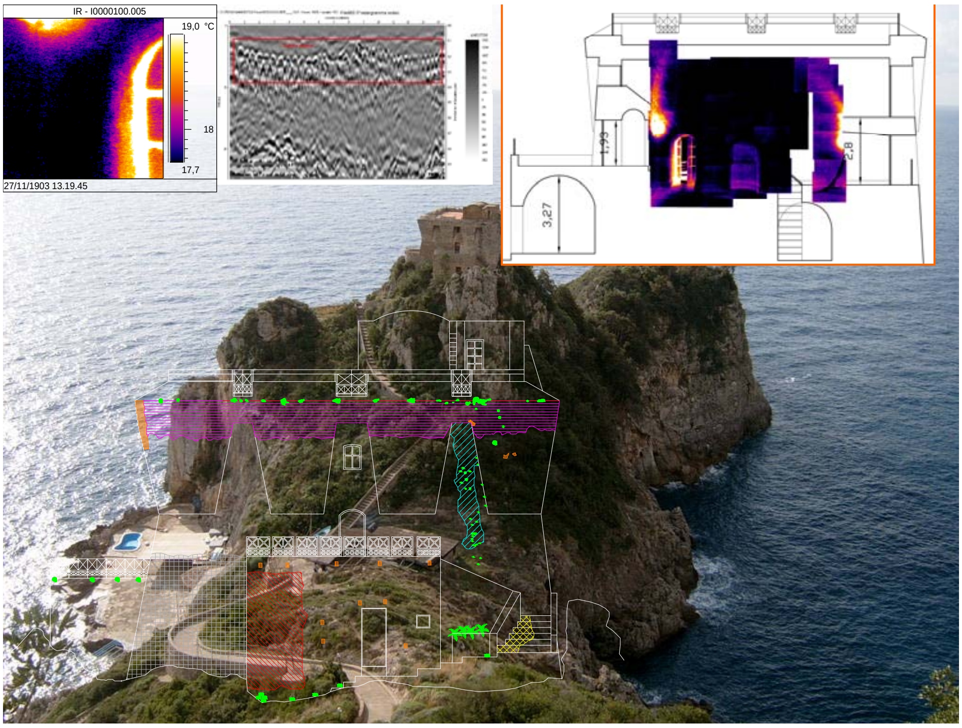

Figure 1: Case study in Conca dei Marini

MAINTENANCE IMMEDIATE ACCESS YARD PROTOTYPE

Improving technologies integration in built environment management is the aim of this phase of the research that dealt with the design of a “vertical yard” dedicated to immediate maintenance on demand. According to European policies for the next ten years (2000-2010), the heritage yard innovation was pursued through technologies transfer, analysing, planning and testing their suitability to built environment. Rethinking built heritage maintenance yard in terms of logistics and kinematics has been assumed as the opportunity for exploring the technological transfer of devices to a “non-structured environment”, rethinking working procedures, operators, and times. On a methodological point of view, the research has been structured as it follows: requirement and needs analysis, definition of technological solutions, critical appraisal of the impact induced. Implementing dedicated technologies for the maintenance yards has been managed with the definition of built environment spaces and dimensions, taking into account emergency conditions, equipments, services. The research allowed the definition of new uses for existing mechanical and electronical devices through links and communication systems. Several cases study have been taken as relevant reference for defining the following design requirements and constraints: safety and security, quickness, environmental quality, obstruction containment, easy assembling and disassembling, portability, flexibility, expandability, reliability. Remote control solutions support the prototype and have been prefigured with the help of mechanic and electronic engineers, architects, computer programmers. On a mechanical point of view the maintenance tools are conceived with a Cartesian geometry, supported by a climbing work platform. The prototype has a control unit able to manage several axes in a continuous and interpolated way. This is the main part of the system, and is connected with the decision support system of the coordination service. Specific software governs the mechanical system and interacts with the images collected by several cameras arranged along the axes. Siemens, Italdata, Alimac, Promec are the companies that cooperated for the prototype. Functionality and usability tests have been realized on built environment.

Figure 2: maintenance permanent yard prototype

CONCLUSIONS

The research experience has been dealing with the strategic Agenda for the European search, Vision 2030, Focus Cultural Heritage, that asks the scientific community to promote the development of the appraisal techniques and control foretell of the cultural heritage. At the same time, the Italian Technological Platform has been taken into account for its attitude in the Areas of search like the "appraisal of the emergency, monitoring and diagnosis, that is, integration of new diagnostic technologies for the structures, monitoring and study of the historical buildings in the processes of safeguard and management in the long term". According to the priorities of the Italian Technological Platform, the research team has been working for the: “development of strategies of preventive conservation based on the monitoring and the use of not destructive techniques in order to promote the monumental heritage maintenance, arranged with the execution of small participations during the inspection under the supervision of competent staff; creation of standardized procedures and of criteria for the development of structural appraisals; integration of a management approach and efficient maintenance". In this way final results can be lead back to the definition of procedures, tools and methods for diagnostic in real time and maintenance planning. Reason of specific interest of the final result is the creation of a synergy between fields that have been developing in separated way, thanks to the ICT in order to promote a radical change for the context within which, agencies, enterprises and single individuals, are found to operate. The maintenance coordination service is supposed to be a fundamental opportunity for facing the technological challenges related to the prefiguration of innovative strategies of conservation of the monumental heritage at the architectonic and environmental scales. The predisposition of a net of monitoring for the control of the state conditions, transforms the monumental heritage into a connected system, equipped of sensibility, intelligent, reactive, guaranteeing very low costs to control. A decisional support system helps the maintenance coordination service in the definition of intervention thresholds and introduces acceptability levels.

REFERENCES

Arbizzani E. (1991), Manutenzione e gestione degli edifici complessi. Requisiti, strumentazioni e tecnologie, Hoepli Editore, Milano

Barret P.,(1998), Facilities management, Butterworth, London,

Cantone F., Viola S., (2002), Governare le trasformazioni. Un progetto per le corti di Ortigia in Siracusa, Guida, Napoli

Caterina G., Castagneto F., De Joanna P., De Medici S., Fiore V., Scarcia L., (2000), "Information tools for built asset management in Italy", in AA.VV., Facilities management and maintenance CIB W70 Congress 2000, Brisbane Symposium, 15 - 17 November

Fiore V., De Joanna P., (2002), Urban Maintenance as strategy for sustainable development, Atti del convegno internazionale, Liguori, Napoli

Viola S., (2004), Innovazione e recupero edilizio, Il cantiere verticale, NAPOLI, Luciano Editore, 2004.

RECOVERY OF BUILT HERITAGE IN NINETEENTH CENTURY ARCHITECTURE. FRAGAPANE PALACE IN GRAMMICHELE (CT)

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ABSTRACT

The scientific beginnings of the proposed research theme is the concept of ‘recovery and maintenance of a building’, seen as a possible area of application of operation repeatable methodologies, mediating between conservation and transformation. In fact the built heritage, often compromised by the absence of recovery and maintenance actions, is a complex system that can hardly justify project choice. The research seeks to find an operational method in which emerge the criteria that lead to operation choices. The approach is based on data obtained from a technological and historical survey and investigation necessary to understand the object in its specific worthiness and transformations. The achieved method is applicable on the nineteenth-century-building through a multidisciplinary process of recovery, coherent with the buildings, with its history, its shape, its technology, and with the other cultural and social factors involved.

KEYWORDS: knowledge, diagnosis, technology, history.

INTRODUCTION

The existing built, that is the architecture of the past in general, is visible matter and produces information related to the reason why it was raised, its constructive character, its cultural values. The history and the long past that mark Italy have manufactured architectures of every kind, tangible sign of domination, of cultural and technological evolution, of cultural, political and social events. These assets are numerous in our cities and deserve to be recovered. The recovery project is, by definition, a set of procedures, decisions and actions, applied to any settlement, directed to seize latent potentiality by the pre-existing assets and able to preserve them for the future. "Recovery is saying again what has already been said, unwinding that first wound (…) The category of recovery becomes an exceptional opportunity to rethink the whole process of architectural creation" (Benvenuto, 1984).

The operation of recovery implies the knowledge of the subject on which it wants to intervene, identifying his characteristics and qualities, to understand his behaviour and stop phenomena of physical degradation and functional obsolescence, after having identified the causes through diagnosis. In this sense, the diagnosis is understood as an analytical judgment on the conditions of a building or some of its parts, subject not only to the inexorable passage of time and work of disruptive weather, but also to the inconsiderate action of man that often creates unfavourable conditions to the preservation of buildings. Any decision to take and action to perform may not necessarily cover the whole building, but its shares and the operation could provide long operating times and diluted over time; so to think of the recovery project as an open and flexible project is essential (Gasparoli et al., 2006). In this context, it is highlighted the multidisciplinary process of recovery; the issues at stake have to compare the contributions of the other disciplines and to establish a dialogue whose purpose is to build an information system as a basis for defining intervention guidelines. In other words it is necessary to recover coherently with the buildings, with its history, its shape, its technology, and with the other cultural and social factors involved.

The aim of the research is to achieve a method for the recovery of nineteenth-century-buildings, like Fragapane palace, subject of this study. Through analysis led to the building is possible to elaborate information about its historical evolution, its material and construction features and possible changes that have involved, in order to guide the intervention choices about what transform and what preserve to safeguard the quality of building.

THE CASE STUDY

Fragapane palace is by the famous hexagonal Carlo Maria Carafa square in Grammichele, occupying the block on the corner of Vittorio Emanuele street. It was commissioned by the Fragapane family, to be purchased (2005?) by the Regional Province of Catania and then sold on loan of free use to the municipality in recent times. The building mirrors the architectural culture of the time, showing a revisionism typical of the period. It was built in 1877 by the designs of the architect Carlo Sada, although the watercolours owned by the Fragapane family, donated by Sada, carry the signature of the engineer Cantarella.
The building, typological recognizable as a bourgeois building, has two elevations in bearing walls. The articulation of space is symmetrical and regular with vaulted rooms. The facades, covered with limestone and with lava stone basement, are marked by pilasters and openings with carved jambs and frames alternately in gable and camber arch.

THE METHOD

The stage of knowledge is fundamental in the recovery project. It is the source of all information that the operator should input into the system to find the operational solutions. The subject of this study, Fragapane palace, was analyzed by several points of view: the historical, technological and structural knowledge. In particular historical knowledge was explicit in *historiography published texts*, and through archival research at public and private structures. To facilitate the difficult task, schemes and filings are used to compare the results obtained. The technological knowledge has taken into account the study of geometries and morphologies of the building, its survey, the analysis of the relationship between the parts, the constructive characters, the materials and their preservation, and has also defined the state of deterioration of the external surfaces. It ultimately shapes the *structural grid*. The area of knowledge structure, closely related to the technology one, is made explicit through the happened structural movements and visible damage (Cantone et al., 2006a).

The recovery project has to be able not only to identify the uniqueness of the analyzed asset, but also to ensure the integration between the new scenarios and the pre-existing buildings through the control of the conservation/transformation process. Hence the recovery project defines a system of constraints intended as a force that is opposed to transformation. The stronger is the constraint, the lesser is the space for transformation and the more is the weight of conservation. The constraints are therefore intended as prominent characters that must be maintained, but also as a potential development that suggests the possibility of modification of the building (Cantone et al., 2006b).

At last, it is necessary to compare findings with the existing building types. This stage produces further indications of operation for the safeguard of typological original conformation. The drafting of guidelines for the recovery of the nineteenth-century-buildings comes then from the identification of constraints to the transformation, from their comparison with the typological relevant elements, in order to identify shares to be modified, parts to be conserved and application methods. In this discussion, for the sake of brevity, we exemplify only information about the historical and technological analysis of building.

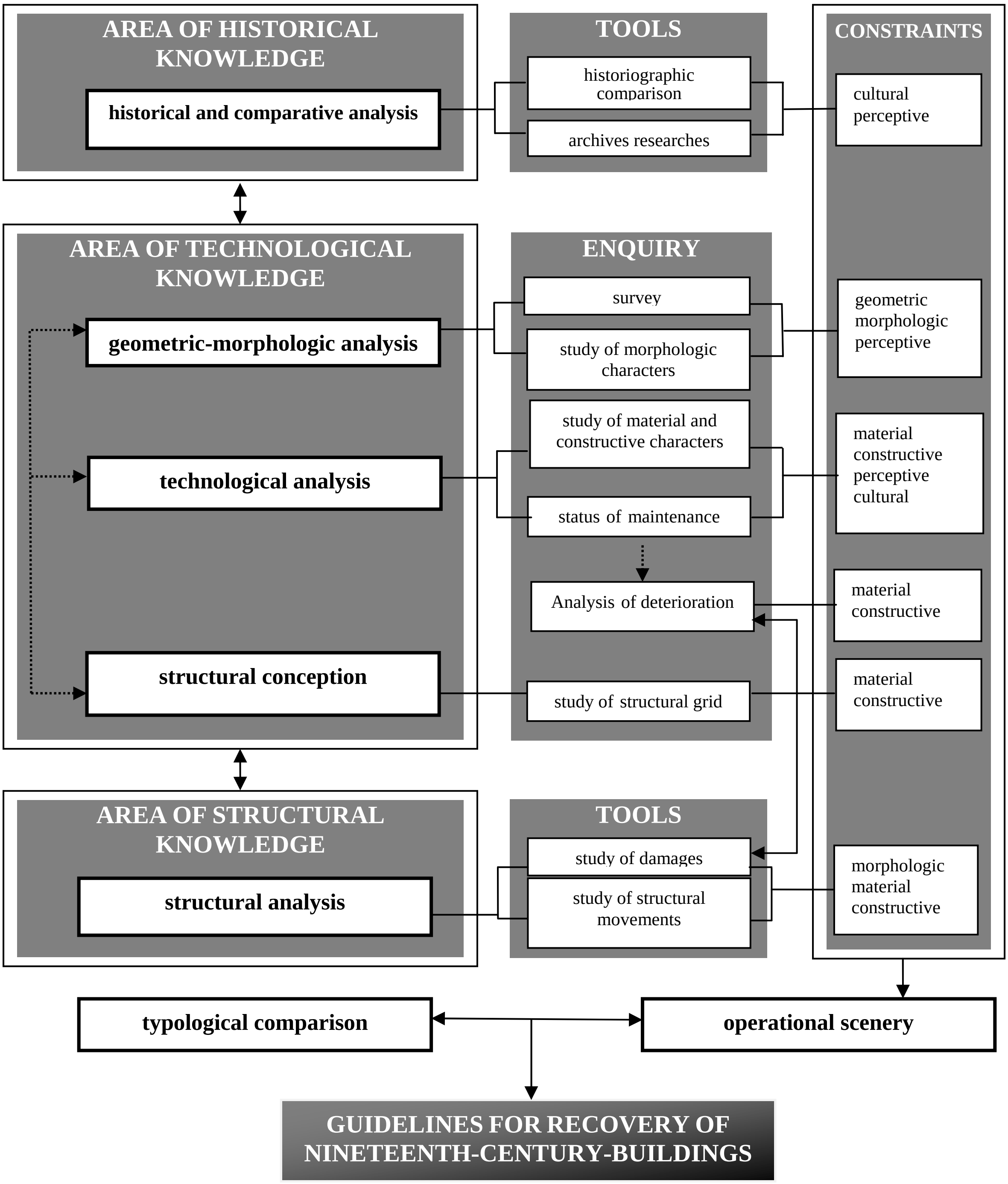

Figure 1. Operational methodology

The historical and comparative analysis

Carlo Sada (Milan 1849-Catania 1924) is called in Sicily in 1873 by the architect Andrea Scala, to cooperate to the design of the Politeama theatre of Catania; this opportunity gave him such reputation among aristocrats and upper bourgeois of Catania, to promote numerous professional appointments, as it is documented in the vast *Sada Fund*, which contains nearly

2000 designs. The success obtained in forty years, arrived up to Syracuse, Ragusa, Reggio Calabria, Malta and even in Russia and Brazil. Sada also operated in Grammichele, making the Town Hall (Project 1893-opening in April 1899), and then winning other appointments: the completion of the facade of the mother-church dedicated to St. Michele the Archangel (1899), the construction of the Coniglione house (1900) and the construction of the Fragapane palace (1877? / 1898-1900?) subject of this research.

Figure 2. Photo of the Fragapane palace and survey of the facade on Vittorio Emanuele street

The story about the construction of the building is rather confused. No documents confirming the year of the appointment have been found, oral sources passed down by the owners of the building testify the will to entrust the project of their residence to the architect Carlo Sada, because enthusiast by the outcome of the Town Hall, built between 1897 and 1899 (the dates were obtained from archival documents). But the two watercolour on the project show a chronology rather incongruous: September 1877. This date seems instead coherent with the contemporary production of the architect: by making a stylistic-typological comparison with residential architecture, produced by Sada in Catania between 1875 and 1880, such as Libertini palace, once Paternò of Raddusa palace of 1875-79, or Polino house of 1877, Baron Cantarella house of 1877, there is a common desire to propose again the Neo-Renaissance palace’s type, with base accentuated by bosses, rhythmic scansion modulated by pilasters and bossy cantonal, and typical formal elements such as the alternating gable-camber arch in coronas of openings on the noble floor. A layout rather austere, if compared to the formal results of the following period, or to more important works, such as those made for public commissions. But then, why do the owners refer to a building of the late '90s of the nineteenth century, if the project indicates 1877? Maybe the heirs, mixing dates and facts, appointed Sada in a moment of still emerging notoriety (1873-78), or the architect, not much involved by the appointment and very busy by commitments that led him everywhere, decided to take inspiration from existing studies and drawings, making marginal changes. The story becomes further complicated by the fact that when analyzing the two drawings the signature of Sada is not found, but that of a collaborator, Giuseppe Cantarella. A similar ambiguity was presented for Libertini palace in Catania, signed by Cantarella; resolved in 1978 with the attribution to Sada, definitively confirmed with the discovery of autograph drawings of the project within the Fund.

This event allows us to clarify some new aspects of the new architectural practice of Carlo Sada: a man very professionally busy, who in some circumstances - so far only two established – used the aids to such an extent to give their projects his signature and the direction of the work. However it is presumed that a careful and meticulous preparatory study was at the base, perhaps with preliminary original sketches or drawings.

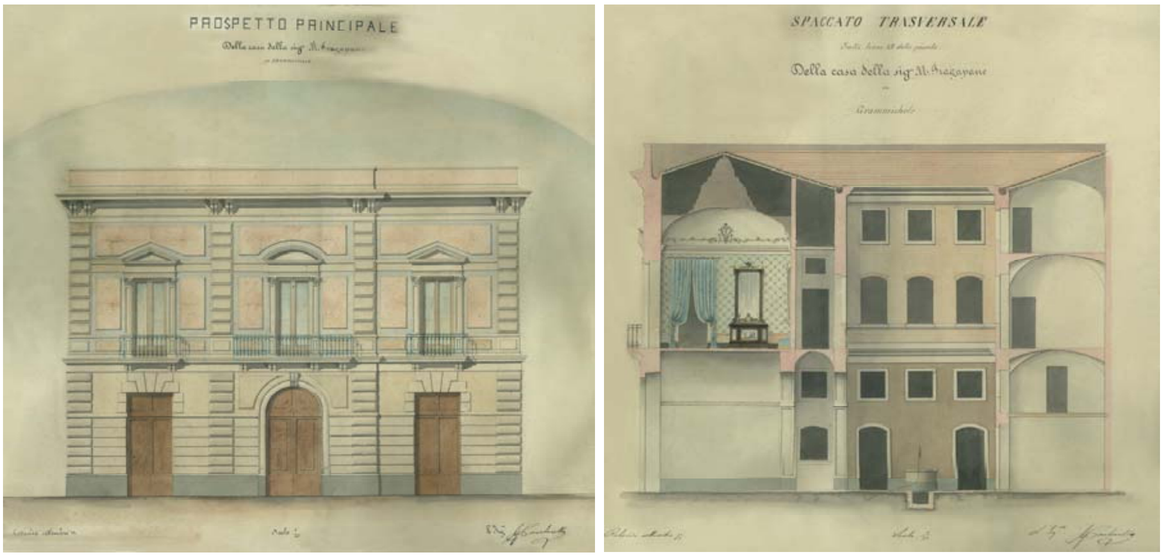

Figure 3. G. Cantarella (C. Sada?), Main facade of Mrs M. Fragapane house in Grammichele, Catania, September 1877, Indian ink pencil and watercolour on paper, scale 1:50, mm 480x 630, graphic field mm 292 x 400.
G. Cantarella (C. Sada?), Transversal section plane on the line A-B of the plan of Mrs M. Fragapane house in Grammichele", Catania, September 1877, Indian ink pencil and watercolour on paper, scale 1:50, mm 485x 620, graphic field mm 293 x 370.

Technological analysis

The study has examined the most significant technical elements, walls, vaults, roofs, stairs and fixtures, identifying the different types and constructive lexicon, the materials and the transformations suffered over time.

The elevation structures of Fragapane palace consist of bearing rubble-filled walls, with variable thickness from cm 20 until cm 130. The main facades have a ashlar cladding. Limestone is the used material, which is used for both structural and decorative parts. There are thin internal partitions, between cm 20 and 30, which consists of limestone slabs, placed in a sheet and tied with mortar.
The used building techniques are readable by the facades: the stone rustic and boasted ashlars of various sizes, are placed tip and band in regular courses, with medium and small elements such as shelf (lava stone and pieces of tiles) and filling of the cavity wall.
The vaults of the ground floor are cross or barrel vaults, covered with plaster, without decorations. The first plan has thin sectioned cloister vault, casting made with rockfill and mortar. These vaults are decorated, but partially cracked and damaged.
The roofs were technologically analyzed on the basis of their geometry, materials with which they are built and technical realization. The most common type is with the single pitched and double frame, with the main beam horizontally placed and inclined according to the slope purlins, the roof covering consists of tiles, the layer under the covering consists in wood boarding.

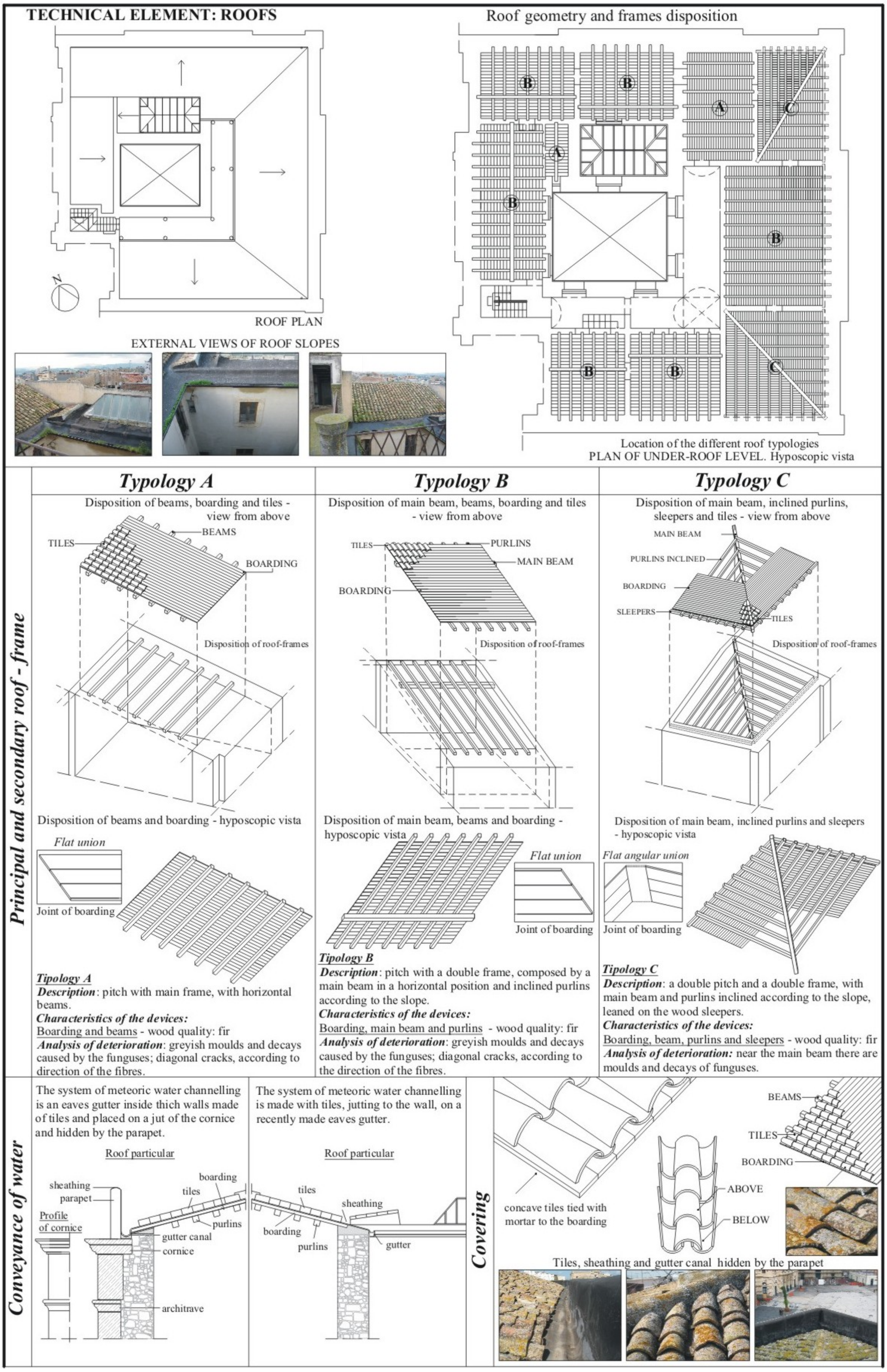

Figure 4. Scheme on the roofs

The system of meteoric water channelling has two different solutions: the first is an eaves gutter inside thick walls made of tiles and placed on a jut of the cornice and hidden by the parapet; the second is made with tiles, jutting to the wall, on a recently made eaves gutter.
The main staircase is made up of neck-goose vaults that support the ramps and the landings. At the ground floor the ramps are supported by pillars with brackets and decorated capitals or by partition walls, with plastered finish and stucco.
The fixtures are made of wood and are made up of a false frame, a fixed frame anchored to the wall, a mobile frame connected to the one fixed by hinges, and a dimming system connected to the fixed frame also with hinges. The glass shutter and the dimming are usually with two leafs, with the exception of the greatest fixtures, that have the dimming with three leafs, and of smaller interior doors, with one leaf.

A good part of the analyzed technical elements has damage of various intensity. Some fixtures require additions, the roofs have shortcomings of proofing. This is reflected in the walls with infiltration and mould. Some openings at the first floor have apparent lesions and yielding architraves.
Here a scheme on the roofs (Figure 4) is produced as examples.

CONCLUSIONS

The recovery operation, applied on nineteenth-century-buildings, must result from a balanced connection conservation/transformation. If once the indifference towards common buildings had led to drastic operations on the structure and to the maintenance only of the outside, today the recovery operations are more sensitive to the preservation of the building and even to its recovery in functional and formal terms.

The systematization of the information collected and the identification of the transformation constraints led to the following needs:

- to exploit nineteenth-century-buildings which strongly characterizes the Italian and Sicilian cities;
- to preserve the morphology and architectural composition of the building and the facade;
- to identify compositional schemes to make in relation to existing and future functions;
- to intervene with clearly distinguishable techniques from existing ones, possibly adopting reversibility criteria;
- to identify clear processing constraints that direct operations recovery towards conservation.

Here guidelines for the recovery were identified, applicable to nineteenth bourgeois buildings, in urban contexts. The recovery operations, in particular for the study case, must point to the safeguard of historical and material identity of the building and of his symbolic, cultural and social importance, even if a change of destination use is provided.

ACKNOWLEDGEMENTS

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Fragapane palace in Grammichele, tutor arch. F. Cantone, at the Faculty of Architecture in Siracusa, Italy, academic year 2007-2008.

REFERENCES

Caterina, G. and De Joanna, P. (2007), Il Real Albergo de'Poveri di Napoli. La conoscenza del costruito per una strategia di riuso, Liguori, Napoli.

Di Battista, V. (2006), Ambiente Costruito. Un secondo paradigma, Alinea, Firenze.

Cantone, F., De Medici, S. and Senia C. (2006), Reuse strategies for sicilian architecture: the case of the "masseria Maucini", Proceedings of Trondheim International Symposium: Changing user demands on buildings. Needs for lifecycle planning and management. CIB W70. Trondheim, Norway.

Cantone, F. and Reale, G. (2006), Criteri di valutazione degli elementi tecnologici e costruttivi ai fini del recupero. Il caso del palazzo Beneventano a Lentini (sr),in Astrua F., Caldera C., Polverino F. (a cura di), Intervenire sul patrimonio edilizio: cultura e tecnica, Celid, Torino, november. pp. 555-564.

Gasparoli, P. and Talamo, C. (2006), Manutenzione e recupero. Criteri, metodi e strategie per l'intervento sul costruito, Alinea Editrice, Firenze.

Cantone, F. and Viola, S. (2002), Governare le trasformazioni, Guida Editore, Napoli**.**

Giuffrè, A. (2000), Sicurezza e conservazione dei centri storici. Il caso Ortigia, Laterza, Bari.

Dato Toscano, Z., Imbrosciano, F. and Rodonò, U. (1996), I disegni del Fondo Sada delle Biblioteche riunite Civica e A. Ursino Recupero di Catania, vol. I –II, Soprintendenza per i Beni Culturali e Ambientali, Sezione per i beni bibliografici, Catania.

Benvenuto, E. (1984), Del recupero: la parola e la cosa, in Recuperare Edilizia, Design, Impianti, anno 3, n°11 maggio-giugno.

Marino, A. (1980), Grammichele, in Storia dell'arte italiana, vol. VIII, Einaudi, Torino.

Editorial (1978), L'autore del palazzo Libertini, in La Sicilia, September.

Succession will, registered on 25.06.1942 at n.n. 14426/11584, Conservatoria of Catania.

Succession statement n. 1, vol. 676, submitted on 16.05.1942, "Ufficio del Registro" of Caltagirone.

Fund OO.PP., b. 80, f. 162.d, Town Archive of Grammichele.

Fund OO.PP., XIX. I., b. 23, f. 2108.c, Town Archive of Grammichele.

COMPUTER-AIDED FACILITIES MANAGEMENT (CAFM) OF INTELLIGENT BUILDINGS: CONCEPTS AND OPPORTUNITIES

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ABSTRACT

Computer aided facilities management (CAFM) systems are increasingly being utilised in facilities management. These systems may be database oriented, computer aided design oriented or independent of either as a web based system. CAFM systems are becoming synonymous with the concept of intelligent buildings (IB) which generally use a centralised monitoring and control system for building services. Such centralised data of intelligent buildings are being integrated with computer aided facilities management. The data itself needed to conform to a format standard such as common arrangement work section such as Integrated Database Background (IDB). Open standards and systems that conform to such IDB make it possible for systems to be integrated. In this paper Definitions of IB are investigated and some definitions embracing this open to effective change were polled using a questionnaire survey. The survey further investigated the extension of CAFM to intelligent buildings concepts and the opportunities that such integrated systems will provide to FM professionals. The results showed variation in the understanding of the concept of IB and the application of CAFM. The survey showed that 46% of respondents use CAFM system with majority agreeing on the potential of CAFM in delivery of effective facilities. However, following the many definitions of an intelligent building does not necessarily lead to technologies of equipment that conform to an open standard. This open standard and documentation of systems produced by vendors is the key to integrating CAFM with other building management systems (BMS) and further harnessing the application of CAFM for intelligent buildings.

KEYWORDS: CAFM, Intelligent Buildings, Integrated Building Management Systems, Information Technologies.

INTRODUCTION

This implementation of information and communication technology is rapidly being deployed in Facilities Management (FM) to enable meeting human needs. Facilities Management Systems, are types of Information Technology systems (IT) providing the buildings, and more specifically designed Intelligent Buildings Management Systems (IBMS), with management system. The incorporation of intelligence by IT is making the facilities management much more innovative than the conventional FM. There are various researches undertaken to develop an intelligent building platform integrating Building Management Systems (BMS) and Facilities Management Systems (FMS) on local area networks as well as exploiting the World Wide Web (internet). IB integrates sensor and monitoring devices. This is enabled by data transmission through telephone lines, fibre optic cable or satellite uplinks. The data management systems that utilise process control and data communication to their best advantage are generically known as intelligent buildings (Clifford *et al.* 2007).

It is apparent that there is no one unified definition for IB concept (Himanen 2004). The only characteristic that all intelligent buildings have in common is a structured design to accommodate change in a convenient, cost-effective manner (Himanen 2003). There are no open system standards that are essential for IB and the implementation of CAFM to effectively manage the systems. There is a difference in the definition of the intelligent building and the intelligent building concept.

It is difficult to define intelligence in Buildings but easier to describe it. A suggestion is made of an approach to describe for the use of computing, communication and control systems in construction to make lives easier, productive and procure an environment that is conducive to work and leisure. Other intelligent building concepts inculcate energy efficiency, security and communication. Some definitions dwell on the energy conservation measures of the building. This view tends to slant towards green buildings definition.

Himanen (2003) points out 'There is no scientific definition available for the factors of the IB concepts. They are keywords, which describe common knowledge about intelligent building. The IB concept has not included the factor of intelligence according to Himanen (2003). The question of considering a building intelligent can be thought of in two different ways:

Firstly; building intelligence effectiveness. This is a measurement for the existence of building intelligence. The effectiveness comes from successful integration of the systems and control. There are features of intelligent buildings that become effective to numerous conditions encountered. Effectiveness from control can be implemented by a multiple agent system deploying information and communication technologies. Secondly; intelligent buildings built according to the intelligent buildings concepts. IB concept parameters such as: Life cycle costing, marketability, the adaptability to change and the wide range of service providers enhances marketability, working efficiency in meeting the purpose of the user so that equipment working efficiency is maintained with facilities management strategies and service-orientation, image of high technology, photovoltaic, structured cabling, information technology, productivity and construction process and structure, etc (Himanen 2004)

The complexity of understanding the concept of IB and its relation to CAFM is further exacerbated by finding an agreeable definition for FM. Facilities management like intelligent buildings is new and lacks a unified definition. This paper while raising the issues of myriad definitions for various concepts in FM, does not try to establish a unified facilities management definition for FM nor IB. The reasons for FM to effectively manage depend on delivery of contractual obligations when outsourcing. The maintenance strategy for this purpose, the use and selection of the CAFM system all contribute to such an end. This outsourcing service can be a bundle of services and total facilities management. A reason to have optimised use of CAFM software is so that it can automate a bundle of services.

The Intelligent Building Management System is separate from or integrated with the CAFM system. There are various developments on the IB platform including integration on projects. The building management system would communicate with the CAFM system e.g. to generate work orders or report alarms. The Intelligent Building Management System is about the building controls being all accessible from a common user interface, from which planning tasks as to routes through the building and action tasks such as calling the lift can be implemented. The software task is where the CAFM system is integrated with the IBMS in managing of massive event reporting. This is accomplished by creating a data base that contains statistical information about the property ranging from general floor area to office space of specific individuals located in the building. Some Computer aided facilities management systems (CAFM) include asset registers and a separate database integrated with the CAFM.

Both Himanen (2003) and Finch (2004) made reference to a correlation being made with intelligent buildings and value contribution in that some building made clear and distinctive statements about its organisation creating a brand. But branding has been maligned for producing inefficient and costly buildings (Finch 2004). This is where facilities management comes into play in the strategic management of non-core activities relating people, process and place. The appropriate strategic management would ensure the provision of space at the lowest cost and occupation at the highest density.

Finley *et al* (1991.) presents a generic definition of the concept of intelligent building: An intelligent building is a single building or a complex of buildings which offers a coherent set of facilities to both the building managers and to the occupants (tenants). Unlike Himanen (2003), Finley *et al* (1991.) do not use convenient mathematical formulae to capture the goal of intelligent buildings (Finley *et al.* 1991). It is argued that FM professionals are just beginning to acquire an understanding of the multi-facet factors involved in creating ergonomic work, recreation, and living environments. There should be a whole new rethinking of what a facility and services provided are, how it should be acclimatized and illuminated and the kind of furniture needed.

CAFM AS A CONTRIBUTING FACTOR TO THE BUILDINGS BEING INTELLIGENT

Computer-Aided Facilities Management (CAFM) are tools for organising and managing various activities within the facilities assets such as; client contract whereby the client is aware of the equipment, locations and services catered for; material, stock, purchases and equipment replaced for repairs; procurement, the subcontractors service and management; service, the services rendered in accordance to service level agreement and other reactive maintenance; work history carried out on equipment; and the strategy used to manage the assets with the engineering instructions to do so at a schedule. CAFM ranges from a simple space management tool to a range of applications (Keller and Keller 2004) such as: maintenance & operations, facility budgeting & accounting, construction & project management, space inventory & management, architectural & interior planning, space forecasting, telecommunications and cable management, lease & property management, and furniture & equipment management.

The application of CAFM is becoming synonymous with the concept of intelligent buildings. Like any other social phenomenon, an intelligent building (IB) as a concept has various meanings articulated in various constituencies of interests and profession (Elmualim *et al.* 2006) and hence open to facets of interpretations. It is argued that IB as a concept is better described by listing criteria for building quality (solutions) rather than by a list of high-tech installation (Himanen, 2004). Himanen (2003) definition of IB has not included the factor of intelligence. Contrary to Himanen's (2003), intelligent is the word for having mental ability. In IB this mental ability is replaced with software agents such as CAFM, which give buildings the ability to make decisions through a fuzzy logic controller. The fuzzy logic controller (FLC) based on fuzzy logic provide a mean of converting a linguistic control strategy based on expert knowledge into an automatic control strategy.

A new wave of intelligent systems began to dominate the office buildings with the introduction of structured cabling. An intelligent building is one which has an information communication, network through two or more of its services systems. It is automatically controlled, guided by predictions based upon knowledge of the building and usage maintained through an integrated data base (Wong *et al.* 2005).

CAFM systems are commonly database oriented systems with knowledge of the building which could integrate with the knowledge based system for predicted control. CAFM systems contribute to the business of facilities management and organisations. Benefits to various organisations included; the advantages of sharing data with other departments; faster processing time i.e. reduced management time; cost savings; reduced crisis management; reduced error; reduced personnel; better control of information; increased product quality; and helping to avoid penalty clauses. The idea of connecting, integrating or opening facilities management and building automation systems, in order to achieve unified software architecture by extending the functionality of a standard management tool capable of handling FM and building control networks, is essential in practise (Himanen 2003, Thomoson and Plouffe 1999).

Himanen (2003) stated that integrated facilities management is the combination of the intelligent buildings with facilities management although a definition that Himanen has not accepted. However CAFM systems are generally split into two groups, modular and integrated systems. The CAFM software named integrated FM do not particularly emphasise on intelligent buildings, they merely produce modules of CAFM that can be integrated. An example of the point is the incapacity of most software to help make strategic decisions on when to recommend replacement of an asset.

Recently advanced CAFM systems have been chosen for their reporting capability such as the MTA Ultra sys. The separate software MTA report builder can query the Ultra sys CAFM system. These non-integrated structured query reporting modules and intelligent building technologies have been used for monitoring, diagnosis and management of potential maintenance problems. However condition assessment surveys can be treated separately from the CAFM system. The cost of these surveys pushes up the running cost of the facilities. Normally the budget for the facilities management system is separate from the condition survey budget. For this reason the condition assessment surveys can only be treated separately rather than via CAFM.

CAFM differ from conventional Building Energy Management Systems (BEMS) in that BEMS are tools for diagnosing, monitoring and causing actuations to assets particularly related to energy services and consumption in a building. With intelligent building and open standards conformity the BEMS is able to function to higher effective levels. The function can be performed by the CAFM querying the BEMS or by form of integration. CAFM systems that were integrated with Computer Aided Design (CAD) have proved effective. Keller and Keller (2002) evaluates the strategic use and implementation of CAFM systems arguing that a number of users only use CAFM operationally and not strategically. This is similar to the proposal to research the optimised usage of CAFM systems. Strategic thinking is all about anticipating and managing change, to predict future facility needs and develop strategies that will enable timely responses (Keller and Keller 2004).

This integrated facilities management has not found its way to the commercial market as yet. The implementation of an integrated facilities management system is possible but because of the complexity of the functionality of such a large system and the co-ordination of multi-vendor systems easily leads to fault situations (Bozany 2006). The reasons for the predicted fault situations are encountered by Bozany (2006) and Thompson and Plouffe (1999). If the designers specify an open standard for vendors, this would help narrow down the faults

(HVCA 1992). However, there has been no true integrated CAFM system seamlessly linking CAD graphics, non-graphic data, and raster images from multiple heterogeneous computer systems through an integrated database (IDB) for use throughout the life cycle of a facility (Teicholz 1992).

The many non-technical impediments to the implementation of integrated systems make it difficult for the implementation of an optimised CAFM system. The factors that have driven an increase in the use of CAFM include the need for: reduced maintenance and logistics costs, improved equipment availability, and protection against failure of mission critical equipment (Lebold, and Thurston 2001). A complete CAFM system comprises a number of functional capabilities: sensing and data acquisition, signal processing, condition and health assessment, diagnostic, prognostics, and decision reasoning. In addition, a Human Computer Interface (HCI) is required to provide user access to the system. The implementation of such a system usually requires the integration of a variety of hardware and software components. There are a broad range of system level requirements such as communication and integration with legacy systems, protection of proprietary data and algorithms, a need for upgradeable systems, implementation time and cost limits.

Standardization of specifications within the community of CAFM users will, ideally, drive the suppliers to produce interchangeable hardware and software components. A widely adopted non-proprietary standard will result in a free market for CAFM components. The potential benefits of a robust non-proprietary standard include: improved ease of upgrading for system components, a broader supplier community resulting in more technology choices, more rapid technology development, and reduced prices (Lebold and Thurston 2001).

RESEARCH RESULTS AND DISCUSSION

The aim of this work was to identifying statements to define intelligent buildings, evaluating an acceptable theory and identifying a list of CAFM systems on the market and those used by intelligent buildings. The questionnaire was devised to be polled by a non-probability group of participants. The sample chosen for the study were members of a professional institution Facilities Management group. Initially a pilot study was conducted on FM firm personnel. This was to assess the clarity of the instructions, weather any topics had been left out. Comments from the personnel were also sought. Initially invitations to participate in the survey went out. Then the agreed questions were Emailed to members of the intelligent building group who expressed they were willing to participate. In support of this study questions were polled to deliver quantitative results with regards to determine the category, size and budget of the participants' organisation. This in addition to question about the role of CAFM systems in effective management of intelligent systems within buildings, identifying a list of CAFM systems on the market and those used by intelligent buildings. The result of the questionnaire survey presented in the paper is based on 15 responses.

Figure 1 gives the category of Organisations of the respondents. The survey participants were from a large cross section of industry serving their organisations in the majority as non-core business services providers. This accounts for over 58% of all the participants. 14% (one quarter of the services percentage) is accounted for by the local Government this includes the Police services, Fire brigade and local councils. The remaining sectors Financial, Consultancy, Public and Manufacturing Industrial are equally represented by 7% each. This shows the organisations in majority, are outsourcing the function of facilities management with service providers.

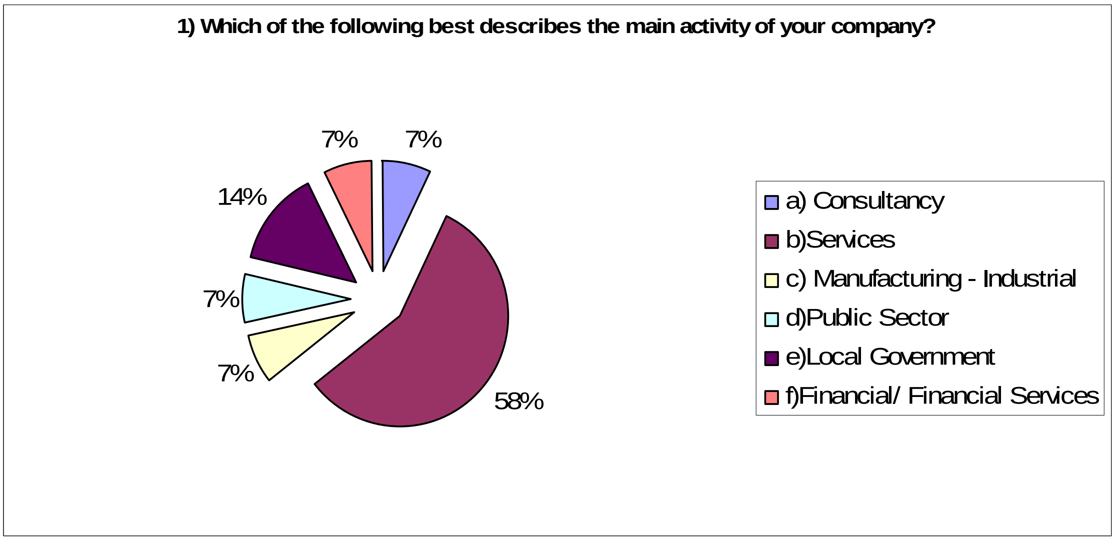

Figure1: Category of survey respondents

67% of the respondents indicated none of their buildings are intelligent buildings. The majority (40%) identified a single intelligent building they were responsible for. 30% of the sample identified 2-4 intelligent buildings, these respondents were Facilities managers and Maintenance managers within mechanical and electrical service. This group were positive to the use of CAFM as a vital FM. 10% of the sample that identified 5-7 intelligent buildings, which were the same number of building they were responsible but their functions were related to building and construction. The mechanical and electrical services were not part of the job function so this 10% do not use CAFM systems. Those that identified 10 plus intelligent buildings (20%) were representatives of Maintenance and Operations managers.

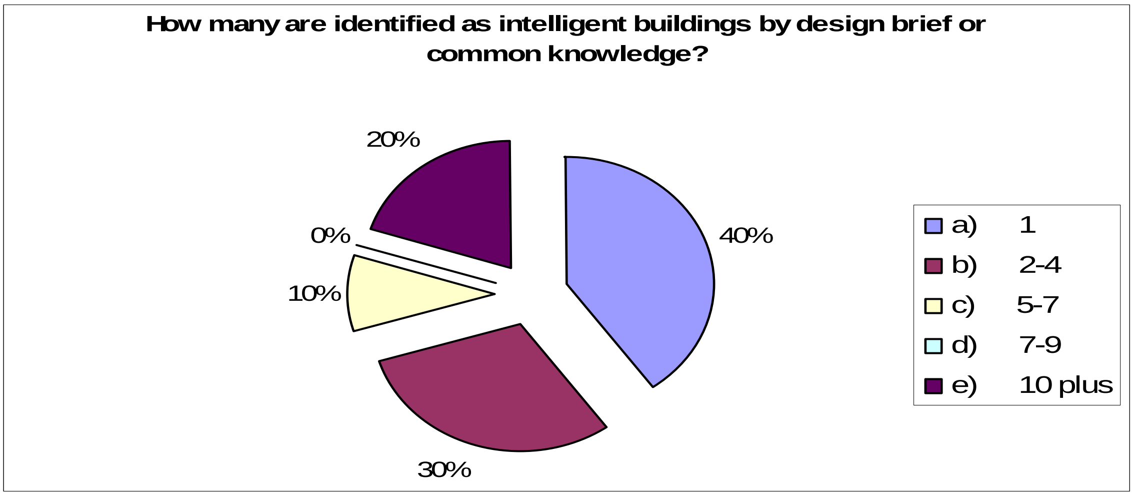

Figure 2: Identification of intelligent buildings

The results showed 46% use CAFM systems for intelligent buildings. This include the respondents that have identified one intelligent building in their portfolio. The majority 54 % do not use CAFM systems for intelligent buildings.

Figure 3 gives the CAFM system used by respondents. The figure indicates that Archibus users are 18% of the sample that use CAFM for intelligent buildings. Maximo users are also 18% of the sample but only half the number of this proportion use CAFM for intelligent buildings. None of the 9% that use Concept have CAFM for intelligent buildings. The majority of this sample 55% is bespoke and other CAFM system users. Not all but a good proportion of the majority also use CAFM for intelligent buildings.

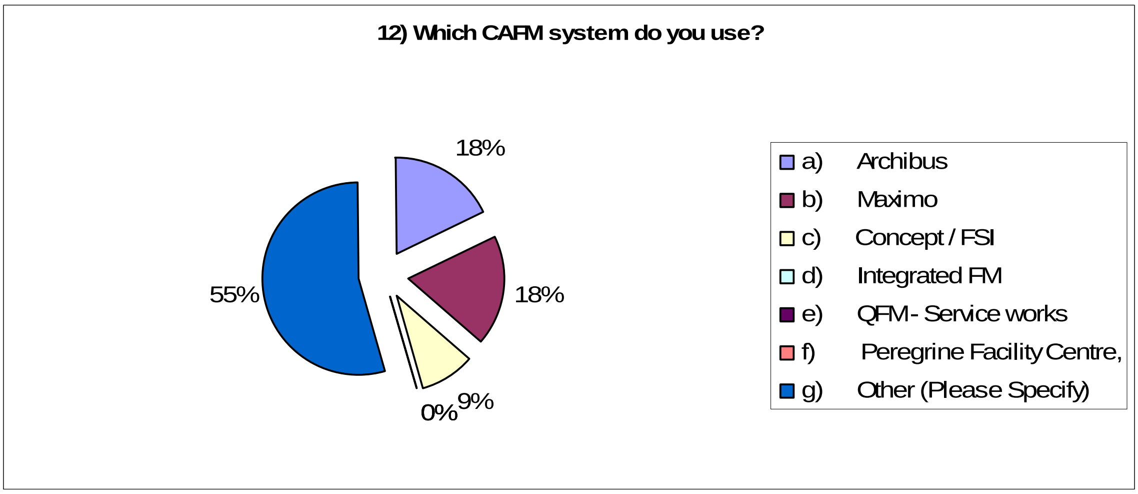

Figure 3: CAFM system by users

Other results showed 38% of the sample use an integrated CAFM system, two thirds of this proportion use CAFM on intelligent buildings. This indicates 13% of the samples are the users of a particular CAFM which can also be used on intelligent buildings. 42% of the sample link the information provided for in the CAFM to any other data bases. With regard to the potential of successful application of CAFM to effectiveness of the FM function the majority of the respondents (64%) strongly agrees or agrees to the statement. This fortifies the potential of integration at management level of the systems of CAFM for intelligent buildings.

CONCLUSIONS

Intelligent buildings are generally viewed as systems composed of a number of distinct yet interfacing subsystems and components such as: a computer and telecommunications system, an alarm/security system, an energy regulatory system management and control system, electrical and communications wiring infrastructure, a command and control centre, an electric power supply system guaranteeing continuous uninterrupted power supply and a utilities system (water, sewage and drainage).

It is evident that there is no scientific definition available for IB concepts. They are keywords which describe common knowledge about intelligent building. A questionnaire survey was conducted to evaluate the understanding of IB concepts as well as CAFM application and their potential for the effectiveness of the FM functions. There are myriad of definitions for the term Intelligent Buildings which generally refer to the application of digital technologies in the design process, and management of building assets. The results of the survey showed that 46% of the respondents do use CAFM systems on intelligent buildings. 36% of the samples do not agree that a successful CAFM system is vital for the effectiveness of the FM function. As the management skills used in place of CAFM are inconclusive. Indeed there are opportunities to exploit digital technologies integrated into CAFM to enable effective assets and facilities management. This call for the provision of such digital technologies and CAFM tools in an open standard to delivery cost effective and efficient facilities.

REFERENCES

Bozany, A (2006) *Integration of building automation systems and facility information systems*, Budapest: Department of Information and Knowledge Management, Budapest University of Technology and Economics, Hungary.

Clifford, C, Elmualim, A A and Child, F (2007) Pervasive technologies for workspace management at Nationwide Building Society. *In, CIB World Building Congress: Construction for Development*, 14-18 May 2007, Cape Town, South Africa.

Elmualim, A A, Green, S D, Larsen, G and Kao, C C (2006) The discourse of construction competitiveness: Material consequences and localised resistance. *In, Joint International Conference on Construction Culture, Innovation and Management (CCIM)*, 26-29 November 2006, Dubai. The British University in Dubai, UAE and CIB.

Finch, E (2004) Facilities Management. *In:* Clements-Croome, D (Ed.), *Intelligent buildings: design, management and operation* (London: Thomas Telford.

Finley, M R, Karakura, A and Nbogni, R (1991) Survey of intelligent building concepts. *IEEE Communications Magazine*.

Himanen, M (2003) *The intelligence of intelligent building: the feasibility of the intelligent building concept in office buildings*, PhD, VTT, VTT Publications.

Himanen, M (2004) The intelligence of intelligent buildings. *In:* Clements-Croome, D (Ed.), *Intelligent buildings: design, management and operation* (London: Thomas Telford.

Keller, J and Keller, C (2004) Bringing strategic efficacy to facilities management through CAFM tools. *Facilities Management*, **3**(2), 125-144.

Lebold, M and Thuston, M (2001) Open standards for condition-based maintenance and prognostic systems. *In, Maintenance and Reliability conference (MARCON)*, 6-9 May, Gatlinburg.

Teicholz, E (1992) *Computer-aided facilities management*. New York: McGraw-Hill.

Thomoson, S and Plouffe, R (1999) Technology and industry trends for building control and facility automation. *In:* Klepfisch, G (Ed.), *CIB Working Commission W098, First International Congress*, 29-30 March, Brugge, Belgium.

Wong, J K W, Li, H and Wang, S W (2005) Intelligent building research: a review. *Automation in construction*, **14**, 143-159.

BEST PRACTICE FOR A SUCCESSFUL CAFM IMPLEMENTATION
CAFM EXPERIENCES FROM GERMANY, AUSTRIA AND SWITZERLAND

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ABSTRACT

Since the 1990s Computer Aided Facility Management (CAFM) has provided efficient IT tools for the illustration, evaluation and control of Facility Management structures and processes. During these years numerous software systems with various systematic approaches, functions and varying degrees of success have been established on the market. Despite the multitude of suppliers and users in different branches of industrial sectors there is still insecurity concerning the procedures and achievable effects. This is closely related to the lack of well documented, transparent and successful case studies. This paper presents the first comparative analysis of the CAFM sectors in Germany, Austria and Switzerland. Due to the geographical location of the project partners the entire German speaking area could be covered and thus the results of the analysis reflect the state of the art of CAFM implementation and use in the German speaking area. This study of successful CAFM projects in companies and public institutions should make the know-how and practical experience available publicly. It presents current trends and technologies and provides recommendations for successful CAFM implementation.

KEYWORDS: Facility Management, CAFM Best Practice, Case Studies, Strategy

BACKGROUND

Seite: 1

After salary and wages, expenditures for facility and real estate represent the largest part of the operating expenses for a company, and any improvement of cost effectiveness results in a significant overall saving of costs (Finlay, 1998). Over the past years, the adoption of information and communication technologies (ICT) has affected property management (Thompson, 2005). Since the 1990s Computer Aided Facility Management (CAFM) has been providing efficient IT tools for the mapping, evaluation and controlling of Facility Management structures and processes. Since then numerous software systems with various systematic approaches, functions and varying degrees of success have been established on the market. Despite the multitude of suppliers and users in the different branches of trade, there is still uncertainty concerning the procedures and achievable effects. This is closely related to the lack of well documented, transparent and successful case studies. In addition, little is known about how CAFM is implemented successfully and the factors leading to success. From an economic point of view, it is very important to support the process of implementation in order to avoid wrong decisions and unnecessary investments. Implementation strategies and formulae for success are especially of great interest.

INTRODUCTION

Information technology (IT) delivers tools and methods which allow control over the enormous complexity of FM processes. Without IT support the challenging goals of FM cannot be reached or can only be achieved insufficiently. IT not only functions as a unifying factor, but often also as a catalyst during the implementation of Facility Management. The correct IT effort becomes a critical success factor of the realization of FM. Consequently, IT is a fundamental “Enabling Technology” for Facility Management (May 2006).

Computer Aided Facility Management (CAFM) with additional help from the latest electronic data processing (EDP) and information technology represents the support and realization of the Facility Management Concept throughout the entire life cycle of a real estate property. CAFM represents the application of computer systems, including hard- and software, to support FM functions efficiently. CAFM software systems are tools which back up the specific processes of FM and the persons directly or indirectly involved in those processes. Thereby all relevant data for the life cycle of facilities are captured, used and analyzed electronically. In addition, the CAFM software has to provide a number of primary functions (GEFMA 2002) to fully meet the requirements of FM entirety. From time to time, FM has been equated with a CAFM software. This point of view ignores the extensive and integrating approach of FM. However, it is correct that nowadays FM without IT support and software systems cannot be carried out efficiently, even if it is still in the early stages of development. The great diversity as well as the complexity of the different FM processes and -tasks is responsible for that.

In many cases, during the introduction of FM, the hope of resolving all FM problems just by implementing a CAFM software is mistakenly assumed. If the necessary preliminary enquiries, planning as well as strategic decisions are missing and the involvement of the personnel and management concerned is lacking, then the implementation of FM is doomed to failure. In addition, the software becomes an expensive investment. FM is developing in various European countries. Certain historical and cultural circumstances, organizations and business areas have been the basis for different views and approaches. In general, all organizations, whether public or private, use buildings, assets and services (facility services) to support their primary activities. By coordinating these assets and services, by using management skills and by handling many changes in the organization's environment, Facility Management influences its ability to act proactively and to meet all its requirements. This is done also in order to optimize the costs and performance of assets and services. “FM is an integrated process to support and improve the effectiveness of the primary activities of an organization by the management and delivery of agreed support services for the appropriate environment that is needed to achieve its changing objectives” (prEN 15221-1, 2006).

The concept of FM was not new when the term “Facility Management” was introduced in the USA in 1979, as the management of large facilities or properties for a profit had already been practiced before. The definition used by the International Facility Management Association (IFMA) is: “Facility management is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology” (IFMA, 2007a). Facility Management contains the concepts of cost-effectiveness, productivity improvement, efficiency and the employees’ workplace quality (IMFA, 2007b).

PURPOSE OF THE SURVEY

For the first time, the paper introduces a comparative survey of the CAFM field in Germany, Austria and Switzerland [see May, et. al. 2007]. The survey of successful CAFM projects in companies and public institutions is supposed to bring know-how and practical experiences to public attention. Current trends and technologies as well as advice and practical instructions will be presented to facilitate a successful implementation of CAFM. The article is directed at users, software manufacturers, partners of implementation, advisors, service providers, students and lecturers as well as decision-makers in Computer Aided Facility Management.

RESEARCH METHODOLOGY

The project was implemented by the University of Applied Sciences, Berlin and the University of Applied Sciences, Kufstein in cooperation with IC Information Company and Reality Consult GmbH. It was supported by the Competence Centre Facility Management of the University of Applied Sciences, Berlin and the Tyrolean Science Funds. The German-speaking region could almost completely be covered in the survey, because of the geographical locations of the project partners. Therefore, the results of the survey reflect the current level of research of CAFM implementation as well as CAFM utilization in the German-speaking area.
The survey was conducted by detailed interviews following exactly the same structure:

- General data related to the organisation (private or public), i.e. description of core business
- Data related to real estate / property
- FM objectives and policy
- Initial situation
- The CAFM project
- Lessons learned and evaluation.

This structure is consequently used in describing the various case studies.

STRATEGIES FOR THE INTRODUCTION OF CAFM

The successful introduction of a CAFM system comprises more than the procurement of software. It entails an extremely complex process which normally concerns the whole organization of a company or a public institution [May 2006]. It is about a process, beginning with a concept and ending with the implementation, which has to be organized and run as a complex project. Naturally, the choice of a strategy for the introduction of FM depends on several factors like the existing budget, the available time frame, the extensiveness of the project and finally the existing know how of the company and the project planner. If and when external know-how has to be consulted depends on the factors described above. Since, in most cases, the introductive companies have only very limited practical experience with the implementation of a CAFM system, it should be attempted to integrate the know-how through an external partner.

The integration of a CAFM software into the company's IT structure is of great importance. While doing that, data transmission and data handling has to be taken into consideration. In particular data collection and data maintenance require a lot of effort and resources. Besides this fact, the strategy for the introduction of CAFM is confronted with the same tasks as other operational information systems. That means that on the one hand the concerns of the informational infrastructure have to be considered, and on the other hand the illustration of the facility processes has to be done as smoothly as possible. Therefore, the strategy of the implementation of CAFM systems should tend to take into consideration prevailing structural and technical conditions which are the company's informational function and of the FM department's functional needs.

FACTOR OF SUCCESS: DATA COLLECTION AND DATA MAINTENANCE

Since the data collection generally appears as the biggest cost block, representing more than 50% of costs during the implementation and the operating phase, this area has to be treated with sensitivity. Further big cost blocks can be summarized as procurement costs of the system (software, hardware) as well as the costs of project work (advice, training, customizing). Data collection and data maintenance usually cause higher costs than the needed soft- and hardware as well as the training of the employees (Nävy 2006, May 2006).

The commencement and/or the production of drawings as well as the recording of the alphanumeric data under consideration of the data base belong to the phase of data collection. The filling of the CAFM system with data is a time-consuming and labour-intensive process. Whereby, not only the data entry, but also finding and providing the data, represent a lot of expenditure. The necessary expenditure depends on the intensity of handling (e.g. while searching for data), the examination of quality and topicality, the update, the revised collection, the input of data and the conversion from other systems as well as the handing over to the CAFM system.

The collection's expenditure of the continuation of data essentially depends on the detail of the desired data. During the first collection, the facts shows that especially the depth of information can be chosen in order that on the one hand the request of use can be fulfilled, and on the other hand regular data care can be guaranteed. Striving for an overly high accuracy in data care is uneconomical, as it results in excessively high labour-intensive expenditure. The negative impact would be that data are neglected, costs rise and consequently a system exists which supports Facility Management insufficiently.

FACTOR OF SUCCESS: STEP BY STEP INTRODUCTION/ PROJECT MANAGEMENT

As not only different groups of persons, but also processes of a company are affected by the introduction of CAFM systems, the introduction involves a highly complex and extensive undertaking. As a consequence, a successful introduction requires good project management and managerial commitment as well as the integration of all areas of a company. Basically, it can be said that during the CAFM introduction concept the following questions should be answered:

- Which processes should be supported?
- Which building-related information is necessary?
- What is the necessary level of detail for the required information?
- What kind of reports and evaluations have to be produced?
- Which department is interested in the use of a CAFM system?
- What kind of informational infrastructure prevails in the company?

Especially the last question has great influence on the relation between costs and usage as well as on the resources for data collection and data care. Experience has shown that a step-by-step introduction, which makes it possible to calculate in steps, has the advantage of achieving success and use with little effort in over a relatively short period of time. In addition, the quickly achieved success and use have an accelerating effect on further project phases.

FACTOR OF SUCCESS: ECONOMIC EFFICIENCY

The proof of the economic efficiency of a CAFM project is one of the key factors to success. If you cannot show that the investment in this technology will pay back, it is hard to gain support from the top management. The economic benefits of using CAFM systems is a hot topic. This is mainly due to the fact that quantitative effects (figures) related to CAFM cannot always be presented and proven very easily. Many of the advantages visible are rather of a qualitative nature. Usually, the cost originating from a certain FM process is not known in detail. This makes it difficult or even impossible to compare the situation with and without CAFM support.

However, to get a reliable view on the financial benefit of CAFM we need to know the (internal and external) cost and benefits quantitatively. Unfortunately, there are hardly ready-to-use models for deriving the return on investment (see May et. al 2007). Consequently, GEFMA's working group on CAFM developed an ROI model for CAFM use in a company (see Hohmann et al. 2001, May 2002). The approach taken can be applied to other software systems as well. Initial point of the model are the so-called ROI drivers.

Hereby, we mean the impact of IT support on fundamental FM factors and processes. The following factors were identified to be the most important ones:

1. maintenance 2. cleaning 3. space utilisation efficiency 4. occupancy (empty space) management 5. Corporate Identity (CI) contribution for the company 6. standardisation 7. transparency 8. relocation / move	9. integration (IT, processes, organisation, ...) 10. service desk 11. security and key management 12. contract management 13. procurement and outsourcing 14. service charge settlement 15. sales support 16. energy and environmental management

Now the size of the achievable return on investment (ROI)

ROI = Output / Input = (Income - Cost) / Capital Invested

can be depicted in a diagram over time (see Figure 1).

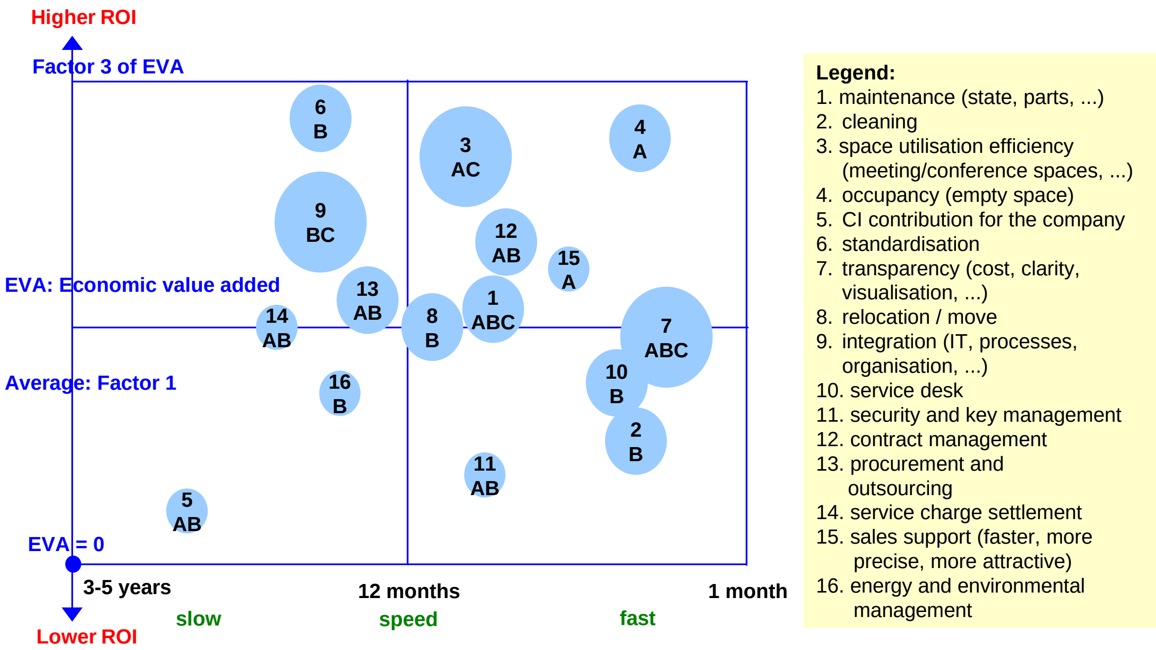

Figure 1: ROI driver model

ROI drivers have an impact on income (A), cost (B) and assets (C) related to the real estate of a company. The size of the bubbles indicates the economic potential of the respective process/factor. Small bubbles mean low potential and big ones a high potential.

Usually, we require support from a CAFM system especially for those processes/factors having a comparable high ROI. The model can now assist the facility manager in estimating the economic efficiency of using a CAFM system for certain FM functions. Processes located in the upper right quadrant of the diagram are those with a high ROI achievable in a short time.

Further research intends to verify the model by investigating examples from different application fields. This will also discover possible deviations of the model for different areas (e.g. hospitals, office buildings).

In the current case study this model was applied and the ROI drivers investigated. It turned out that the most important drivers in the case studies were: transparency, maintenance, cleaning, space utilization and standardization.

RESISTANCE DURING INTRODUCTION

Most of the time, the introduction of a CAFM system causes extensive changes or adaptations of the company's processes, and therefore, concerns a large number of employees. If the members of staff are informed insufficiently or if they are not integrated, resistance has to be expected. In principle, it should be taken into account that resistance against changes in processes is a natural reaction, because changes or reforms always cause fear and insecurity. With the help of an open and targeted informational policy as well as an active integration of the persons affected, the critical phases could be reconciled in a shorter period. It is to be recommended that by speedily achieving "Quick Wins" the persons affected can already gain individual advantages out of the system. Consequently, resistance is minimized and acceptance increases rapidly. In many introduction processes, the company's management, however, refuses to collaborate with the affected employees with the argument that this would require too many resources and would be too costly).

ANALYSIS OF THE ECONOMIC EFFICIENCY OF CAFM

On the basis of case studies (see May et. al 2007) it can be clearly recognized that the CAFM of the analyzed companies was economical. Furthermore, apart from this clear and comprehensible efficiency of usage, further usage can be generated indirectly. That can occur through improvements of the data quality, by company wide availability of the relevant information or through the possibility that data can be analyzed individually. Thus, also during the strategic planning of Real Estate and Facility Management, indirect benefits will be achieved. For the last two years the discussion during consultations with organizations, which establish integration and processes supporting CAFM, has shifted from the question of how large the return on investment is, to the question of how quickly efficiency can be generated and what measurements have to be taken in order to improve the productivity of the affected organizational units. The general question of the economic efficiency of CAFM is not at the centre of attention anymore, but the speed of achieving the efficiency of usage comes to the fore. Now, during the realization of restructuring projects and organizational changes, the factor "time to market" also became an important indicator in the overall context in the area of secondary processes. During all these change projects IT support comes first.

In the near future there will have to be a special focus on the subject of system change. As a result of the ongoing consolidation of the CAFM provider market and on the increased focus of the systems on processes rather than on inventory data as well as on the integration of CAFM systems into the company's ERP landscape, a lot of implemented stand-alone systems from the 90s will be replaced. Thereby, the reusability of data from the old systems will turn out as a critical factor of success. If the achieved benefit should not be ruined by the data's incompatibility, the standardization of CAFM data materials under content and technical criteria must receive high attention while considering the introduction or the change of the systems. While examining the economic efficiency of CAFM systems from a FM service provider's perspective, it becomes apparent that they mostly have similar demands on IT support in Facility Management compared to the self-interested consumer. However, the necessity of integration into the company-wide ERP system has much more significance. The trend of many service providers to simply use a CAFM system, which was chosen or already provided by the customer, does not dissolve their complex assignments which include, but are not limited to the evidence of achievement and calculation requirements. Solutions, which integrate processes of the target group - customers, the service providers and the subcontractors - and display them regardless of their location on several levels, will capture a remarkable position for this target group in the future.

These approaches are strengthened by requirements of national and international Real Estate Portfolio owners who are independent of individually detailed on-site-solutions and who formulate a central and location-independent need for index information from the portfolio-administration. This demand can only be fulfilled by web-based portal solutions which are fully integrated in ERP- and CAFM systems. For the target group, which consists of service providers, the economic efficiency of IT investments plays a significant role. This is due to its portal solutions attractiveness for gaining customers and its ability to fulfil the requests of international customers for information management.

RECOMMENDATIONS FOR A SUCCESSFUL CAFM IMPLEMENTATION

From the experiences of the case studies a couple of recommendations can be derived. They can be used as a simplified check list for the company's CAFM implemenation. The introduction of a CAFM system requires the utilization of methods of change and project management. The people in charge of the realization have to be equipped with adequate competences and responsibilities. The maximum support of the project by the management and the adequate qualification of the affected employees is of great importance. During the phase of the CAFM implementation following key success factors can be found continuously:

- Efficient data collection and data maintenance
- Projective procedure – step-by-step introduction
- Integration of the decision makers and the affected employees.

Table 1: Recommendations for a successful CAFM implementation

- In the beginning all affected personnel including the management should be involved. This eliminates a lot of resistance against changing processes,
- Participation of a group of people on important project decisions,
- Professional project marketing. Not only the FM department, but also the employees of all other organizational units have to be convinced of the advantages and user potential,
- During the realization of the project clear goals and milestones have to be defined; thereby, success can be verified and presented to the corporate management,
- Determination of the application areas in which CAFM is highly beneficial,
- Formulation of a sufficiently detailed requirement specification including tasks and obligations,
- Clarification of the data basis,
- Selection of the correct collection of data and technology of data maintenance,
- Definition of a pilot project which delivers measurable results in a short period of time,
- The project should stand on an integrated basis. Often, the purchase of CAFM software is considered as the end of the CAFM project. A CAFM project consists of the preparation of the project, the identification of basic principles, the process of system selection, the data collection and data transfer as well as project controlling,
- Development of an overall budget. During software projects, the training and introduction of employees is often an underestimated cost factor,
- Never equate the cheapest contractor with the best contractor,

- The software should always be adjusted to the operating activities,
- Put a lot of emphasis on the usability of the software. Users are often impressed by the awesome functionality of the systems,
- Test the comfort of usability,
- Examination of projects reference of the software contractor,
- If necessary, involvement of external support (consultants).

The results of the research project have been extensively presented in a book entitled: Computer Aided Facility Management im deutschsprachigen Raum, CAFM-Praxiserfahrungen aus Deutschland, Österreich und der Schweiz (May et al. 2007). In the following, an evaluating matrix will be shown as an example.

Table 2: Example of analysis from the survey

<table>
<tr><th>Data of the company</th><th>Experiences</th></tr>
<tr><td>Name: xyz
Type of organization: public
real estate properties: 2,700
NUA : 2,200,000 m2
Duration: 2002-2005
Software used: SAP</td><td rowspan="2">• Clear goals and a clearly defined project framework prove to be very helpful.
• The involvement and commitment of the management is a basic requirement for the success of a CAFM project. In this situation, a project leader belonging to the management is a very important factor.
• The internal and external marketing of the project is a determining factor, but it is often disregarded. The marketing includes a transparent information policy for persons both inside and outside the company. Through active involvement, in addition to a transparent marketing policy, the persons affected become participants.
• The collective procurement of the CAFM software and the capacity of data collection and data maintenance can develop towards an interesting model in the area of CAFM. Thereby, the risk of the initiator decreases.</td></tr>
<tr><td>Initial Situation
• Creation of cost transparency on the basis of secured data.
• FM-relevant data are available in different systems and formats.
• The heterogeneous landscape of data causes problems. For this purpose, the connection between ERP systems to a CAFM software is missing.
• Different IT systems with reference to FM are already in operation.</td></tr>
</table>

CONCLUSION

The main conditions for successful CAFM implementations are faultless project management and well prepared coordination with the company’s processes and the resulting user prospects. An essential criteria for success is the integration of the affected employees during the decision making process. An introduction strategy turns out to be advantageous when it starts step-by-step with those project intervals that verify the benefits of CAFM. An accompanying project marketing strengthens the acceptance within the company. Additionally, it contributes essentially to the success of the project.

Subsequently, an analysed example of a CAFM project will be presented. In addition, it will be summarized in reference to the success potential during the introduction. It should be kept in mind that the introduction of a CAFM system in particular supports and improves the FM processes. This requires a systematic analysis of those processes during the implementation phase. Our research shows that the maximum saving potential lies in the improvement of processes and their integration. Those potential savings could be intensified by IT operations.

ACKNOWLEDGEMENTS

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REFERENCES

Finlay, D. (1998): A commercial approach, Premises & Facilities Management, Vol.4 No.1, pp. 25.

Gasteiger, T. (2002): Auswirkungen auf das gesamte Unternehmen bei der Einführung von CAFM, Mastertheses, University of Applied Sciences KufsteinTirol, Austria

Hohmann, J.; Prischl, P.; Quadt, M.; Warner, T. (2001): Ein Modell zur Bestimmung des Return on Investment für die Einführung von Computer Aided Facility Management. Presentation on the IFMA Deutschland Regional Meeting, Ottobrunn, 11.12.2001.

IFMA (2007a): What is FM?, International Facility Management Association, Retrieved December 22, 2007, from http://www.ifma.org/what_is_fm/index.cfm

IFMA (2007b): What is FM?, International Facility Management Association, Retrieved December 22, 2007, from http://www.ifma.org/what_is_fm/fm_definitions.cfm

May, M. (2002): Erfolg im Facility Management mit CAFM. Tagungsbeiträge Build-IT 2002, Berlin (06.-08.02.2002) 14-17.

May, M. (2005): CAFM-Einführung – (K)ein Buch mit sieben Siegeln – Tipps zur CAFM-Einführung, Facility Management, Vol.12 Nr. 6, pp.2-5.

May, M. (2006) (Hrsg.): IT im Facility Management erfolgreich einsetzen – Das CAFM-Handbuch, 2. Auflage, Springer-Verlag, Berlin-Heidelberg-New York

May, M.; Madritsch, T.; König, T.; Meier, J.; Scharer, M. (2007): Computer Aided Facility Management im deutschsprachigen Raum – CAFM-Praxiserfahrungen aus Deutschland, Österreich und der Schweiz, BOD-Verlag, Norderstedt.

Nävy, J. (2006): Facility Management, 4. Auflage, Springer-Verlag, Berlin-Heidelberg-New York.

Thompson, B. (2005): Information and communications technologies and industrial property, Journal of Property Investment & Finance, Vol. 23 No. 6, pp. 506-515.

prEN 15221-1, (2006), Facility Management -Part 1: Terms and definition, European Committee for Standardization, CEN/TC 348, CS: 01.040.01;03.080;03.100.99

DECISION SUPPORT BY COMPUTER AIDED FACILITY MANAGEMENT

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ABSTRACT

Computer Aided Facility Management (CAFM) means the support of Facility Management activities by modern information technology during the life cycle of real estate. It is focussed on the supply of information related to the facilities. All relevant data in the life cycle of facilities are collected, processed and evaluated to support the management in decision making process especially in the area of modelling, evaluation, control, and feedback of key Facility Management structures and processes. This paper will illustrate the cutting edge of CAFM and its relevance for Real Estate and Facility Management decision making. The paper will provide a review of the state of the art and practical experiences of CAFM applications - presenting an analysis of current trends and technologies, and providing recommendations for successful CAFM implementation based on a research study of successful CAFM projects in companies and public institutions. The paper will conclude with an informed speculation on future CAFM developments, trends and research opportunities.

KEYWORDS: Facility Management, CAFM, Decision Support, Strategy

INTRODUCTION

Nowadays Facility Management (FM) and Real Estate activities contribute to about 5-10% of the gross domestic product (GDP) of advanced industrialized countries. For example the total value of FM activity including support services is about 8.2% UK GDP (Harris, 2002). Computer Aided Facility Management (CAFM) software is a new class of ICT tools to support management in the preparation of relevant data in the decision making process especially in the area of illustration, evaluation and control of relevant facility management structures and processes. Recently, CAFM tools have been developing from simple information systems to multifunctional decision support systems for private as well as public organisations. Until now however, little attention has been given to this relevant change in business and academic communities.

At the same time, numerous software systems with various systematic approaches, functions and varying successes have been established on the market. Despite the multitude of suppliers and users in the different branches of trade, uncertainty concerning the procedures and achievable effects still prevails. This is closely related to the lack of well documented, transparent and successful case studies. In addition, little is known about how CAFM can be implemented successfully and the factors leading to its sustainable success. From an economic point of view it is very important to support this process in order to avoid wrong decisions and unnecessary investment. In particular, implementation strategies and formulae for success are of great interest (May, 2002).

The purpose of this paper is to describe the relevance of Computer Aided Facility Management (CAFM) as a decision support tool in the field of Facility Management (FM). The authors will illustrate the recent developments and market demands of FM and CAFM.

The main part will provide an overview of the basic concept as well as building management e.g. CAFM and give detailed insight into the topic and how CAFM may serve as a Decision Support System (DSS) from an organizational perspective. The next part will introduce some examples of good practices. The paper closes with an overview of future developments, trends and research opportunities of CAFM as a decision support tool.

BACKGROUND

According to a survey of Berger (2001), 70% of US companies and 50% of European companies consider their property and real estate as a strategic resource. Top management take this into consideration when making strategic decisions strategies and planning. The relevance of real estate is represented in the balance sheet. According to Cotts (2007) 25-50% of the assets are related to property or real estate. Life cycle costs are 5-7 times higher than the investment costs of buildings (Grabatin, 2001). This shows the need to optimize the operating costs. A professional Facility Management can help to raise the efficiency of the secondary processes of companies for e.g. building facilities and services (Brown, 1995). Therefore the management will need the relevant information of the building services engineering for their decision making. Companies are challenged by limited budgets and high customer expectations. Especially in the field of building services engineering there is a demand for integrated ICT to provide relevant data for the decision support process (May, 2005).

FACILITY MANAGEMENT

Facility Management is developing in various European countries. Certain historical and cultural circumstances, organizations and business areas have been the basis for different views and approaches. In general, all organizations, whether public or private, use buildings, assets and services (facility services) to support their primary activities. By coordinating these assets and services, by using management skills and by handling many changes in the organization's environment; Facility Management influences its ability to act proactively and to meet all its requirements. This is done also in order to optimize the costs and performance of assets and services. “FM is an integrated process to support and improve the effectiveness of the primary activities of an organization by the management and delivery of agreed support services for the appropriate environment that is needed to achieve its changing objectives” (prEN 15221-1, 2006).

The concept of FM was not new when the term “Facility Management” was coined in the USA in 1979, as the management of large facilities or properties for a profit had already been practiced before. The definition used by the International Facility Management Association (IFMA) is: “Facility management is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology” (IFMA, 2007a).

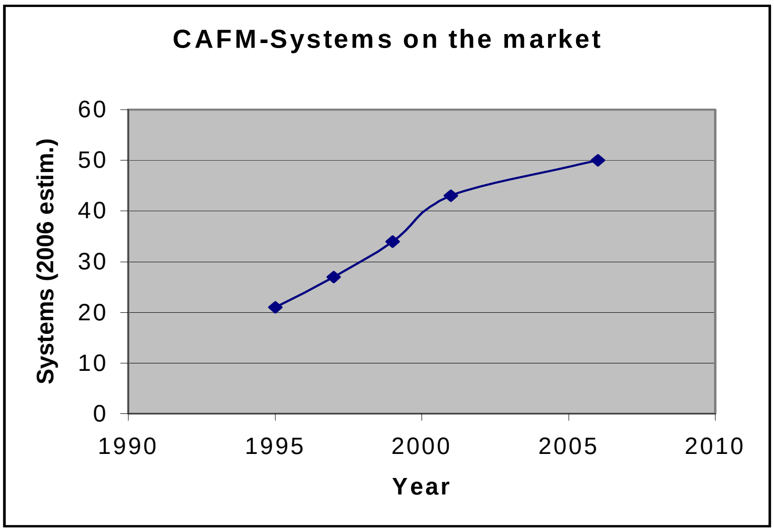
COMPUTER AIDED FACILITY MANAGEMENT (CAFM)

Computer Aided Facility Management (CAFM) means the support of Facility Management activities by modern information technology during the entire life cycle of a real estate property. It is focussed on the supply of information related to the facilities. All relevant data in the life cycle of facilities are collected, processed and evaluated electronically (GEFMA, 2007). Typical CAFM systems combine database technology with graphical systems, e.g.

CAD systems, but also process modelling and integration tools. Without IT support the ambitious goals of FM cannot be reached efficiently. The appropriate use of IT has become a critical success factor for the implementation of FM. Thus IT is a fundamental „Enabling Technology“ for FM (May, 2006).

Since the 1990s Computer Aided Facility Management (CAFM) has been providing efficient IT tools for the mapping, evaluation and controlling of Facility Management structures and processes. During these years numerous software systems with various systematic approaches, functions and varying degrees of success have been established on the market (May, 2004). The following chart (Naevy, 2006) shows the development of different CAFM systems / providers in German speaking countries.

Fig. 1. Growing number of CAFM providers in German speaking countries (Nävy, 2006)



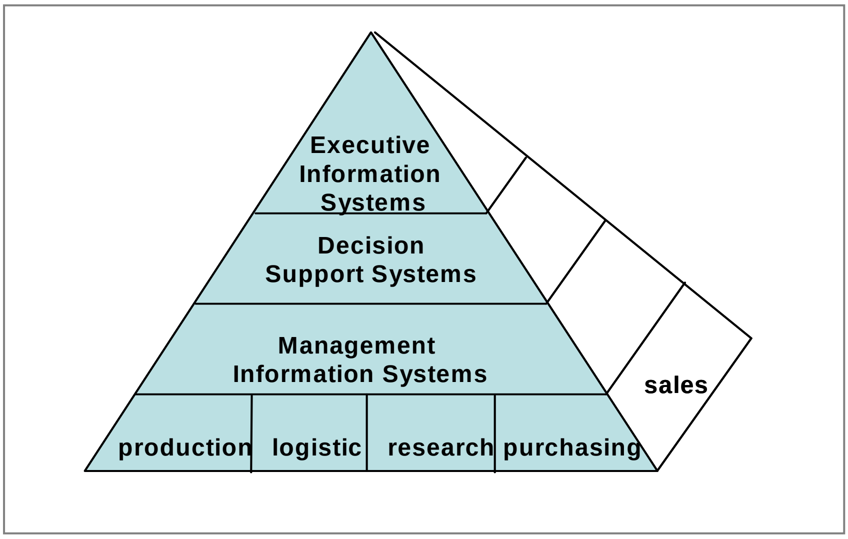
The use of CAFM systems is very common. A Swiss FM study showed that approx. 30% of the enterprises questioned in the study are using CAFM systems. In the strategic range the support is considerably smaller. Only a few companies are using Data Warehouses as management information systems for the decision support (FM-Monitor 2004). The most common IT systems in FM are still office applications and commercial software such as ERP systems. In the future, companies expect more support in the business decision making process.

CAFM AS A MANAGEMENT SUPPORT SYSTEM

The strategic value of real estate in companies makes it necessary that the management is supported by information and communication technology. They are generally summarized under the generic term "Management Support System” (MMS) (König, 2003). CAFM systems are developed with the goal to generate relevant information from the existing real estate-economical database and transfer it directly into planning and control processes. Primarily the decision relevant data and representations will be generated for the decision makers. In a further development step CAFM systems will provide detailed and consolidated information for the decision makers via a partly automated report system. Most CAFM systems have limited interactivity for the users. In the sense of the above categorization this first stage of development of CAFM systems can be called "Management Information System".

Concerning the amount of relevant data in real estate management, the market demands effective support in the planning and decision making processes. Therefore CAFM systems must develop into real "Decision Support Systems". With the use of interactive CAFM modules, the decision making processes will be more effective in the simulation and evaluation of the decision relevant data. Contrary to the pure management information systems, this will support managers in their planning and decision making processes and improve the quality of decisions. In particular, these next generation CAFM systems can support the decision makers by generating and evaluating scenarios more effectively in the future.

Fig. 2. ICT as Management Support Tool (König, 2003)



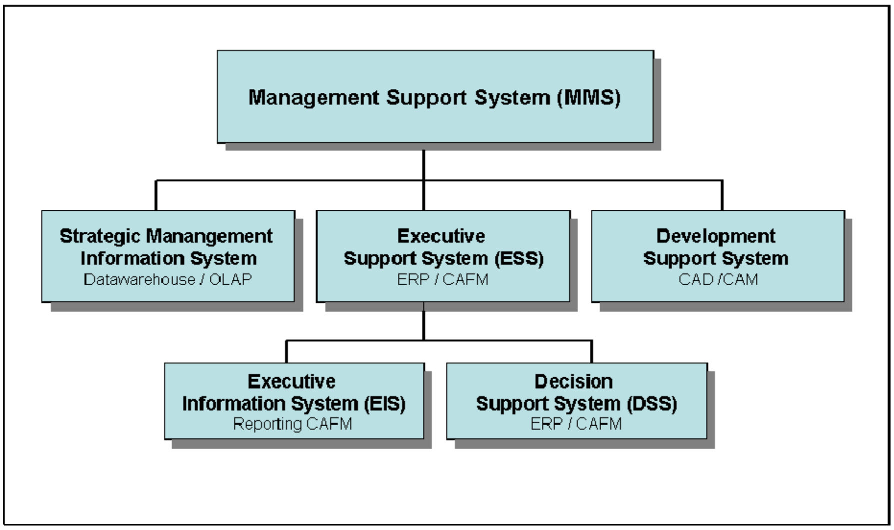
Businesses rules management systems model routine decisions, analyze the criteria and automate the decisions. If the basic conditions are changing, an enterprise can adapt the decisions with the help of the software within minutes. By the coupling of ICT with business processes, the management of the infrastructure is no longer a stand-alone process from the technical point of view, but is also integrated in the business context.

THE RELEVANCE OF CAFM AS A DECISION SUPPORT SYSTEM

Facility Management contains the concepts of cost-effectiveness, productivity improvement, efficiency and the employee quality of life. Very often there are no set answers for fulfilling all expectations, but management decisions still have to be made (Cotts 1992). Organisations cannot ignore the potential for cost saving within their real estate portfolios and increasingly they are using property-based information for corporate strategic decision making. The extent to which the information is fed back into strategic decision making varies depending on the implementation, experience in using the information produced and the links made between departments within the organizations concerned. (Fenwick, 1998)

After salary and wages, facility and real estate expenditure is the largest cost item for a company and any improvement of cost effectiveness results in a significant overall saving of costs (Finlay, 1998). CAFM systems are increasingly developing into a strategic planning tool in order to support decision making in facility and real estate management, e.g. in the fields of space planning, cleaning, room conditions and maintenance strategies.

Fig. 3. Management Support Systems (Imitation Stahlknecht, 2005)



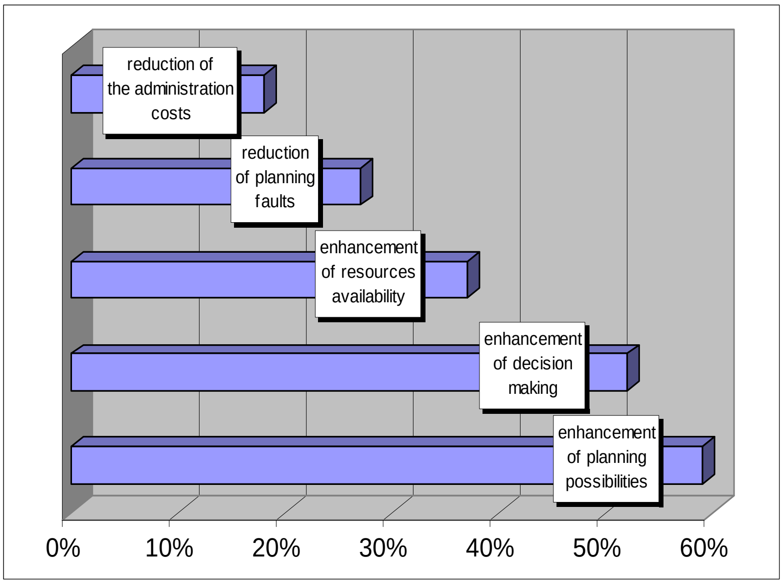
CAFM AS A DECISION SUPPORT SYSTEM

By using CAFM systems, all decision relevant data are represented correctly, in time and transparently. Economic data about real estate is the basis for the strategic management of the facilities. To optimize management processes in Facility Management it is necessary to link real estate information with business processes (Schach, 2005). Decision makers demand more relevant data just in terms of quality and quantity. CAFM systems provide information on the whole range of FM functions enabling tactically pervasive decision making performance for strategic long-term business success (Lunn, 2000).

The use and the saving potential of CAFM are evident in the chart below. In this investigation of the US market (Teicholz, 1990, Naevy, 2006) the improvement potentials after the introduction of CAFM systems were examined. It becomes evident that enterprises regarded the improvement of decision making and improvement of the planning possibilities as the most important advantages of CAFM technology.

The introduction of new work forms such as teleworking, desk sharing and virtual enterprises leads to rapid changes of the use of real estate. Facility management develops into a know-how oriented technology. Modern information and communication systems will simulate different scenarios to find the optimum operating points in relation to the occupancy of buildings. In this context a bi-directional exchange of data between building automation and CAFM system will become necessary in the future (Schach, 2005).

Fig. 4. Benefits of CAFM implementation (Naevy, 2006)



CAFM-BASED DECISION SUPPORT FOR SPACE OPTIMIZATION

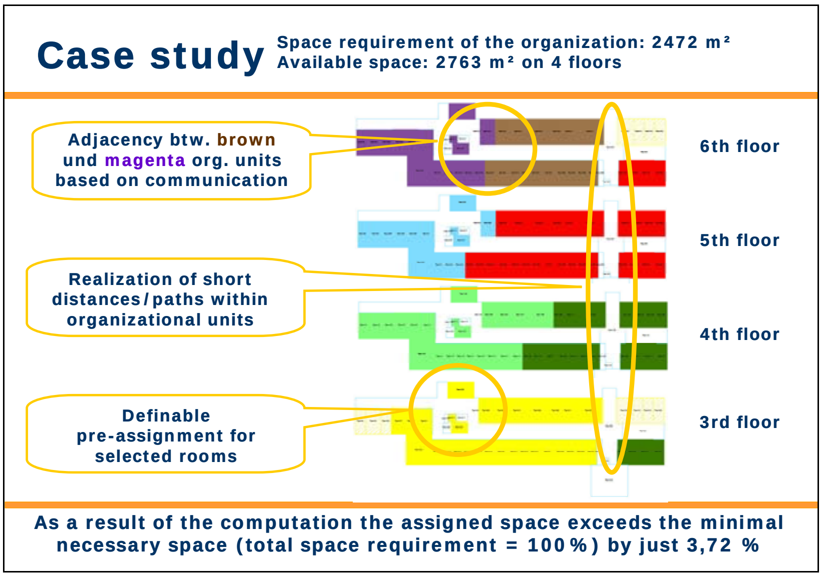
In the following we give one of the few examples so far, where CAFM and related technologies are used to support a real and complex decision process with a considerable economic impact. Optimal utilisation of office space is both a challenge and an opportunity, especially in large organisations. Space allocation is a tedious work and a great challenge for the Facility Manager with considerable economic impact on the entire organisation. To provide for the spatial requirements for a thousand or more employees in a way that maximises overall efficiency is a complex task in which the facility manager will be supported by. For example, an organisation with more than 3.000 employees has to move into a new building or various departments distributed over several buildings are to be located in one place. How does the FM achieve the ideal allocation efficiently? The problem is illustrated in figure 5.

Fig. 5. The space utilization/assignment problem

Nowadays, this work is hardly assisted by any IT tools. This is mainly due to the complexity of the underlying mathematical problems the exact solution of which exceeds the computing power of the most capable computers to date dramatically. So problems to be solved resemble the so-called Quadratic Assignment Problem (QAP) which is known to be one of the hardest (NP-hard) problems in discrete mathematics. So the problem can only be tackled by developing sophisticated heuristic algorithms.

In a research approach an IT tool (ReCoTech) was developed (see Rettinger et al., 2007, Marchionini and May, 2008) which is able to solve the underlying problem in an efficient heuristic way highly automatically. The basis data necessary for the tool come from CAD/CAFM systems. E.g. CAD drawings are used to generate a formalised building model automatically and CAFM systems provide data on the utilization and state of the available space. Not only are the space requirements of organisational units/employees taken into account but also their communication relationships (interaction), which is to result in a spatial adjacency in the final assignment (layout scheme). Figure 6 shows an example result of an automatic assignment.

Fig. 6. Result of an automatic space assignment based on CAFM data



A divide-and-conquer (top-down) approach was used to develop the assignment algorithm which is able to solve in an iterative way subproblems of a certain complexity (number of organisational units and spatial units) optimally. The software developed generates different variants of space allocation and evaluates their quality based on criteria such as reduction of cost, time, number of necessary reallocations, and/or communication traffic. In this way, the FM is able to set free valuable space in one site and to utilise office space more efficiently in other locations. By modifying several parameters this innovative algorithm is able to provide a number of allocation variants in a short time thereby giving the FM a real decision support. This is mainly due to the fact, that the result is easily comprehensible and objective. Additionally, the result can easily be evaluated in graphical form, where standard CAD formats as IFCs are used. The new technology which is considered a strategic planning tool is able to reduce space utilization costs dramatically (see Marchionini and May, 2008).

FINDINGS FOR IMPLEMENTATION

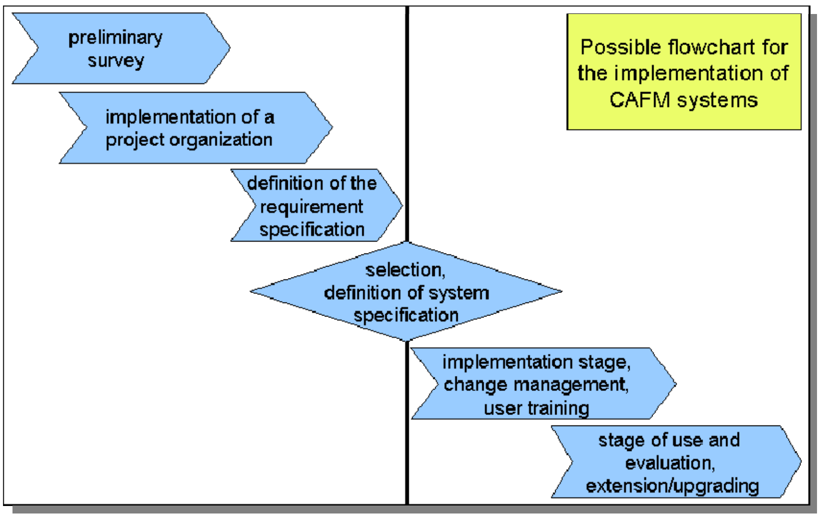
A large area of growth is the use of information between CAFM systems and building automation. By simulating real estate processes, important data can be created in order to support the management in the decision processes to find the potentially most efficient operation point. A further potential lies in the controlling of the efficiency of real estate management. When linking CAFM and building instrumentation, relevant building data can be generated, such as consumption data, malfunction and status messages, operation hours, maintenance and inspection dates as well as repair reports for the controlling process.

A further example for infrastructural building management concerns demand-related cleaning management (Schach, 2005). Instead of static cleaning cycles, information about the actual degree of pollution determines the cleaning cycles. The degree of pollution is determined, for example, by the operational personnel in the areas and the cleaning requirement. The user can be informed about this process and can make decisions for the cleaning process.

Despite the multitude of suppliers and users in different branches of trade industries there is still uncertainty concerning the procedures and achievable effects. This is closely related to the lack of well-documented, transparent and successful case studies. In addition, little is known about how CAFM is implemented successfully and the factors leading to success. From the economic point of view, it is very important to support this process in order to avoid wrong decisions and unnecessary investments. Especially implementation strategies and formulae for success are of great interest.

In 2006 the authors carried out a market survey about CAFM implementation (May et al., 2007). This survey presents the first comparative analysis of CAFM projects in the German-speaking countries. Due to the geographical location of the project partners the entire German-speaking area is covered and thus the results of the analysis reflect the state-of-the-art of CAFM implementation and use in the German-speaking area. The study of successful CAFM projects in companies and public institutions is intended to provide the know-how and practical experience to the public. It presents current trends and technologies and provides recommendations for successful CAFM implementation. The author recommends the following steps (see next Fig.5)

Fig. 5. Recommended steps for the CAFM implementation (May, 2007)



CONCLUSION

The CAFM market is currently facing a permanent development towards the needs of the customers. As mentioned before web-based CAFM solutions are established on the market. In contrast to many standard CAFM systems with client/server architecture, web-based CAFM solutions touch down on a multilevel (multi-tier) architecture. These applications are frequently based on three logical layers (3-tier architecture): presentation layer, business logic layer and data layer. If an enterprise decides to outsource its CAFM solution additional extensive installations for remote access have to be accomplished for client/server systems. With a fully web-based solution only inter-/intranet access is necessary.

The study of MacAndrew, 2005, shows that a new wireless web-based service for CAFM systems would be considered useful by facility managers and would improve current practice. Mobile CAFM solutions are usually no independent solutions, they are modules of CAFM solutions. The mobile devices update the data via an interface with the CAFM data. The operational areas of a mobile solution vary. It can be used e.g. for maintenance management and inventory management.

This development creates a further step to a management information system for FM. National and international enterprises need a holistic view of their real estate in order to optimize the real estate strategy in combination with the enterprise's strategy. This requirement can only be fulfilled, if a high degree of transparency of the data and processes is available in the appropriate quality, in real-time and in the correct format at any time. Also the term ‘workplace management’ comes up more often, which is a combination of facility management, real estate management, project management and other sections. Employee self-service systems guarantee a user-centred approach. With help desks and self-service Intranet, it meets the needs of the customers.

The examples mentioned above show what potential a future CAFM software as a decision-support system can offer to the management. Moreover, key success factors as well as critical points have been identified for the implementation and operation of CAFM systems. Taking a glimpse at emerging technologies, the authors conclude that further development of CAFM systems into decision support tools, which meet the requirements of a holistic integrated facility management, is on the way.

ACKNOWLEDGEMENTS

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REFERENCES

Berger, R. (2001): Trend Studie für Facility Management, Roland Berger Strategy Consultants und GEFMA, München

Brown, E., Kevin, R., Lapides, P., & Rondeau, P. (1995): Facility Management, John Wiley & Sons, New York

Cela, E. (1998): The Quadratic Assignment Problem. Theory and Algorithms, Kluwer Academic Publishers

Cotts, D. C., & Lee, M. (1992): The facility management handbook, Amacom, New York

Fenwick, J. (1998): Competitive advantage. Premises & Facilities Management, Vol 4 No.1, pp.23-24.

Finlay, D. (1998): A commercial approach, Premises & Facilities Management, Vol 4 No.1, pp.25.

FM-Monitor (2004), Swiss facility management monitor, pom+Consulting AG, Zürich

GEFMA (2007): Computer Aided Facility Management CAFM – Begriffsbestimmungen, Leistungsmerkmale, GEFMA Richtlinie 400, Bonn

Grabatin, G. (2001): Betriebswirtschaft für Facility Management, TAW-Verlag, Wuppertal

Harris, I. (2002): Bigger and better FM - to improve everyday life, European Facility Management Conference, Madrid

IFMA (2007a): International Facility Management Association: What is FM?. Retrieved January 30, 2007, from http://www.ifma.org/what_is_fm/index.cfm

IFMA (2007b), International Facility Management Association: What is FM?. Retrieved January 30, 2007, from http://www.ifma.org/what_is_fm/fm_definitions.cfm

König, W., Rommelfanger, H., & Ohse, D. (Eds.) (2003): Taschenbuch der Wirtschaftsinformatik und Wirtschaftsmathematik,Verlag Harri Deutsch, Frankfurt am Main

Lunn, S. D., & Stephenson, P. (2000): The impact of tactical and strategic automation, Facilities, Vol.18 No. 7/8, pp. 312-322.

May, M. (2002): How to Implement CAFM Successfully, Proc. I. European Facility Management Conference, Madrid, pp. 41-52.

May, M. (2005): CAFM-Einführung – (K)ein Buch mit sieben Siegeln – Tipps zur CAFM-Einführung. Facility Managemen, Vol.12 No.6, pp. 2-5.

May, M. and Hohmann, J. (2004): CAFM in Europe – Quo Vadis?, Proc. 4th European Facility Management Conference, Copenhagen, pp. 8.

May, M. (2006): IT im Facility Management erfolgreich einsetzen: Das CAFM-Handbuch, Springer-Verlag Berlin Heidelberg New York

May, M., Madritsch, T., Koenig, T., Meier, M. and Scharer, M. (2007): Computer Aided Facility Management im deutschsprachigen Raum – CAFM-Praxiserfahrungen aus Deutschland, Österreich und der Schweiz, BoD-Verlag, Norderstedt

Marchionini, M., May, M. (2008): Neue Technologien zur Optimierung einer strategischen Flächennutzungsplanung. to appear in Der Facility Manager 4(April 2008)15.

McAndrew, S. T., Anumba, C. J., & Hassan, T. M. (2005), Potential use of real-time data capture and job-tracking technology in the field. Facilities, Vol. 23 No.1, pp. 31-46.

Naevy, J. (2006): Facility Management (4th ed.), Springer, Berlin

Rettinger, C., Marchionini, M., May, M. (2007): Computerbasiertes Generieren von Belegungsplänen bei Umzug oder Flächenverdichtung in großen Organisationen“. Facility Management 2007, Frankfurt, pp. 195-203.

Schach, R. (2005): Integriertes Facility-Management: Aus Forschung und Praxis (Bd. 4), expert-Verlag, Renningen

Stahlknecht, P. (2005): Einführung in die Wirtschaftsinformatik (11.ed), Springer Verl., Heidelberg -New York

Teicholz, E. (1995): Computer-Aided Facilities Management and Facility Conditions Assessment Software. Facilities, Vol.13 No. 6, pp. 16–19.

prEN 15221-1, (2006): Facility Management - Part 1: Terms and definition, CEN/TC 348, European Committee for Standardization, CS: 01.040.01;03.080;03.100.99

RFID TECHNOLOGY CHANGES FM SERVICES DELIVERIES

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ABSTRACT

Radio Frequency Identification (RFID) is a common technology and widely used in logistic applications, and a large amount of envisaged applications in consumer, welfare and industrial sectors. In the construction and Facility Management (FM) sectors there are several identified potential application areas including component tracking, inventory management and equipment monitoring. Despite of anticipated potentials the usage is still slight. In this paper, we shortly review the RFID technology including near field communication (NFC) evolved from a combination of earlier RFID contact-free identification. This very short-range wireless point-to-point interconnection technology is expected to become a common technology in mobile phones, and in fact these kinds of phones already exist offering intuitive, easy-to-use touch-based communication and interaction between two devices with reasonable price and low immunity to eavesdropping. Based on existing mobile phones we give examples and hands-on exploitation experiences in janitorial and real estate management services, access rights controls and mobile access managements. In addition we give general overview on RFID utilization, its obstacles and diffusion in construction and FM applications. Finally the paper suggests the FM owners and service providers to increase communication and sharing of real time information with customers due to its importance in looking for opportunities in enlarging offerings not yet comprehended by owners and providers.

KEYWORDS: RFID, Near Field Communication, mobile phones, mobility, services

INTRODUCTION

RFID (Radio Frequency IDentification) is a common technology and widely used in logistic and retail trade applications. It is expected to be the next wave in the evolution of computing. Essentially, it is a technology that connects objects to the Internet or databases, so they can be tracked, and companies can share data about them. Applications utilizing RFID technology can be found in such areas as pharmaceutical and healthcare industries as well as libraries and sporting events. In the construction sector there are several identified potential application areas for RFID technology (Wing, 2006). These include component tracking, inventory management and equipment monitoring. Suggested applications for the future include guided control of equipment, tags that can communicate fatigue or excessive stress in concrete and steel members, and concepts for safety management. Further the reference anticipates that maintenance applications probably hold the trigger needed to launch and propel RFID in construction and facilities management, which starts from the hand over of the building until its demolition (including the demolition phase). The FM processes encompass real estate (lease management), maintenance (preventive and repair), janitorial services, utilities (electricity, fuel, water, sewage), telecommunications (voice, video, data), projects (new buildings, remodelling), space management (space planning, move management, allocations), building management and building operations (amenities, parking, landscape, safety and security). FM is a rather big single investment flow and one of the fast growing service sectors. It is obvious that cost-effective applications will be those that offer exploitable technology and services throughout the whole service life of the building and not just during construction. Since FM is concerned with long term operations, there is both scope and motivation for improvement.

Mobility is characteristics for FM work and hence mobile phones are heavily used for speech and text messaging (SMS) communications, but usage of other mobile phone services has not been established as a part of operation processes according to the market study (Leskinen, 2006). However, usage of mobile phones for sending and receiving e-mails is increasing. Today new mobile and wireless communication technologies provide platforms for advanced communication (Sallinen, 2007). Short range communication technologies such as RFID, Bluetooth, Zigbee and IrDA offer a huge amount of applications. From these technologies, RFID is one of the promising technologies to be used with human operator. New technology will change service deliveries and also generate a new business for service sector. Development of the state-of-the-art technology goes very fast, and therefore there are concerns how well it is suited for industrial applications, and does it fulfil requirements of the harsh use conditions. In fact, RFID is more robust technology than bar coding and, more importantly, is able to provide not only bond between information and material, but also provides output in electronic form that is immediately usable for unique identification or a hyperlink to a database, whereupon RFID is quite suitable for construction and FM applications. On the other hand, prices are coming down all the time. When the price of a single tag has decreased from 30 cent (year 2004) to 7 cent (year 2007), and in the future there is possibility to expect the price of one cent for a single tag. Also RFID reader integrated with mobile phone is an important promoter for this kind of new applications.

The paper is structured to give an introduction to RFID technology with near field communication (NFC) to enable users to access content and services with hand-held devices. In the FM applications chapter we give a general overview on RFID utilization, its obstacles, diffusion and expected benefits. Examples of RFID in fundamental FM services chapter presents some pilots we have made in cooperation with service providers (FM and IT), building owners and building users (customer). Some of pilot applications are already taking commercial use. Finally, applications of the technology in the FM industry are summarized.

RFID TECHNOLOGY

Generally, Radio-frequency identification (RFID) is an important automatic identification technique with a great potential. RFID technology is currently being used in such areas as agriculture, athletics, manufacturing, security and law enforcement, and transportation, but few applications have been developed that are related to the construction and facilities operations environment (Erabuild, 2006). With RFID it is possible to read a tag through the packaging or the product itself. RFID scanning is done by automatic readers and does not necessarily require labour force. RFID tags are categorised as either active or passive. Passive RFID tags have no power source and no transmitter. They are cheaper than active tags and require no maintenance. A passive RFID transponder consists of a microchip attached to an antenna. Read-only tags are typically passive and are programmed with a unique set of data (usually 32 to 128 bits) that cannot be modified. Typical read range is from a few centimetres to less than one meter. Active tags are used on large assets, such as cargo containers, rail cars and large reusable containers having a read range of 20 meters to 100 meters.

One of the most important differentiators between bar coding and RFID tagging is the ruggedness and environmental performance of the electronic tags. RFID tags can operate effectively in temperatures ranging from -40 to 200 degrees C and can perform under rugged conditions or even when dirty. Other main difference between bar-code and RFID is that RFID does not require line of sight as bar-coding does.

RFID in short range communication

Near field communication (NFC) is a very short-range (max. 20 cm, but typically only a few cm), wireless point-to-point interconnection technology, evolved from a combination of earlier RFID contact-free identification and interconnection technologies (ISO14443/MIFARE/FeliCa). It enables users' handheld electronic devices to access content and services in an intuitive way by simply "touching" smart objects (e.g. sensors, RFID tags, other handheld devices), i.e. connecting devices just by holding them next to each other (Sallinen, 2007). The communication is based on inductive coupling.

The legacy of earlier standards gives NFC compatibility benefits with existing RFID applications with a possibility to operate with old infrastructure, e.g. even if the RFID card or reader is replaced with an NFC-enabled mobile phone. NFC hardware can include a secure element for improved security in critical applications such as payments. It is expected to become a common technology in mobile phones in the near future, and when readers are implemented into mobile phones being moisture and other condition resistant, they can be used in industrial applications. These kinds of phones already exist. This technology offers:

- Intuitive, easy-to-use touch-based communication and interaction between two devices.
- Short communication set-up latency time being typically some hundreds of milliseconds.
- Longer lifetime of the sensor battery, or even implementation of the sensor without any battery.
- Reasonable price.
- Low immunity to eavesdropping and intentional or unintentional interferences

FM APPLICATIONS

In general, RFID utilization in construction and FM industry is slight due to the fragmented market with no dominant actor to enforce ICT solutions (Erabuild, 2006). FM industry is a conservative one where changes are occurring rather slowly and the main incentive has been the cost saving in real estate maintenance. This might originate mainly from the fact that landlords and investors are selling space, and the only way for the landlord to compete for tenants is the location of real estate and rent rates. However, the FM service provider should take care of service and maintenance operations, provide real time information for tenants and landlords about the progress of different duties; what duties are going on, what has been completed and when and so on. From the provider side these processes should be lean to be cost effective. Thus, in addition for offering efficiency also real time information on operations is important with the interacting parties in FM industry. Actually the whole FM supply chain management is one of the most demanding service and information environments.

The emergence of local connectivity e.g. to an RFID tag with mobile devices opens up possibilities for implementing novel user interface paradigms where manual inputs are no more necessarily required (Ailisto et. al, 2006). In this scenario the user can open a wireless GPRS (general packet radio service) connection by touching the physical icon e.g. a passive RFID tag attached to a device, a place or room enabling the user to access the information at the website or establish a secure connection to the back-end system and open up the context related application with an appropriate user interface.

Obstacles and RFID diffusion in FM operations

In general, primary reasons for slow implementation of RFID applications in construction and FM industry are the fragmented market with no dominant actor like WalMart in the retail industry to enforce ICT solutions (Erabuild, 2006). Further on, lack of industry standard, both national and international, and consensus as to what applications to use. In addition, this industry is acting local; it is project oriented influencing incentives, accounting, etc., when ICT must be deployable and profitable within one project to all/several partners. In spite of, several pilots are underway to increase productivity of FM services and to track materials at construction sites, as well as to apply RFID for construction access control and security (http://www.rakennusteollisuus.fi/RTKOY/Henkil%C3%B6tunnisteet+ja+kulunvalvonta/) (ELKU). Also individual objects such as tools are being tagged to decrease the economic loss they cause. Thus, priority in the RFID applications seems to be on:

1. Access control
2. Construction site safety and security
3. Tracking and control of bulk material, plant and equipment

Regarding to FM industry, access control seems to be almost the only exploitation of RFID, others are very few. Another type of example is the RFID based facilities maintenance application at Frankfurt Airport, where all fire shutters are equipped with RFID tags to store maintenance related information (Legner et al., 2006). That information is stored in the RFID memory and updated after the maintenance operation. As a whole the exploitation of RFID in FM industry seems to be rather low, in fact in an infant stage.

The price of RFID technology has now come to the level where it is no more a barrier to adoption. Currently the missing of industry wide standards and operational models in every day construction and FM business are seen barriers in mobile solutions rather than technological barriers. Construction and FM industry has only a little tradition for consensus and standardisation for exchange of information. Today the connectivity of mobile phones is excellent and several models have an integrated digital camera, Bluetooth radio, GPS (Global Positioning System) or even an integrated RFID reader. By taking the advantage of these accessories it is possible to change the way how service tasks are delivered. However, construction and FM industry have not yet comprehended the benefits of utilizing mobile devices and RFID tags. Mobile phones with accessories, in-situ RFID tags and connection to corporate IT system provide ways to share retrieve and respond rapidly to customer needs. In both cases the mobile worker requires a connection to and from corporate IT systems to mobile terminals and an efficient and user friendly way to achieve and perform given tasks out on the field with connections to back end systems and basic processes.

Expected benefits of RFID technology in FM industry

Generally, services will lead to increased customer satisfaction, saving money (cost reduction) or making money (increased revenue) and finally lead to increase in productivity of the FM industry. In FM applications benefits mainly lie in the time and cost savings increasing yield by improving operational efficiency and productivity, and only slightly in generating new revenue for an individual actor. However, in innovative services positive customer experience will lead to customer satisfaction and further to customer loyalty; e.g. sincerity and transparency of FM operations or sharing information to interacting parties will be an excellent starting point. By exploiting RFID tags and mobile technology with access to updated information in the server the owner, service provider and tenant can strengthen mutual communication and confidence, and hence increase customer experience. This will result in a better tenant or customer retention thus generating new service opportunities in building operations, new amenities the provider can offer and take responsibility of, thereby generating new revenues. As a result, speed-up of operation and increased efficiency can be rather straightforwardly converted into money or savings, but customer satisfaction e.g. in the forms of sincerity and transparency have an indirect influence in the revenue. Nonetheless they will yield better customer satisfaction and loyalty and hence in a positive spiral in the services delivery, which will result in new revenues in the form of new or enlarged services. Thus by initiating new concepts and looking at the ecology around the services that is what else the customer is close to or in contact with when performing his activity giving the provider a change to bundle the most economically attractive elements into a total opportunity. In services the communication with customers is important. Evidently, FM owners and service providers have not yet comprehended the benefits of using RFID and mobile technology to improve not only the communication with customer, but also operational efficiency and productivity, customer satisfaction with new opportunities.

EXAMPLES OF RFID IN FUNDAMENTAL FM SERVICES

This section presents some pilots we have made in cooperation with service providers (FM and IT), building owners and building users (customer). Used applications are very generic, and hence widely usable. Some of pilot applications are already taking commercial use.

Management of maintenance work with mobile application

Cleaning, both inside and outside of the facility, especially in commercial buildings, is one of the fundamental services provided by the service operator. In addition, cleanliness gives the first impression to tenants and visitors and also influences employees' mood and motivation. In the cleaning case the maintenance personnel can give starting and completing information of the needed work e.g. by touching an RFID tag attached in the place or room related to the service task with a mobile phone having add-on RFID reader covers. This is a sign and time stamp the workers starts the task and after completing the worker touches ones again the tag with the phone to give a sign and time stamp the work has been completed. Based on updated and real-time information both the tenant and the owner can make their own decisions and in addition, these signs create good and transparent base for the service provider for billing for the needed service. User interface can be made very simple, after touching the RFID tag the user ticks the start or completed box shown on phone screen and pushes the send button, when the phone takes connection to the server and updates the information (Figure 1). Additional simple but important services where use of RFID application are piloted are guarding and reception in the lobby or snowploughing and gritting of pathways in the outdoor area.

Furthermore, attaching tags in spaces in the facility the maintenance worker can go around the building and when entering a certain position he/she can touch the RFID tag with the phone and get information or task list from the server related to this space, acknowledge receipt of the task list and finally update to the server the duties he/she has performed. Hence, information on the server is always updated and accessed by relevant parties when needed.

Figure 1. Principle of service and quality management of maintenance work using mobile application (e.g. cleaning and building maintenance)

Electronic key-lock concept

Safety, security and theft counterfeiting are more important and more emphasised also in FM operations. Mobility is a central part in guarding and alarm services as well as in remote monitoring. Commercial guarding and alarm services with mobility exploitation are already in the market. Instead usage of mobile phones in access control is an emerging possibility. Mobile phone with RFID reader enables to replace physical keys with electronic keys in controlling maintenance personnel access rights to premises (Figure 2). Physical keys are replaced with phones having JAVA enabled secure chip covers. The server includes customer card IDs and expire date and access rights to a certain space. After authenticating the user client through SAM (Security Access Manager) and checking access rights to that specific space when in valid case the system opens the door and saves the time and place of that person in the back-end system. Thus, persons with access rights can be tracked and traced. Profiles and access rights can be updated over the air. Such electronic key-lock services can be used for instance to allow customized access to exhibitions, performances, sport halls etc.

The mobile lock management encompasses the following steps:

1. Insert customer information, card IDs and access information to the database
   - Installation and initialization of the applets to the customer clients
   - Profile installation e.g. expiry date and access rights

2. Update the customer profile over the air
3. Open the door or access to event for authenticated users with valid access-rights
4. Blacklist management via GPRS/WLANThe use of sensor output data

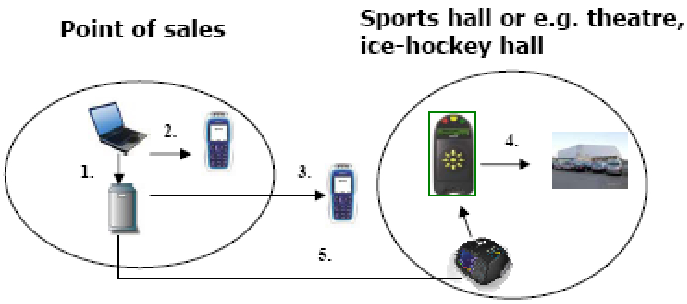

Figure 2. Electronic key-lock concept for access rights control

Mobile Access Management for Construction Site

Personal pictorial identification of employees is mandatory in Finland at construction sites encompassing employees working for several employers. This kind of personal identification is widely used at large professional construction sites. It is, however not an automatic access right to the site, but it presupposes that a separate right to access and work at the site has been given to the worker by the management and in practice by the site manager. The goal is to make sure that the management knows who are working and moving at the site. This is also a mandatory obligation for the main constructor according to the work safety law.

In the new access rights management model developed by VTT the permission to enter and work on a construction site is controlled by utilizing NFC/RFID, internet, mobile technology as a service fulfilling the new law from the year 2006. The new method is based on the personal identification card with embedded RFID tag, a mobile phone with RFID reader and a back end system containing employees' information. When touching the employee's personal identification card then the mobile phone contacts to the back end system, looks for the picture of the employee and checks the access rights as well as tells to the authority the worker's personal information data for facilitating them to verify the taxation notes (Figure 3). The solution is easy to use and flexible allowing adding or updating a new access and working pass to the construction site. The solution also enables a state authority to check on site the legal standing of the worker at the work site. The developed concept enables real time access rights maintenance and control.

CONCLUSIONS

In this paper, we have presented technologies for short range communication for FM and construction site application. Although the RFID utilization in construction and FM industry is slight there is such a big potential that it will certainly enter that branch of business. The technology is developing all the time and is exploited in other industry sectors. After shortly reviewing the NFC technology we describe obstacles and RFID diffusion and expected benefits of that technology in FM operations with some simple examples about RFID exploitations. Both cases demonstrate easy and straightforward applications of RFID tags applied together with mobile phone technology to give real time information for users. Regarding to FM industry, access control seems to be almost the only exploitation of RFID until now, others are very few. The price of RFID technology is no more a barrier to adoption, but primary reasons for slow implementation to construction and

Figure 3. Principle of construction site access control

FM industry are the fragmented market with no dominant actor and lack of industry standard. In FM applications benefits mainly lie in the time and cost savings increasing yield by improving operational efficiency and productivity, and only slightly in generating new revenue. However, in services the communication with customers is important in looking for opportunities to enlarge offerings. Evidently building owners and service providers have not yet comprehended the benefits of using RFID and mobile technology to improve not only the communication with customer, but also operational efficiency and productivity, customer satisfaction and new opportunities in the FM and construction industry.

REFERENCES

Leskinen Sonja. (2006), Mobile Solutions and the Construction Industry - Is it a working combination? VTT PUBLICATIONS 617, Espoo 2006, 93 p. + app. 2 p.

Wing, R. (2006), RFID applications in construction and facilities Management. ITcon Vol. 11, pg. 711-721. http://www.itcon.org/2006/50/

Ailisto Heikki, Pohjanheimo Lauri, Välkkynen Pasi, Strömmer Esko, Tuomisto Timo, Korhonen Ilkka. (2006), Bridging the physical and virtual worlds by local connectivity-based physical selection. Personal and Ubiquitous Computing Vol. 10 No: 6, pp. 333–344.

Erabuild, RFID in Construction; Review of the current state of Radio Frequency Identification (RFID) Technology, its use and potential future use in Construction, ERABUILD final report, June/July 2006, 100 p.

Sallinen Mikko, Strömmer Esko, Ylisaukko-oja Arto. (2007) Implementation of NFC technology for Industrial Applications: case flexible production. SPIE conference, 10 September 2007. Vol. 6773.

Near Field Communications (NFC). Simplifying and Expanding Contactless Commerce, Connectivity, and Content. ABI Research, Oyster Bay, NY (2005).

ELKU http://www.rakennusteollisuus.fi/rtkoy/Sahkoiset_kulkuluvat_/etusivu (in Finnish only)

Legner Christine and Thiesse Frédéric. (2006), RFID based maintenance at Frankfurt Airport, Pervasive Computing, IEEE, Jan-March 2006, pp. 34-39.

THE BENEFITS AND OBSTACLES OF MOBILE TECHNOLOGY IN FM SERVICE PROCUREMENT

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ABSTRACT

By nature FM work is characterised by full mobility or micro-mobility workplaces. In both cases the mobile worker requires a connection to and from corporate IT systems to mobile terminals and an efficient and user friendly way to perform given tasks out on the field. Mobile phones with accessories, in-situ RFID tags and connection to corporate IT system provide ways to share retrieve and respond rapidly to customer needs. This paper presents an integration of several studies conducted at VTT to identify the current benefits and obstacles of mobile technology as perceived by the Finnish FM professionals. The main means of the study were (1) to describe the current technological enablers for the utilization of mobile technology at FM settings and (2) to interview the FM professionals on their perceived benefits and obstacles of the utilization of the currently available technology. The perceived benefits are mostly related to improved resource efficiency and quality control. To gain the benefits, according to the FM professionals it is essential to successfully integrate mobile applications into the company's other information systems and company's processes. The gaps in the integration undermine the potential benefits. More obstacles show up when the value chain extends outside the company's control, if the benefits fall into other parties.

KEYWORDS: FM services, mobile technology, perceived benefits, perceived obstacles

INTRODUCTION

Facility management is by definition integration of processes within an organisation to maintain and develop the agreed services to support and improve the effectiveness of its primary activities. The basic concept of FM is to provide integrated management on a strategic and tactical level to coordinate the provision of the agreed support services (CEN EN 15221-1:2006(E)). A recent study (Lehtonen and Salonen, 2005) exploring the procurement and relationship management trends in business services, particularly in the FM settings, found that a transition towards closer relationships and bigger purchase entities is taking place in FM in the same way as in other industries. But in contrast to the prevailing trends in other industries, there was increase in the size of supplier bases in FM. This might be partly due to the organisations outsourcing more of their facilities related functions during the last years and partly due to the shift from using a sole supplier to using number of specialist partners. As the lack of sourcing strategies, this also mirrors the fact that the outsourcing and procurement practices of FM services are still under transformation phase.

The fact that FM related services are created to meet user requirements by provision of both material and human resources makes the efficacy and accuracy of communication critical to success: FM is the intersection of the demand and supply chains, and in position to optimise the process by its ability to turn information into efficient decision tool. A factor that amplifies the importance of ICT is that the professional FM and service providers are increasingly large enough to cover wide areas and utilise often international service providers, where the value is created in different organisations and places. It is critical to gain valid and timely information on aspects to manage, including the performance of the facility (i.e. thermal conditions, energy consumption) and the people (i.e. how long have the cleaning staff worked on the negotiation room, is it clean and available for the next meeting). Therefore the potential of ICT technology to add value to the services is in the core of the business.

Real estate and FM businesses are typically manpowered with mobile staff and equipment, and significant material flows. The businesses have notably scant utilization of the mobile applications, in particular in relation to the potential. The mobile phones are almost entirely used for speech and text messages. These are, however, well established as a support to work. Some new applications are at trial stage, including control of safety matters at construction site; some quality control aspects have been piloted with mobile applications; and logistics. The most frequent mobile application for real estates is the service request processing from reception of the request to acknowledged response and reporting. Additional applications are emerging from combination of RFID (radio frequency identification), NFC (near field communication), GPS (general positioning system) and mobile phones. Further innovations for utilization of camera and multimedia transfer with mobile phones are under development.

The advances in the usability of mobile technology and simultaneous increase in market saturation with mobile devices has accelerated the diversity of benefits from access to data regardless of time and place. The use has diverged from original speech and text messages. The current applications are mostly aimed at non-professional and often entertainment contents. In addition to private aspirations, some professional applications have been developed. Typical areas of operation are public services (library, health care etc.) and business to customer issues such as travel items (ticketing, hotel reservations, and confirmations) and importantly, information delivery. Business to business solutions include process follow-up, tracking of transports, and various information services. Businesses to employee solutions include calendar, work time recording, guidance for mobile workforce and reporting. Natural settings for such are sales, maintenance and service activities.

MOBILE TECHNOLOGY AND FM SERVICES

Mobility has become an essential part of our life and it will continue to grow in significance. Mobility, sharing of information and knowledge, and collaboration across organisational networks is key aspects of workplace innovations. New information and communication technologies enable a diversity of future workplace scenarios. However, coping with the human and organisational aspects involved will determine their success or failure. According to Schaffers (2006) there are four generic forms of mobile work 1) Full mobility workplace, 2) Micro-mobility workplace, 3) Multi-location workplace and 4) Dynamic workplace. Regarding to FM work two first mentioned apply, since in full mobility workplace the collaborative workspace is supporting full worker mobility and adaptive to any context.

The development of new mobile services has been slowed down by a series of obstacles (Tolman et al. 2006) such as the ignorance of the new possibilities which mobility could bring to the facility services; problems of interoperability; i.e. the immature development of systems and software architectures that link services and content to the mobile world; the question of how and to what extent will users embrace new ways of consuming content and services; and the need for new successful business and delivery models that involve industry and research organizations restructuring through new kinds of agreements, etc.

Currently used mobile technology

The technologies commonly utilized within facility management profession are mobile phone (speech and text messaging), GPRS and somewhat lesser the integrated camera in the cell phone. RFID reader is applied in the context of logistics and control of equipment, and quality control. Further exploitation of RFID is emerging in janitorial services, access rights controls and mobile access managements with very short-range wireless point-to-point interconnection technology is expected to become a common technology in mobile phones, and in fact these kinds of phones already exist offering intuitive, easy-to-use touch-based communication and interaction between two devices with reasonable price and low immunity to eavesdropping. The new communication and messaging systems give new possibilities and methods to manage and communicate with embedded sensor networks in buildings with general terminal equipments trough local or global information networks (Tolman et al., 2006).

Today the connectivity of mobile phones is excellent and several models have an integrated digital camera, Bluetooth radio or GPS (General Positioning System) or even an RFID reader integrated in the back cover to mention some of them. By taking the advantage of these accessories it is possible to change the way how service tasks are delivered.

The current uses of mobile technology in FM

The common FM related uses of the integrated technologies in mobile phones include the management of service requests, reporting of services related incidences and accepting the activities. The quality control from either the demand or supply side and better accuracy of the facility services is a major field of applications. Furthermore, the utilization degree of equipment, machinery and vehicles, and the related maintenance needs and location information follow-ups are gathered with integrated mobile devices. The logistics of mobile services are controlled, monitored and optimized, and various pieces of data are transferred and reported with mobile phone applications.

THE FEASIBILITY: RESULTS OF INTERVIEWS

To test the feasibility of enhancing FM service procurement by the utilization of currently available mobile technology the Finnish key players of the profession were interviewed during 2007. In particular the benefits and obstacles of mobile technology implementation on their businesses were sought for.

The perceived benefits of mobile technologies

Main part of the interviewees felt the technology exceeding the minimum requirements for implementing current mobile applications. Integration to the back end systems as well as usability and clearness of the mobile application will be decisive whether the application is exploited or not.

The perceived benefits are mostly related to improved resource efficiency and quality control. The better service instruction and guidance, and timely working instructions improve the output. The quality control issues are enhanced with visual aids of camera and other gadgets integrated to mobile phones.

Paper work has been lessening, the quality of data and information has improved and become real-time for multiple parties (i.e. the facility manager, service provider and the client have access to the same information at the same time). Lesser disputes occur.

The management of fixed assets is enhanced. Occupancy rates can be better adjusted according to real circumstances.

Follow-up is easier and on real-time. A facility manager even in another country can visually observe real-time incidences of the site. The location of an employee with confirmation of things to be done, and resulting acknowledgments of actions give real-time control of staff and resource use. Monitoring of performance and output quality can be done and recorded for i.e. payments or documentation in case of disputes.

The perceived obstacles of mobile technologies

The previously observed obstacles (such as the above mentioned) have been only partially overcome. Yet the currently perceived obstacles are more on the frame of the integration of mobile services than on the maturity of mobile services.

When a market study was carried out (Vähä et al., 2006) among the companies involved in services for facilities management sector either as service providers or clients, the consensus result among the companies was that the companies recognize their need for upgrading their activities (either as service providers or clients), but feel the development of mobile supporting systems as outsider to their core business and even more outside of their capabilities. Currently the enabling mobile technology for upgrading the FM related services is in relatively mature stage, but the value chains lack the business intelligence for sharing even the identified benefits. Furthermore many benefits remain unidentified.

To gain the benefits, it is essential to successfully integrate the mobile applications into the company's other information systems and company's processes. The gaps in the integration undermine the potential benefits. To gain optimal solution, the processes need re-evaluation with the options to change or omit parts of current practice. The obstacles show up when the value chain extends outside the company's control. If the benefits fall into other parties, there is no motivation. If the change of practices needs to modify other companies' modes of actions, it is hard to endorse for external parties.

Both construction and FM sectors agree that the obstacles to exploitation of mobile technology are rather related to the lack of modes of operation with the enabling technology than in the capacities of the technology itself (Leskinen, 2006). The problems occur both within companies and between them. The lack of knowledge on mobile solutions, difficulties in integration of systems, and lack of routines in procurement and operation are hindrances.

The technology related problems often hinder the integration of mobile applications to existing IT systems within the company. The integration may be technically challenging and the costs may rise to make the effort unprofitable. The mobile solutions and IT background systems often have different suppliers, which is a major hindrance to the integration and interoperability. The success in the integration is vital for the profitable exploitation of mobile applications.

When the amount of data transfer increases and the integration to company's background system becomes more essential, the need for data protection becomes more critical. This has been recognized as something to take good care of, but not seen as an unsolvable problem.

CONCLUSIONS

Main part of the interviewees felt the technology exceeding the minimum requirements for implementing current mobile applications. Integration to the back end systems as well as usability and clearness of the mobile application will be decisive whether the application is exploited or not. The usual processes possess several daily routine tasks like monitoring, reporting and logistics, where mobile technology could be applied as a natural part of the service process, if the back end systems and processes are on a satisfactory level. In repetitive processes like in information collections mobile solutions are believed to increase, but they do not bring, however, considerable strategic solutions to FM companies. Instead, more significant benefits could be gained from mobile solutions strengthening the operation of the whole value chain. This in fact presupposes that the whole value chain is integrated in it. Responsible providers offering these services are missing, and FM companies do not feel themselves to be the right operators for this kind of tasks. Thus, new entrants are required to provide, maintain and guide the usage of mobile solutions. This will result also in the emergence of new operational models and to open up novel possibilities e.g. to sign for a delivery from the supplier or a subtask performed by a subcontractor. All these performed actions will be transparent to all suppliers and subcontractors in the value chain (Leskinen 2006).

Mega trends like internet usage, digital imaging, broadband connections, location and map information, user created content, and open source business models prevailing and shaping the field and profoundly influencing the practices of the daily routines. The last two, user created content and open source business models do not fit well to the construction sector, but the others do and are already partly applied. Remarkable new potentials will be the usage of RFID tagging, GPS, and digital cameras. Once these last mentioned three potentials are integrated into the mobile phone, they offer huge possibilities. At the moment such phones were one or two the characteristics can be found, but not all three in the same, but maybe in the near future. Regarding to RFID tagging test cases in asset management and maintenance within the construction sector especially applications involving handheld computers for use on-site have reported (Wing, 2006).

Connectivity creates a new business model for facility managers. Network allows leasing of spaces to move toward service rendering by providing ability to optimize building and tenant management e.g. by tracking status of work orders. It enables 24-hour availability and also enhances responsiveness. It provides facility managers and tenants with a greater control over the FM operations; a tracking system for maintenance people and work progress. This shifts the business model from space to service.

REFERENCES

European Committee for Standardization. EN 152221-1-1:2006:E. Facility Management – Part 1: Terms and definitions. Brussels. October 2006. 15 p.

Lehtonen, T., Salonen, A. (2005), Procurement and relationship management trends in FM services. 21st Industrial Marketing and Purchasing Conference, 2005. 13 p.

Leskinen Sonja, Mobile Solutions and the Construction Industry - Is it a working combination? VTT PUBLICATIONS 617, Espoo 2006, 93 p. + app. 2 p.

Shaffers, H. (2006), "Innovation and systems change: the example of mobile collaborative workplaces" available at: https://doc.telin.nl/dscgi/ds.py/Get/File-50064/AI_Society_paper_HS_v3.pdf.

Tolman, A., Möttönen, V., Tulla, K. (2006) Mobility in Facility Services. in: Proceedings of Changing user demands on buildings, needs for life cycle planning and management. Edited by Haugen, T. I., Moum, A., Bröchner, J. Trondheim international symposium CIB W70, 12-14 June 2006. Norwegian University of Science and Technology. Trondheim June 1996. ISBN 82-7551-031-7. Pp 559 – 565.

Vähä, P., Tolman, A, Savioja, P., Lampila, P., Kangas, S. (2006) Service beyond- enabling technologies to boost service business. in: IBM Research, Almaden Services Research. Services Science, Management & Engineering Conference. New York, October 2006. 4 p.

Wing R (2006) **RFID applications in construction and Facilities Management**, ITcon Vol. 11, Special Issue IT in Facility Management , pg. 711-721, http://www.itcon.org/2006/50

ACCESSIBLE TOILETS IN SHOPPING CENTRES

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ABSTRACT

Consumers visiting shopping centres are obliged to visit toilets every now and then. On the other hand, shopping centres and restaurants are often built in a way that would attract consumers to spend there as much time as possible. The longer a consumer stays in a shopping centre or restaurant, the more money is spent and cash flow created to the individual stores and restaurants, consequently also for the centre. However, the accessibility in public toilets is often limited originating from the location, design and maintenance of the toilet spaces. When toilet spaces are designed, built and maintained like the way consumers want, the overall satisfaction level of the visit increases. In this research, the idea was to find out the attributes of a well-functioning and good accessed public toilet space.

KEYWORDS: Shopping centres, toilets, consumer behaviour

INTRODUCTION

Shopping is widely regarded as a major leisure-time activity. According to Cullen (1990), it is second only to television watching in the pantheon of British pastimes and broadly similar statistics have been cited by many other commentators on popular culture (Brewer and Porter 1993).

Consumers visiting shopping centres are obliged to visit toilets every now and then. On the other hand, shopping centres and restaurants are often built in a way that would attract consumers to spend there as much time as possible. The longer a consumer stays in a shopping centre or restaurant, the more money is spent and cash flow created to the individual stores and restaurants, consequently also for the centre. However, the accessibility in public toilets is often limited originating from the location, design and maintenance of the toilet spaces.

When toilet spaces are designed, built and maintained like the way consumers want, the overall satisfaction level of the visit increases. In this research, the idea was to find out the attributes of a well-functioning and accessible public toilet space. The standpoint is in toilets located in shopping centres but also restaurant and office toilets are analysed.

This paper starts with the theoretical discussion about consumer needs and shopping. After this are the research method and results presented. The last part of this paper discusses about the results and gives implications to shopping centre management and design.

Shopping as a phenomenon

If the innumerable "shopping" epithets are any indication, an ethos of "shop til you drop", "when the going gets tough, the tough go shopping" and "I shop, therefore I am" is extremely widespread at present. Granted, this apparent preoccupation with shopping is not exactly a recent phenomenon - acts of compulsive consumption were being reported in the seventeenth century - and the economic recession of the early 1990s has undoubtedly reduced the ardour of the “consuming passion” that gripped the country in the late 1980s (Gardner and Sheppard, 1989).

Nevertheless, it is still true to say that, as Gardner and Sheppard (ibid.)emphasized at the height of the 1980s shopping boom, “retailing has been imbued with a whole new ethos, a new significance, a new cultural meaning - and commodities themselves seem to have taken on a new, central role in people’s lives” (Gardner and Sheppard ibid.). The idea of shopping centres is to attract consumers for as long time as possible. The longer they stay in a shopping centre, the more money they spend.

Need for toilets in shopping centres

The water closet (WC) is an essential facility for all washrooms and its minimum provision in shopping malls has been specified in building regulations, codes of practice and design guides (British Standard, 1994; Wistort, 1995). A large shopping mall could be designed to house various types of retailers, cinemas, playgrounds, and areas for exhibitions and multifunctional activities to attract thousands of customers. The demands for sanitary accommodation in shopping malls are very different from those in other types of premises, e.g. offices and schools, in terms of the time between user arrivals and the service time (e.g. Green and Smith, 1976).

Demands may peak at certain short periods in offices (e.g. before lunch) and schools (e.g. breaks between classes), but remain relatively low for other periods (Davidson and Courtney, 1976, 1980). However, such demands in a shopping mall depend very much on the nature of activities held there, the composition of its retailers and the length of time a customer spends in the facility, presenting considerable uncertainty regarding the arrival distribution. The research within the shopping centre toiletry is limited. However, Wong and Jau (2005) have contributed to this theme.

More recently, it is suggested that the higher the experiential component and consumer involvement, the greater the emphasis not only on subjective or emotional aspects but also on objective aspects (Holbrook, 2000; Addis and Holbrook, 2001) of consumption. This suggests that the emphasis should not be on either experiential or utilitarian functional aspects but on how the consumer weighs these attributes in their overall judgments (Pine and Gilmore, 1999; Addis and Holbrook, 2001). Some researchers have suggested that experiential outcomes of the service offering are not the economic offering. They highlight the importance of subtleties, such as augmented service attributes and suggest it is these that drive value and satisfaction judgments (Johnston, 1999; Pine and Gilmore, 1999) and subsequently repurchase or re-consumption intention.

RESEARCH SETTING

As consumers develop perceptions of malls, it is important to understand how these perceptions are influenced by the consumption variables commonly associated with consumer socialization. The present study examines the consumption motivation of consumers, focusing specifically on the comparison of objective and social motivations for consumption (Moschis, 1976). In this study the focus is on exploring the relationship between these social predispositions and attitudes toward malls. Since malls are seen as both a habitat (Bloch et al., 1994) and as a more socially oriented place to shop, consumers with divergent predispositions or consumption motivations are likely to see the mall very differently.

However, at this time, it is not known if specific mall-related variables are perceived differently between socially and objectively motivated consumers, or if specific motivations to consume influence on a consumer's overall perceptions of a mall's environment.

Therefore, the present study will attempt to formulate answers to four important and related areas of research focusing on consumers, their perceptions of shopping malls, and specific stimuli that drive these consumers to shop or browse in malls. The research questions are listed below:

Research question 1: What perceptions do consumers possess of shopping centre toilet services?

Research question 2: What operations do consumers perform to make shopping centre toilets more accessible?

Research question 3: How does a dream toilet look like?

RESULTS

The empirical background data consisted of totally 3079 e-mail interviews made in seven European countries (Table 1). The research was conducted through an e-mail survey. The sex ratio was balanced as well as the geographical ratio inside the countries. The age ratio was 16 to 65 years.

Table 1. Research group

Country	Amount of respondents
Sweden	474
Norway	410
Denmark	459
Finland	483
Poland	421
Germany	442
UK	433
TOTAL	3079

The results were performed through factor analysis. The data was analysed with statistical program SPSS 12 (Gorsuch, 1983; Velicer and Jackson, 1990).

The provision of sanitary accommodation for casual users is difficult to quantify. WC installations appear to be satisfactory with respect to the statutory requirements that an appliance is designated to serve a number of occupants. However, inadequacy of such sanitary facilities, in some shopping malls has been reported recently (Wong and Yau, 2005). In other words, a long waiting time to get the sanitary services has been experienced during peak hours although the design meets all the building regulations. The waiting time is probably one of the primary concerns to quantify a user's satisfaction of the service provided.

Additional WCs have been actually installed in some shopping malls to reduce the probable waiting time at peak demands, so that the overall service of the shopping mall can be enhanced. The additional provision could be determined by the professional judgments of designers but the performance of a provision is still uncertain without further feedback from the users. This practice is obviously costly in terms of time and money. Probable reduction in waiting time and queue length for the additional appliances installed must be quantified for a cost-effective installation.

The answers for research question 1 were approached through the worst thing that makes consumers to feel a toilet unaccessible. The worst thing was the toilet being stuffed-up. It was followed by bad signing and the dirtiness of the toilet. The toilet as a subject to a fee was considered next. No toilet paper, bad smell and no possibility of flushing were next in order. Finally were ranked the wet toilet paper and the lack of soap.

Research question 2 was approached through the operations consumers perform in order to avoid harmful toilets. The most important factor was that consumers wipe the toilet seat in order to avoid diseases. Placing paper to the toilet seat and avoiding touching the door handle were the followers.

Research question 3 was approached through the design perspective. What consumers actually demand for an accessible shopping centre toilet facility? The result was that whatever the toilet does look like, whatever the physical attributes are, a dream accessible toilet should be clean. The cleanliness was the major component of all factors. Secondly, a dream accessible toilet should be free-of-charge. A factor that a dream toilet should possess a hand shower was mentioned as the third important factor. Clean toilet paper, the possibility to clean the toilet set by self and fresh odour was mentioned as the following factors. Interesting design and the beauty of the toilet space were the last mentioned factors.

According to the results, design criteria of accessible toilets depends first and foremost on psychological and cultural attitudes, such as basic physiological and anatomical considerations and physical or the ‘human engineering’ problems of performing the activity (mentioned also in Kira, 1976)

Other major concerns in accessible toilet design are the lack of privacy, insufficient lighting and physical safety. Spending some extra time upfront in designing the toilet is better than wasting lot of time in maintenance later on (Allyn, 1999). Attention to details in the toilet layout is very important in the design of a toilet. There are also a few design options to be added: automatic faucets, motion sensors instead of light switches, plastic stalls with heavy weight hinges and urinals without edges to prevent unaccessibility.

IMPLICATIONS

The most important implication arising from this study is that as a group the toilet preferences display some diverse shopping attitudes and behaviours. The findings indicate that this group is largely motivated by objective, functional and economic motivations to toilet services, they spend relatively low levels of time in the mall, and they are likely to visit a relatively little time in toilets during a visit. Although untested, these results tend to indicate that this group of consumers is more strongly associated with utilitarian rather than hedonic shopping values. Utilitarian shoppers are likely to purchase products in a deliberate and efficient manner, while hedonic shoppers are motivated by the emotional and entertainment dimensions associated with shopping.

The observed emphasis that consumers place on objective shopping and utilitarian benefits is important to mall managers as they attempt to draw consumers into their shopping malls. Based on the present results, mall managers would be more successful in drawing these consumers into their mall locations by emphasizing unique supportive (such as toilet) facilities or sales at popular specialty stores within the mall. As these consumers limit their time spent within the mall stores, it is important for these consumers to have an objective reason or motivation driving their mall visit.

A final implication is that both objective and social motivations significantly predict perceptions of ambiance in shopping malls. This is the only variable used in this study that is predicted by both forms of motivation. The measure for ambiance (Wakefield and Baker, 1998) is composed of items for choice of music, music volume, lighting and temperature. Since two of the four-item are concerned with music, this is a variable with which mall managers should be particularly careful in the toilet facilities. Research indicates that music tempo influences consumption behaviour, and that consumers tend to shop to the beat of the music played in retail environments. However, care should be taken as playing music with relatively faster tempos may shorten the already brief time that consumers spend in a store.

In the future, research should be aimed towards the more physical attributes of the toilet space; the lightning, lay-out and size of the toilet space. It has long been recognized that some shoppers derive considerable personal satisfaction from the opportunity it gives them to meet other people. The introspective account, however, suggests that the social side of shopping is rather more complex than this.

For example, the informant’s clear desire to avoid certain individuals or be avoided in turn, his hostile reaction to other people combined with an expectation of reciprocal hostility and, not least, the negative response to simulated conversations with store employees (an unanticipated side-effect of customer care training programmes?). At the opposite extreme from such antisocial “social” elements, are those which are predominantly sexual in orientation.

The introspective account employed many sexual or sex-related allusions and, although these can be dismissed as idiosyncrasies of the essayist, such a response may prove to be somewhat hasty. Apart from the fact that anthropologists have long recognized a connection between the consumption of food and the consummation of sexual encounters, the growing incidence of grocery store “singles nights” and, indeed, reports of marriage ceremonies being conducted in-store, suggests strongly that the connection between sex and shopping is ripe for further academic investigation (Brown, 1995). In summary, shopping centres must appropriately modify the basic components of consumer satisfaction to develop a context-specific definition that will guide the assessment of satisfaction.

Shopping centre facilities research is still in its early days. Real estate and marketing practitioners and researchers have been extending retail store atmospheric concepts to the shopping centre environment because primary data are not available. Similar to retail stores, the shopping centre is part of the wrapping of products and services together. Real estate and marketing scholars should give more attention to the shopping centre environment.

REFERENCES

Addis, M. and Holbrook, M.B. (2001), “On the conceptual link between mass customization and experiential consumption: an explosion of subjectivity”, Journal of Consumer Behavior, Vol. 1 No. 1, pp. 50–66.

Allyn, N. (1999), “Hygienic by design: Improve image and cleanliness, reduce waste through careful restroom planning”, Building, Vol. 93, p.24.

Bloch, P.H., Ridgway, N.M. and Dawson, S.A. (1994), “The shopping mall as consumer habitat”, Journal of Retailing, Vol. 70 No. 1, pp. 20-43.

Brewer, J. and Porter, R. (1993), Consumption and the World of Goods, Routledge, London.

British Standard (1994), British Standard BS6465. Part 1: Code of Practice for Scale of Provision, Selection and Installation of Sanitary Appliances, British Standard Institution, London.

Brown, S. (1995), Sex ‘n’ Shopping, Institute for Retail Studies, Stirling University, Working Paper Series.

Cullen, C.W. (1990), Shopping as Entertainment: Implications for the Shopping Centre Manager, Institute for Retail Studies, Stirling University, Working Paper Series.

Davidson, P.J. and Courtney, R.G. (1976), "Revised scales for sanitary accommodation in offices", Building and Environment, Vol. 11 No.1, pp.51-56.

Davidson, P.J. and Courtney, R.G. (1980), "A basis for the revision of scales for sanitary accommodation in schools", Building Services Engineering Research and Technology, Vol. 1 No.1, pp.17-23.

Gardner, C. and Sheppard, J. (1989), Consuming Passion: the Rise of Retail Culture, Unwin Hyman, London.

Gorsuch, R. L. (1983), Factor Analysis, Lawrence Erlbaum, Hillsdale, NJ

Green, M.F. and Smith, B.S. (1976), "Sanitary appliance provision scales based on a probabilistic analysis of use", Building Services Engineer, Vol. 43 No.1, pp.197-201.

Holbrook, M.B. (2000), “The millennial consumer in the text of our times: experience and entertainment”, Journal of Macromarketing, Vol. 20 No. 2, pp. 178–92.

Johnston, R. (1999), “Service transaction analysis: assessing and improving the customers experience”, Managing Service Quality, Vol. 9 No. 2, pp. 102–09.

Kira, A. (1976), The bathroom, Viking Press, New York.

Moschis, G. P. (1976), “Shopping orientations and consumer uses of information”, Journal of Retailing , Vol. 52, pp. 61-70

Pine, B. and Gilmore, J. (1999), “Welcome to the experience economy”, Harvard Business Review, Vol. 76, pp. 97–105.

Velicer, W. F. and Jackson, D. N. (1990), “Component analysis versus common factor analysis: Some issues in selecting an appropriate procedure”, Multivariate Behavioral Research, Vol. 25 No. 1, pp. 1-28.

Wakefield, K. and Baker, J. (1998), “Excitement at the mall: determinants and effects on shopping response”, Journal of Retailing, Vol. 74 No. 4, pp. 515-39.

Wistort, R.A. (1995), A Critique of Queueing Theory Approaches to Plumbing Design, ASPE Research Foundation, Los Angeles, CA.

Wong, L.T. and Yau, C.L. (2005), “Modelling water closet demand in shopping centres”, Facilities, Vol. 23 No. 9/10, pp. 453 – 65

TACTILE PAVING SITE SELECTION CRITERIA

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ABSTRACT

SURFACE Inclusive Design Research Centre at the University of Salford is currently conducting an EPSRC funded research, - I'DGO TOO (Inclusive Design for Getting Outdoors). The project is concerned with tactile paving whether it is inclusive as an indicator of access hazards for visually impaired people and other vulnerable population groups (e.g. older people). After an extensive literature review and pilot studies, research methodology of the project was established in the form of a model that calls for full characterization of the pedestrian, access hazards and any other contextual issues that affect performance of the pedestrian. This paper reports on the rigorous methodology that has been adopted to develop site selection and benchmarking criteria (both microscopic and macroscopic) for characterization of the pedestrian and access hazard environment. The process included reviewing databases and literature leading to selection of 54 short case study sites (rural and urban) across UK. These sites were will be observed and recorded over a period of 12 hours and benchmarked. 18 longitudinal study sites will be selected from the 54 sites and observed and recorded for a two year period (at different times of days, different days of week and in different seasons). The resulting data will be analysed to critically evaluate existing pedestrian environments and access hazards in terms of their design, execution and outcome. A series of site selection and benchmarking criteria that may be adopted for studies of a similar nature are given.

KEYWORDS: access hazards, benchmarking criteria, inclusive design, tactile paving.

INTRODUCTION

SURFACE Inclusive Design Research Centre at the University of Salford is currently conducting an EPSRC funded collaborative research - I'DGO TOO (Inclusive Design for Getting Outdoors) (I'DGO, 2007). The overall aim of the I'DGO Consortium is to addresses the demands, consequences and impacts of new policies and design strategies on older people's environments, and make specific recommendations to make them inclusive; thereby improving quality of life for older people, in such a way that it will become general practice in the years to come. SURFACE is currently investigating the use of tactile paving at road crossings and external steps. Tactile paving is used as an indicator of access hazards for vision impaired people. After an extensive literature review and pilot studies, the research methodology of the project was established in the form of a model that calls for full characterization of the pedestrian environment and access hazards and any other contextual issues that affect performance of pedestrians.

This paper reports on the methodology that has been adopted to develop site selection and benchmarking criteria (both microscopic and macroscopic) for characterization of the pedestrian and access hazard environment. The process included reviewing of Transport Research Laboratory (TRL) database, Local Transport Note (LTN) 1/95 and 2/95, which led to selection of 54 short case study sites (rural and urban) across UK. These short case study sites will be observed and recorded over a period of 12 hours and benchmarked. 18 longitudinal study sites will be selected from the 54 bench marked sites (1 in 3), observed and recorded for a two-year period (at different times of days, different days of week and in different seasons). Collected data will be analysed critically to evaluate existing pedestrian environment and access hazards in terms of their design, execution and outcome.

TACTILE PAVING

Tactile paving provides a warning system for vision impaired people to aid their independent mobility in external environments. Since its introduction in the UK in the early 1990's tactile paving has become a key design feature in improving the accessibility of various public spaces. The advent of the Disability Discrimination Act (1995, 2005), with its requirements for inclusive design and equality of access to services, has increased the rate of installation of tactile paving. Tactile indicators are primarily intended for vision impaired people, but may be less suitable for older people where they are a potential trip hazard (Loo-Morrey 2005). Design, siting and laying criteria of tactile paving is currently embodied in various guidelines (DfT, 1998; 1995a & 1995b; LTNZ 2004), and these represent various benchmarks for pedestrian crossing design and construction. As various local authorities around the UK may interpret the benchmarks differently, there could be differences between various sites in each local area that need to be taken into account.

The research objectives are:

- To examine how blister and corduroy paving is designed, sited and laid;
- To examine older people's perceptions and approach in using tactile paving;
- To quantify the relationship between tactile paving design parameters, the biomechanics of ambulation and the risk of falling.

Whilst the objectives are relatively straightforward the factors that determine the risk of falling and the manner in which pedestrians tackle stairs and pedestrian crossings are quite complex. There has not been any study that integrates the process of pedestrian navigation through a pedestrian crossing, or stair, in the form of a model logically linking various acts and decisions involved (Maclennan, 2007). Both pedestrian crossings and stairs are seen as a hazard, which is confirmed by literatures (DfT, 1998; 2007a & 2007b; LTNZ 2004; Abbas 2008). The researchers, therefore, have decided to adapt an experiential prototyping approach: conducting a pilot study as part of the research methodology; developing a research toolkit; and a pedestrian crossing cognitive model (Figure 1). This approach will provide more cohesion in terms of focus between method and the objectives.

DESIGN CRITERIA

The design criteria comprise two classes of indicators - macroscopic and microscopic. The macroscopic indicators place the study areas in context, whilst the microscopic indicators capture the setting and physical characteristics of each site (pedestrian crossing/stair) within each study area. The selection criteria represent:

- A benchmark, i.e. examples or a range of sites that demonstrate a range of physical design characteristics that may, or may not, enhance pedestrian safety;
- Assessment, or rating scales, and / or factors;
- The picture throughout UK comprising urban and rural planning schemes that have tied to them pedestrian, traffic and other information.

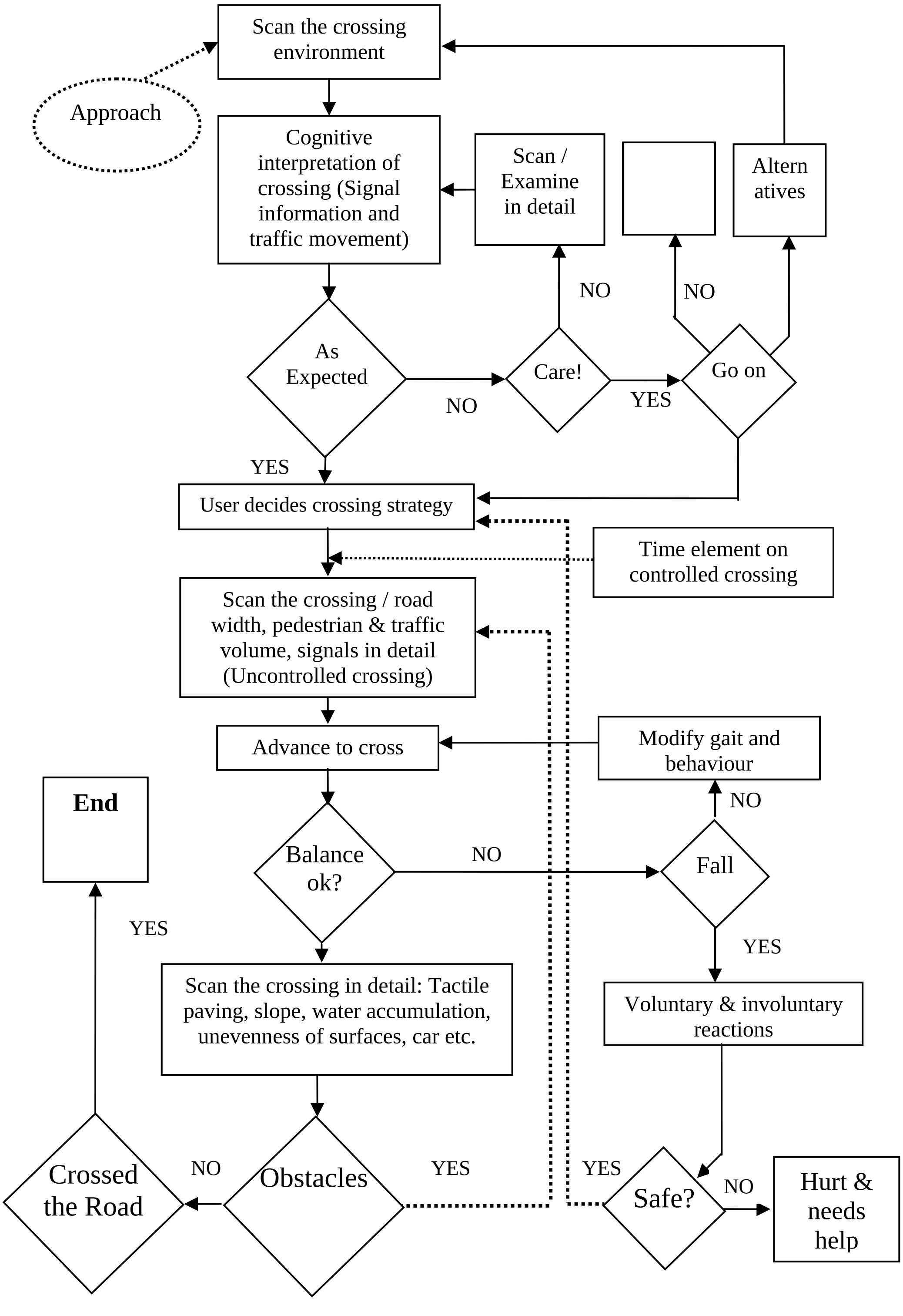

Figure 1. Pedestrian crossing cognitive model (Faruk. M, 2008)

AVAILABLE INFORMATION

The sample site selection criteria align with the TRL Database Criteria and Framework'. It allows the outline of a sample to be formed with appropriate macroscopic/microscopic mix.

The TRL Database is taken as being representative as it is based on 1106 Urban and 1203 Rural Planning Schemes.

The 2001 Census contains (Population Census UK, 2001) demographic details such as population density, which lines up with the even distribution of schemes. Within each main urban district such as London or Manchester there are areas that could be classified as Rural (i.e. below 15 persons per hectare) whilst others would be more Urban (i.e. greater than 20 persons per hectare). It is argued that the denser the area (coupled with land use) the greater would be the number of pedestrians and vehicles and therefore potential conflicts. As macroscopic criteria can be aligned with census, locations and planning schemes, a simplified list of macroscopic factors are:

- Demographics;
- Land Use;
- Urban planning form;
- Geographical location;
- Topography.

Table 1. Population density (Per Hectare)

	Southern Region		Central Region		Northern Region	
High Density	Euston Westminster	100 50				
Medium Density	Brighton	65.0	Liverpool	43.84	Tyneside	41.0
	East Bourne	45.0	Birmingham	43.55	Edinburgh	37.65
	Oxford	45.0	York	43.0	Dundee	33.45
	Reading		Leeds	40.0	Aberdeen	32.3
	Southampton	41.8	Sheffield	39.0	Glasgow	31.71
	Hastings	39.7	Manchester	38.4		
Low Density	Cheam	20.0	Kirk Thorpe	14.33	Inverness	20.56
					Aviemore	4.5

Demographics, land use and location combine well (Table 1). These are also influenced by topography categorized as Extreme (Edinburgh); Mixture (Leeds / Manchester / Inverness) and Even (London). The design of the sample therefore needs to provide a reasonable distribution between the ranges of each factor described. This distribution can be applied across the entire sample. Demographics and land use therefore represent two of the obvious macroscopic criteria. An examination of the Census reveals that the population density of urban areas in England varies from about 30 - 50 persons per hectare and from 15 - 40 persons per hectare in Scotland.

One can argue that the urban demographics of the UK are almost homogeneous except for parts of the South. The Central region varies from the 15 - 46 (persons per hectare) whilst the North including Scotland varies from 4.5 – 41 (persons per hectare). To determine whether population density, geographical location and land use will be significant in terms of variations in the microscopic data then the following areas as highlighted in the table would be suitable for the study:

South/Density: 50-100: Sites in London would comprise three areas such as Euston (Camden), Westminster representing mid range density and outlying suburb of Cheam as Urban/ Rural. The sites also represent all land use types. Planning layout and building forms are mixed because of the age, higher density of population with predominantly diversified ethnic communities compared with Central and Northern Regions.

Central / Density: 39–49: Leeds and Manchester / Salford comprising the Central Business District (CBD) areas that are formed by the central pedestrian precincts bounded by access roads for pedestrian drop off by public transport, or private vehicles. Other town centres with more residential land use has also been included within the study. This district also includes the village of Kirk Thorpe, which is more rural in character with a true village centre.

North / Density: 20-38: Edinburgh and Inverness, comprising CBD areas that are consolidated along the main vehicular access roads, some of which are restricted to private vehicles during shopping and business hours. The planning form of the city is a network with various accessible areas situated along the main roads of the network. Aviemore is included as a true rural area, within reach of Inverness on one of the main access roads, but a village containing a significant retirement community.

Low Density / Rural: As the Planning Scheme distribution is relatively even for each region, other than London the Rural Areas are defined as those where the population density is 20 persons per hectare or less. The Rural Areas therefore relate proportionately to the overall urban population rate for each region.

Associated with each of the sites above, we have obtained information on the following factors from the TRL database and interviews with the Local Authority Transport Engineers on an overall local planning scheme basis: vehicular flow; pedestrian flow; and pedestrian accidents per annum. These factors can also be broken down into microscopic form which is site specific and can be used to benchmark sites and the selection of the final 18 sites.

SITE SPECIFIC FACTORS

The microscopic factors are seen as being site specific. The factors are represented in LTN 1/95 and 2/95 (DfT, 1995a; 1995b). Each one of these factors may not be present at every site, so the same approach as that used with the macroscopic factors is required, but this time on a site to site basis. It is essential therefore that all the microscopic criteria are covered across each region in turn.

The framework of the research in relation to the actual sites requires short case studies of 54 sites distributed over the three regions. 18 longitudinal studies selected from the 54 (1:3) being sites that are of most interest. These 18 sites will be observed and recorded for 2.5 hours interview period per site, once a month, over the 18 months. The selection of 18 significant sites will be based on a rigorous analysis of the 54 sites with distinct trends and relationships established. The aggregate of sites in each region is presented in Table 2. Each region will cover all seven types of pedestrian crossings (as defined by the Department for Transport), and the following major microscopic factors will be included:

- Refuge and extended kerb side crossing aids;
- Carriageway types;
- Carriageway junction and intersection types;
- Proximity to public transport drop off point;
- Proximity and frequency of seating;
- Signage;
- Desire Lines;
- Capacity of pavements in terms of their effective width making allowances for landscaping and street furniture;
- Pavement material, width, surface and condition;
- Lighting;
- Pedestrian Flow and Crossing Time – measured;
- Vehicle Flow – measured;
- Designed crossing interval and signal sequence timing gathered from interviews with traffic engineers.
- Tactile paving types in terms of type, contrast, condition, layout etc.
- Pedestrian Crossing physical characteristics that would include warning devices (audible/visual/tactile), width and length, ramping, paving materials, guarding, refuge islands, etc. extracted directly from LTN documents. (Each site may not contain all the features mentioned above. But these would definitely help us to select each site and also to rate them against the benchmark – whether good, bad or average.
- Condition of crossing and degree of maintenance
- Access and Mobility Code considerations
- Drainage
- Other.

Table 2. Selected sites for I'DGO TOO

Region	**Local Area**	**Population Density (per Hectare)**	**No. of Sites and Ref. Nos.**
Southern	Camden/Euston	100	6 sites i.e. 5 crossings and 1 stair.
Southern	Greenwich	50	5 sites i.e. 4 crossings and 1 stair.
Southern	Surrey	<20	3 sites
Central	Salford	35.33	4 sites i.e. 3 crossings and 1 stair.
Central	Manchester Downtown	38.4	8 sites i.e. 6 crossings and 2 stairs.
Central	Stockport	46.13	3 sites i.e. 2 crossings and 1 stair.
Central	Marple	>22.13	2 sites
Central	Leeds Downtown	40.59	5 sites i.e. 4 crossings and 1 stair.
Central	Armley (Leeds)	<40.59	2 sites
Central	Kirk Thorpe (near Wakefield Leeds)	14.33	2 sites

Northern	Edinburgh Downtown	37.65	5 sites i.e. 3 crossings and 2 stairs.
Northern	Currie – Edinburgh Local Area	<37.65	2 sites
Northern	Balerno	<37.65	2 sites
Northern	Aviemore – Highland Rural	4.5	2 sites
Northern	Inverness Downtown	20.56	3 sites i.e. 2 crossings and 1 stair.

SITE INFORMATION, CHARACTERISTICS AND ASSESSMENT SYSTEM

Each site will be measured in accordance with a site checklist and recorded electronically in AutoCAD Design Data (DWG) format with all the concerned factors being included. A complete photographic record of each site will also be kept. The ideal version of each crossing and stair type will be benchmarked from LTN 1/95, LTN 2/95 and Part M of the Building Regulations (Approved Document M, 2004). A rating system based on a combination of Pedestrian Environment Review System Version 2 (TRL 2006) and the LTNZ 1/95 Pedestrian Network Planning and Facilities Design Guide (Dept. of Land and Transport New Zealand 2007) will be used. It is intended that this rating system will be refined by a Delphi Group of Transport Engineers. Each site will then be rated in a similar manner so that they can be compared with the Benchmark, and then correlated with the results of on site interviews and/or questionnaires. The stairs will be assessed in a similar way. The rating system is in the process of being developed.

CONCLUSION

This paper has presented the methodology that has been adopted to develop site selection and benchmarking criteria (both microscopic and macroscopic) for characterization of the pedestrian environment and access hazards for I'DGO TOO. The process included reviewing of TRL database, LTN 1/95 and LTN 2/95, which eventually led to selection of 54 short case study sites (rural and urban) across UK. These sites are to be observed / recorded over a period of 12 hours and benchmarked. 18 longitudinal study sites will be selected from the 54 benchmarked sites and will be observed / recorded for a two year period (at different times of days, different days of week and in different seasons). Analysis to critically evaluate existing pedestrian and access hazard environment in terms of their design, execution and outcome will be made. The site selection and benchmarking criteria presented in this paper could be adopted for studies of similar nature.

REFERENCES

Abbas, M. Y., Ormerod, M., Newton, R., Faruk, M., MacLennan, H. A. (2008), Pedestrians: Just a simple flow? *Ergonomics and Human Factors annual conference*, 1-3 April 2008, University of Nottingham. (Forthcoming).

Approved Document M., (2004), Access to and Use of Buildings, *Building Regulations 2000*, Available at, http://www.planningportal.gov.uk/uploads/br/BR_PDF_ADM_2004.pdf

Department of Land and Transport. (2007), Local Transport Note 1/95, *Pedestrian network planning and facilities design guide*, New Zealand, Available at, http://www.ltsa.govt.nz/consultation/ped-network-plan/

DfT (Department for Transport). (1995a), Local Transport Note 1/95, *The assessment of pedestrian crossings*, London, HMSO.

DfT (Department for Transport). (1995b), Local Transport Note 2/95, *The design of pedestrian crossings*, London, HMSO.

DfT (Department for Transport). (1998), *Guidance on the use of tactile paving surfaces*, The Scottish Office, DETR, 2007, updates available at, http://www.dft.gov.uk/transportforyou/access/tipws/guidanceontheuseoftactilepav

DfT (Department for Transport). (2002), *Inclusive Mobility: A Guide to Best Practice on Access to Pedestrian and Transport Infrastructure*, London, HMSO.

Hale, A. R., Glendon, A. I., (1987), Stair user cognitive model, *The Staircase*, MIT Press, Cambridge, MA.

I'DGO. (2007), Available at, http://www.idgo.ac.uk/

Loo-Morrey, M. (2005), *Tactile paving survey*, Health and Safety Laboratory, Harper Hill, Buxton.

Maclennan, H. A., Ormerod, M., Faruk, M., Newton, R. (2007), Pilot study Report, *I'DGO TOO working paper*, Surface Inclusive Design Research Centre, University of Salford.

Faruk, M., Ormerod, M., Newton, R., MacLennan, H. and Abbas, M. Y. (2008), Tactile paving a necessary intervention, but does it suit everyone?", *Ergonomics and Human Factors annual conference*, 1-3 April 2008, University of Nottingham. (Forthcoming)

Population Census, UK., (2001), Available at, http://www.statistics.gov.uk/cencus2001/census2001.asp

The Disability Discrimination Act 1995 and 2005, London, HMSO.

TRL (Transport Research Laboratory)., (2006), *Pedestrian Environment Review System* (PERS, Version 2), Available at, http://www.trl.co.uk/content/main.asp

WILL CURRENT EMERGENCY EVACUATION SYSTEMS BE ACCESSIBLE, SAFE AND USABLE IN 2030?

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ABSTRACT

By 2030 30% of workers in high rise offices will be unable to evacuate by stairs due to the increasing incidence of obesity, functional ability and the ageing of the workforce. Australian Studies from 1980 confirm that 18% of office workers are unable to evacuate buildings of more than 19 storeys using the stairs. The impact of this non stair user is reflected in the World Trade Centre Incidents. The macroscopic evacuation model is challenged by the group dynamics. A longitudinal study plan to test these issues is discussed. The framework of an integrated risk based evacuation ability model that will provide for the testing of an integrated solution utilising elevators is presented. Issues on elevator capacity are also presented. Factors requiring additional research are noted throughout the paper. It is concluded that a safe and inclusive evacuation strategy geared to the height of the building should be provided.

KEYWORDS: elevator, evacuation, inclusive design, risk, stairs.

INTRODUCTION

In the evacuation of World Trade Centre, Tower 1, the average surviving occupant spent 48 seconds per floor descending the stairwell (0.2m/sec) (NIST, 2005). This slow descent speed was not just due to density but also due to the presence of those with mobility impairments who required assistance. A group of people all travel down stairs at the speed of the slowest mover (Fahy and Proulx, 2001), This can occur with a family group, or any group (MacLennan et al, 2007; Fahy and Proulx 2001). Trial evacuations of high rise buildings have shown that it is not always the crowded stairs where slow descent speeds are encountered (Proulx et al, 2006). The traditional design approach is macroscopic and relies on density homogeneous (groups). This approach assumes merging at each floor so that the density increases and the descent speed slows (Nelson and Mowrer, 2006). There is other evidence to the contrary where groups are formed, and one group defers to the other, causing one group to wait (MacLennan et al, 2007; Proulx et al, 1996 and 2006). Other stair users may be slow movers due to age, obesity and other impairments not covered by the traditional definition of "disabled persons". Obese persons with a Body Mass index (BMI) > 35 will occupy more space on the stairs (MacLennan et al, 2007) and travel at a slower speed (Proulx et al, 2006; Moody, 2000). Society is rapidly ageing, and obesity is at critical levels in the UK and USA (Center on an Aging Society, 2003). According to the World Health Organisation Data Base over 30% of the UK and US populations are at risk just due to ageing and obesity. This is significant in that the risk of injury due to the means of evacuation may be equivalent to that of lift failure due to fire. 3000 persons were able to evacuate Tower 2 of the World Trade Center in 16 minutes (NIST, 2005). There is a strong argument for an integrated evacuation solution utilising stairs and lifts (Groner and Levin, 1992). An inclusive approach is required so that office workers can have access to a 'toolkit" in order to determine whether or not they can cope with stairs in the building in question, and that this toolkit is based on a predictive model developed and tested in the field. The development of this inclusive design evacuation toolkit is in progress and a framework is presented in this paper.

IS DENSITY THE ISSUE?

The Concept of the "Plug"

The use of density models in the analysis of the evacuations of office buildings promote the merging of occupants at each floor. The macroscopic approach where stair users merge and the density increases thereby slowing the rate of descent (Fruin, 1985; Nelson and Mowrer, 2006) has been challenged by research (NIST, 2005; MacLennan et al, 2007; Proulx, 2006). where merging behaviour is replaced by deferment, group dynamics, and the functional ability which are all microscopic issues These behaviours require more investigation in the field. In fact the impact of group dynamics in terms of entry behaviour, or group dynamics combined with functional ability limitations, are supported by new microscopic evacuation models (Castle, 2007) and the results of field observations (MacLennan et al, 2007; Proulx et al, 1996 and 2006; Fahy and Proulx, 2001). Table 1 provides some examples.

There is also the spatial impact due to obesity and an increased body ellipse of $0.44m^2$ derived by MacLennan et al (2007) from CT scan data (Geraghty and Boone, 2003) and arm anthropometric data (Ostchega et al, 2006). The slow moving group, group entry sequence and the obstruction created by the obese person creates a 'plug' in the evacuation stream which naturally increases the density of the following group (Fahy and Proulx, 2001) and slows the descent speed. The descent speed here is critical and can be directly related or derived from the physical characteristics of the stair user (Fahy and Proulx, 2001).

Evacuation Height and Limitations in Descent Ability

Many of the stair users in the evacuation of the WTC Towers reported that they were totally unprepared for the physical challenge of the evacuation with many of them having to rest during descent (NIST, 2005). This brings into question the total distance that the stair users would be able to travel before needing to rest. A pedestrian study in Leeds showed that a significant percentage of the sample comprising older and mobility impaired pedestrians were not able to travel further than 135m without a rest (Leake et al, 1992). Translating this into a stair descent equivalent (Fujiyama, 2005) would impose a 15 storey limit on stair users with identical characteristics. An Australian study carried out in the 1980's which has now been incorporated into the writer's research plan (MacLennan et al, 2007) in the form of a longitudinal study showed that 10% of the sample spread across eight high rise office buildings would not be able to evacuate more than 19 storeys.

Further Work Required

Further trial evacuations are proposed to complete this longitudinal study, from this data a multiple regression based model can be developed, based on functional ability and other physical characteristics to predict stair evacuation capability and limitations. This would provide the basis for the inclusive design evacuation toolkit, providing the office worker and facility manager with the necessary support for the use of elevators for evacuation, using a microscopic approach.

Table 1. Speed and Density Comparisons

Study	Stairwell	Density p/m^2	Observed Mean Speed m/sec	Calculated Speed (s=1.08-0.29d) m/sec (Proulx et al. 2006)
Proulx et al 2006	E	1.6	0.40 (min 0.17); substantial delay due to obese persons and person using a cane with two assisting.	0.62
MacLennan et al, 2007	Manchester Piccadilly Station	2.2	0.32 (family group of grandparents and two children with bags holding up general flow)	0.44
NIST, 2005	Not noted	3.1 (calculated from flow)	0.2 (large number of mobility impaired stair users removed from stairs to allow increase in flow rate and people tiring or resting)	0.25

OCCUPANT CHARACTERIZATION – FUNCTIONAL ABILITY AND DESCENT CAPABILITY

A snapshot of the UK population profile shows up those sections of the population whose functional ability will vary their circulation ability:

- Ageing and associated health disorders where approximately 10% of the population are over 65 years and that this will grow to 11.5% in 2025.(US Census Bureau, 2007)
- 19.7% of the population are disabled people, of these 15.77% have impairments that would affect their functional ability to circulate.(DRC,2007)
- Approximately 29% of the population has a BMI > 30 and 5% > 40. (The Information Centre, 2006)

The above represents an overall population profile where 1 in every 5 persons could be at risk so that these need to be analyzed in more detail to assist with building occupant characterization (Boyce, 1999). The framework is shown in Table 2 (LTNZ 2004). This process of characterisation is in line with international guidelines (ABCB, 2005) and can also be coupled with stair environment and building characterisation. The stair environment is critical as current research still confirms the contribution of stair geometry, slippery surfaces and other factors to accidents (Scott, 2005). Table 2 provides the characterisation format together with examples of occupant characteristics. When this is viewed with a profile of the UK population it demonstrates that 1 in every 5 persons has some kind of characteristic that will impact on stair descent performance then stair capability should be viewed as an integral component of evacuation design and research. The references are also provided in Table 2.

Following on the work of Boyce et al (1999) on characterisation which highlighted information about a significant section of the population Fahy and Proulx (2001) proposed the basis of a data base format that could be used to formulate a critical stair descent rate. An evacuation simulation could be carried out using one of the accepted microscopic evacuation software packages (Castle, 2007) with different input evacuation scenarios. These scenarios could also be inclusively developed via a representative focus group. An example of the data base format is provided in Table 3. Table 3 also provides a cross section of the type of data that is available[1]. There is no doubt that these data have been gathered for over 20 years, but data relating to obesity[3], age related disorders[2] and other impairments[2] especially relating to endurance (Leake et al, 1991) (MacLennan et al, 2007) require further research. This research forms part of the model outlined in Figure 1.

Table 2. Characterization Framework (LTNZ, 2004) (Boyce et al, 1999)

Characteristic or Behaviour	**Resulting in**	**Impacting Upon**	**Reference**
All age groups – Group Dynamics when a group of friends form prior to stair descent	Talking between themselves and become distracted and linked with their associate	Move as a group occupying the same space, reducing descent speed and replacing merging behaviour at each floor with deference.	Finnis and Walton, 2007; MacLennan et al, 2007;(Via questionnaire – part of longitudinal study)
Obese – BMI> 30 and waist to hip ratio > 0.9	Greater amount of space occupied and lack of endurance/ stability due to associated conditions such as fatigue, breathlessness, cardiac problems; Body ellipse of 0.44m^2	Reduces descent speed and in stairs less than 1100mm between handrails creates blockage as well as total height that can be evacuated.	Lahli-Koski, 2001; Messler, 2007; Geraghty and Boone, 2003; MacLennan et al, 2007; Proulx et al, 2006; Center on an Aging Society, 2003
BMI > 30 where this has been prevalent for adult life – manifesting in age group 50+.	Possible knee osteoarthritis, type 2 diabetes, foot problems, hip disorders, dementia, poor balance etc.	Reduced endurance and descent speed because of perception of falling, pain in knees/hips/feet.	Moody, 2000
Impaired Vision, Mobility Impaired measured by increased ADL's.	Require assistance in using the stairs	Reduced stair descent speed, holding up other evacuees. Also reduces total height that can be evacuated.	NIST, 2005; Proulx et al, 2006; Fahy and Proulx, 2001; Leake et al, 1991; (interpolated from walking distance)
Older People 65+ - many conditions exacerbated through obesity.	Balance, reduced strength, and endurance and other lower limb muscular skeletal disorders.	Reduced stair descent speed and vastly reduced dynamic stability.	Hamel et al, 2004; Messler, 2007; Center on an Aging Society, 2003

The research proposed will provide real world cross cultural data and comparisons from trial evacuations of high rise buildings between 15-30 storeys. The real world data will be further supported by selected controlled trials where more detailed measurements are required e.g. gait cycle and dynamic stability performance and begin to fill in the gaps as well as providing the basis of the proposed predictive model.

Table 3. Possible Data Base Framework (Fahy and Proulx, 2001)

Occupant Characteristics	Min	1st Quartile	3rd Quartile	Max	Mean
All impairments[1]	0.10	0.42	0.7	1.83	0.60
Mobility impairment[1]	0.10	0.42	0.7	1.22	0.58
No aid[1]	0.28	0.45	0.94	1.22	0.68
Crutches[1]	0.42	-	-	0.53	0.47
Cane[1]	0.18	0.35	0.7	1.04	0.51
Walking Frame[1]	0.10	-	-	0.52	0.36
Assisted mobility impairment[1]	0.42; 0.2 WTC	0.52	0.86	1.05	0.69
Vision impairment[2]	0.25	-	-	-	-
Older people[2]	0.35	-	-	0.94	0.62
BMI > 30 and Waist to Hip ratio >0.9[3]	Instances of stair descent speeds as low as 0.2m/sec – references are varied – lower muscular skeletal problems that cause pain will have an increased affect e.g. knee osteoarthritis and feet problems – see Table 2.				

[1 – 3] See text in the paragraph immediately preceding Table 3.

THE RISK ASSESSMENT MODEL FRAMEWORK

Much of the performance based evacuation design at present relies on an adaptation of the Density Model (Fruin, 1985). The research that underpinned this Model was carried out in the late 1960's. There is concern amongst the life safety professionals about the accuracy of the data being used in macroscopic evacuation models (Castle, 2007) especially in terms of the rapid increase in ageing, obesity and the significant numbers of people who were limited by their impairments to evacuate buildings via stairs (Groner and Levin, 1992). The microscopic approach to evacuation research reveals areas where there is a paucity of data. Further tests are therefore required in these areas and the results analysed and presented in the form of a predictive model to demonstrate which means of evacuation would most suitable for each building occupant (stairs or elevators) . This approach is supported by the findings of the World Trade Centre Incident Study (NIST, 2005) and other high rise evacuation research (Groner and in, 1992). A proposed framework for the model is shown in Figure 1.

The data gathered from the testing activities (numbered 2-4) will comprise field measurements and observations as well as estimates from expert and user opinion. The output from the predictive model in activity 5 needs to be integrated with the estimates from activity 4.The most appropriate simulation tool for the testing of these outputs is a risk based simulation tool such as Risk AMP ® (Structured Data, 2007). This research is still in the early stages of development and will involve close liaison with risk data model developers. The ultimate aim of the model shown in Figure 1 is therefore to:

- Gather the missing stair descent data and associated user characteristics / functional abilities from a series of 6 international trial evacuations (NZ, Australia, Dubai, Hong Kong, UK and USA.
- Further corroborate the real world results via controlled stair descent tests.
- Analyze the data and develop a predictive model that will test the hypothesis especially in terms of occupant endurance (safe evacuation height in terms of ability)
- Test the predictive model via expert and user derived scenarios and estimates (e.g. minimum, most likely and maximum evacuation times where possible) using an appropriate simulation tool such as RiskAMP® (Structured Data, 2007).

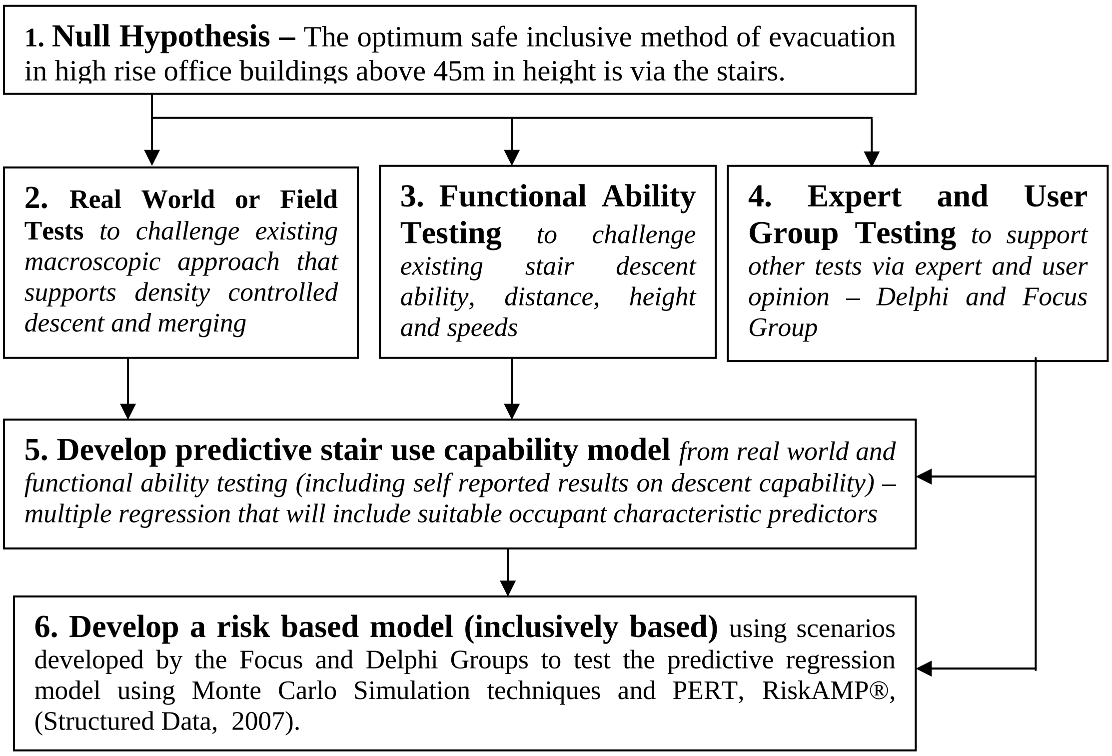

Figure 1. Risk Evaluation Model / Process

The model will be developed concurrently with gathering and analysis of data collected in each of the trial evacuations to be carried out in 2008, and presented in a series of journal papers. The Delphi and Focus Groups will be assembled at the same time.

THE NEED FOR AN INCLUSIVE INTEGRATED SOLUTION

Lessons Learned

Approximately 3000 building occupants were able to evacuate Tower 2 of the World Trade Centre during the 16 minutes prior to aircraft impact (NIST, 2005), which corresponds to a flow rate of 183.5 persons/minute, an extremely efficient outcome. Guidelines are already available for the use of elevators for emergency evacuations (Klemencic et al, 2004) that involve the use of staging areas. Such an approach may not be inclusive and has been challenged (Groner and Levin, 1992). The World Trade Centre Incident of September 11, 2001 shows the way forward as there is a need to develop a solution for the entire population.

Elevator Passenger Capacity Issues

This paper does not address the design of the system components as these are highlighted in guidelines prepared for use in evacuation (Klemencic et al, 2004). There are issues of concern regarding elevator capacities and passenger loadings arising from this paper in terms of the characteristics of those occupants who would be at risk using the stairs.

Table 4. Revised Passenger Elevator Service Capacities

Normal Capacity (Kg.)	Normal Passenger Capacity	Emergency Evacuation Passenger Capacity
1600	23* (17)	10+
1800	27* (19)	11+

*+ Based on a mass of 115Kg (Geraghty and Boone, 2003) and a standing body ellipse of 0.44m^2 (MacLennan, 2007) * This number is based on a mean individual passenger mass of 68 Kg whilst the figure in parentheses represents an accepted standing body ellipse currently used in pedestrian system design (Rouphail et al, 1998).*

THE INTEGRATED EVACUATION PLAN PROCESS AS INPUT FOR RISK ASSESSMENT

It is envisaged that a comprehensive systems approach that links the lift system design and traffic analysis with a inclusively based user derived evacuation and access plan (US Army Corps of Engineers, 1998) (MacLennan et al, 2007) (Groner and Levin 1992) would be used to derive the evacuation scenarios required for the proposed Monte Carlo Simulation (RiskAMP, 2006). The Focus/ Delphi Groups will formulate the scenario inputs following standard performance based design protocols set down in international fire and emergency engineering guidelines (ABCB, 2005).

CONCLUSION

Comments by NIST (2005) in the Life Safety section of their report on the WTC Evacuation (NIST, 2005) that a number of persons had to be removed from the stairs as they were slowing up the evacuation, that elevators in Tower 2 were able to quickly evacuate a significant number of people and that these arguments had been presented since 1992 (Groner and Levin. 1992) demonstrate the need for the proposed predictive stair user capability model as presented in Figure 1

REFERENCES

Australian Building Codes Board, 2005, *International Fire Engineering Guidelines*, Edition 2005, Australian Building Codes Board, Canberra.

Boyce K.E, Shields T..J. and Silcock G.W.H, 1999, “Toward the Characterization of Building Occupancies for Fire Safety Engineering: Prevalence, Type and Mobility of Disabled People”, *Fire Technology*, Vol. 35, No.1. pp, 35-50.

Castle Christian J.E., 2007, *Guidelines for Assessing Pedestrian Evacuation Software*, Working Paper Series, Paper 115, University College London, March.2007.

Crowd Dynamics, 2007, “Graphic Levels of Service”, www.crowddynamics.com, site visited on 6th December 2007.

Center on an Aging Society, 2003, *Obesity Among Older Americans*, Center on an Aging Society, Georgetown University, Data Profile No. 10, July 2003.

Disability Rights Commission, 2007, *Disability Briefing*, Disability Rights Commission, May, 2007,

Fahy R.F. and Proulx G, 2001, *Toward creating a database on delay times to start evacuation and walking speeds for use in evacuation modeling*, National Research Council Canada, NRCC 44758, NRC-CNRC.

Finnis K.K. and Walton D., 2007, “*Field Observations of factors influencing pedestrian walking speeds”*, in 2nd International Conference Proceedings on Sustainability Engineering and Science, Auckland, February 2007, Paper 19, pp. 1-13.

Fruin John J, 1987, *Pedestrian Planning and Design*, Revised Edition, Elevator World Inc., Mobile, Alabama.

Fujiyama, T. and Tyler N, 2005, *Pedestrian Speeds on Stairs; An Initial Step for a Simulation Model*, Working Paper, University College of London.

Geraghty Estelle M. and Boone J, 2003, “Determination of Height, Weight, Body Mass Index and Body Surface Area with a Single Abdominal CT Image”, *Radiology*, September 2003, pp. 857-863.

Groner N.E. and Levin B.M., 1992, “*Human Factors Considerations in the Potential for Using Elevators in Building Emergency Evacuation Plans*”, National Institute of Standards and Technology, NIST-GCR-92-615, Gaithersburg.

Hamel K.A. and Cavanagh PR, 2004, Stair Performance in People Aged 75 and Older, *Journal of the American Geriatric Society (JAGS)*, 52, 563-567.

Land Transport NZ/ Opus Consultants, 2004, *Pedestrian Network Planning and Facility Design Guide*, Land Transport New Zealand.

Lahli-Koski M., 2001, “*Body Mass Index and Obesity Among Adults in Finland; Trends and Determinants”*, Academic Dissertation in Publication A12/2001, National Public Health Institute, Helsinki, Finland, pp 56-80.

Leake G.R., May A.D. and Parry T., 1991, *An ergonomic study of pedestrian areas for disabled people*, Institute of Transport Studies, University of Leeds, Transport and Road Research Laboratory, Department for Transport.

MacLennan H.A., Ormerod M., Faruk M. and Newton R, 2007, *Pilot Study Report*, Working Paper, I'DGO TOO Project, Surface Inclusive Design Research Centre, University of Salford.

Messler S.P., 2007, "The Biomechanics of Obesity; Conference Coverage; NAASO - The Obesity Society", *Medscape General Medicine*, Vol.9 No.3 pp.18.

Moody J.S., 2000, "*Stairway locomotion in individuals with knee osteoarthritis*", in DeVita P., (Ed), East Carolina University, pp 83.

National Institute of Standards and Technology, 2005, "*Life Safety (Evacuation, Emergency Response, Active Systems)*", in Comprehensive presentation on NIST'S World Trade Center Investigation, April 5, 2005, WTC Investigation Archives, National Institute of Standards and Technology, Gaithersburg.

Nelson H.E. and Mowrer F.W., *Emergency Movement*, (third Ed.) The SFPE Handbook on Fire Protection Engineering, NFPA, Quincy, 367-380.

Ostchega Y., Dillon G., Prineas R.J., McDowell M. and Carroll M, 2006, "Tables for the selection of correct blood pressure cuff size based on self reported height and weight and estimating equations for mid arm circumference: data from the US Health and Nutrition Examination Survey", *Journal of Human Hypertension*, Vol. 20, pp.15-22.

Proulx, G., Benichou N., Hum, J.K., and Restivo K.N., 2006, *Evaluation of the effectiveness of different photoluminescent stairwell installations for the evacuation of office building occupants*, Report B4546, NRC-CNRC, National Research Council Canada, Ottawa.

Proulx G., Kaufman A. and Pineau J., *Evacuation Time and Movement in Office Buildings*, Internal Report No. 711, NRC-CNRC, National Research Council Canada, Ottawa.

Rouphail N., Hummer J., Milazzo J. and Allen P, 1998, *Literature Synthesis Pedestrians' Chapter 13 of the Highway Capacity Manual*, Federal Highway Commission, Washington D.C.

Scott A., 2005, *Falls on Stairways – Literature Review*, Report Number HSL/2005/10, Health and Safety Laboratory, Harper Hill, Boxton, SK17 9JN.

Structured Data LLC, 2007, *Risk AMP® User Guide and Reference Manual*, RiskAMP® Version 2.5, Structured Data LLC, February 2007, http//www.riskamp.com.

US Census Bureau, 2007, "International Data Base", *http://www.census.gov./ipc/…, last visited 6th December 2007.*

US Army Corps of Engineers, 1998, *Technical Instructions; Elevator Systems*, Report T1 810-90, Headquarters, US Army Corps of Engineers, Engineering and Construction Division, Directorate of Military Programs, Washington DC.

AN INNOVATIVE SYSTEM FOR THE CONTROL IN THE BUILDING SITE

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ABSTRACT

The aim of the present research is to investigate the management of building processes by controlling and monitoring information and data passing from one phase to another. The attention is focused on the execution phase where information and data are converted into manual operations and techniques operative. The passage node from the design phase to the execution represents a critical point for the correct transmission of data. The purpose of the present work is to explore methodological and operative aspects of building sites design and of production procedures. The intention of this research is to define methodologies and procedures for the management of information and data of the building site that, using the Information Technologies, could contribute to the control of quality of the operation in the building site. Particularly this research deals with the definition of a system for the management of design data in the building site and for the gathering of data and information generated during the production phase. The system proposed will be based on the use of synthetic visual representation of the working steps that will be easily readable by means of the definition of variables and parameters needed for the decision process in the building site. This topic is of significant interest because of the need of operators for improving quality and efficiency of the building productive process even with the use of innovative Information Technologies.

KEYWORDS: Quality, Knowledge, Management, Information Technologies, Site.

INTRODUCTION

Building stock sector shows a strong need to improve production quality, to overcome difficulties which can be met in regaining competitiveness, and to introduce innovation systems in production and decision-making processes. Management and control instruments can support the decision-making activity of process operators and allow building sector to compensate a gap in delay with other manufacturing sectors; the use of information technologies can be really useful in execution and production phases. The use of informatics is widely spread in building stock sector, most of all during the design phase of the building process through the use of CAD platform. On the contrary, in order to manage building sites, informatics applications are only used for sectorial computer solutions – such as accounting, safety – and not to an integrated management and control system. Informatics is naturally capable of managing manifold users – operators and a great deal of data and information – and this peculiarity can be used to manage building sites and in particular to control and file information brought about and produced during processing. Nowadays the production structure of a building site shows a considerable complexity because of manifold process actors having strong and diversified specializations. Furthermore, it is characterized by the use of materials and products with a higher and higher technology content and therefore with complex laying procedures. The building site activity has a direct consequence on the final quality of the building. The use of informatics in managing the work phases in a building site allows continuous process controls and the prompt accomplishment of the changes which are considered necessary during production phases The final product is therefore followed, from design phase to execution phase, by a stream of information and data which are managed through the IT (Information Technologies) and produce the product information file. The presented work is focused on the analysis of the building site and the stream of information and data which refers to it, suggesting a control system which can contribute to the final quality of the production and can be a useful instrument for the management and planning of maintenance interventions on the building itself.

THE STREAM OF INFORMATION IN THE BUILDING PROCESS

Like every modern production process, the building one is also accompanied by a great deal of information and data, which – starting from the conception phase – develop and grow rich in contents through the different passages. During the design phase, project data – containing the data necessary to produce and show the features of the final product – are carried out. Information deriving from the design phase merges into the execution phase. All this information has to be understood and processed by the different actors of the execution phase. The same piece of information needs to be properly transferred in order to guarantee the quality of the final product.Incomplete or dissenting information can reach the management or maintenance phase of the building. In fact, the data contained in design writings have to be integrated with those developed and produced during the execution-production phase. In a modern building site, where materials and products with a high technology content are used, process operators are required an intense control activity and an operating quality which can be only developed basing on the information deriving from design phase integrated with the data coming from application activity. The same systematic approach can be also applied to the monitoring of maintenance interventions. In fact, even in a building site concerning an intervention on an existing building, an important set of information is produced, which has to be managed and filed. Design documents are generally written on paper support with very limited possibilities of updating. On the contrary, the use of control systems in the building site is aiming at allowing a complete update of the data. In fact, file documents are not often exhaustive in order to explain the specificities and features of the building and its materials. The building process execution phase, both for a new building and for interventions on already existing building, needs, therefore, some control and monitoring systems which allow an arrangement of a database of the building, containing information and data essential for management and maintenance. The data referring to every possible change occurred during the works are not always available for process operators in the management and maintenance phase of the carried out building. In fact, the data coming from design and execution phase are from different communication channels. For the design phase the channel is that of the approved project data, while for the execution phase there is no permanent and standardized communication channel. Therefore, coming from different channels, the data can be non-homogeneous, determining some objective difficulties in interventions on the building.

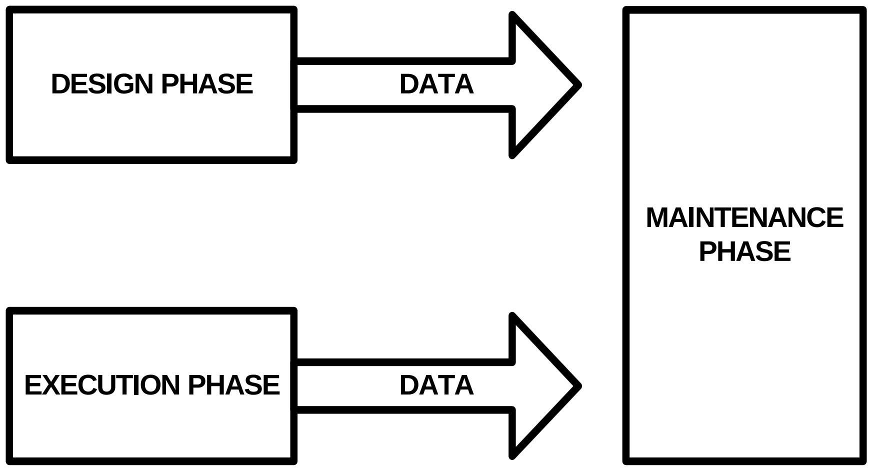

Figure 1. Traditional system to transfer of information into the phases.

The representation – which is currently being developed – is a radial representation which shows at the centre the virtual image of the building site, which becomes an information system of the building.

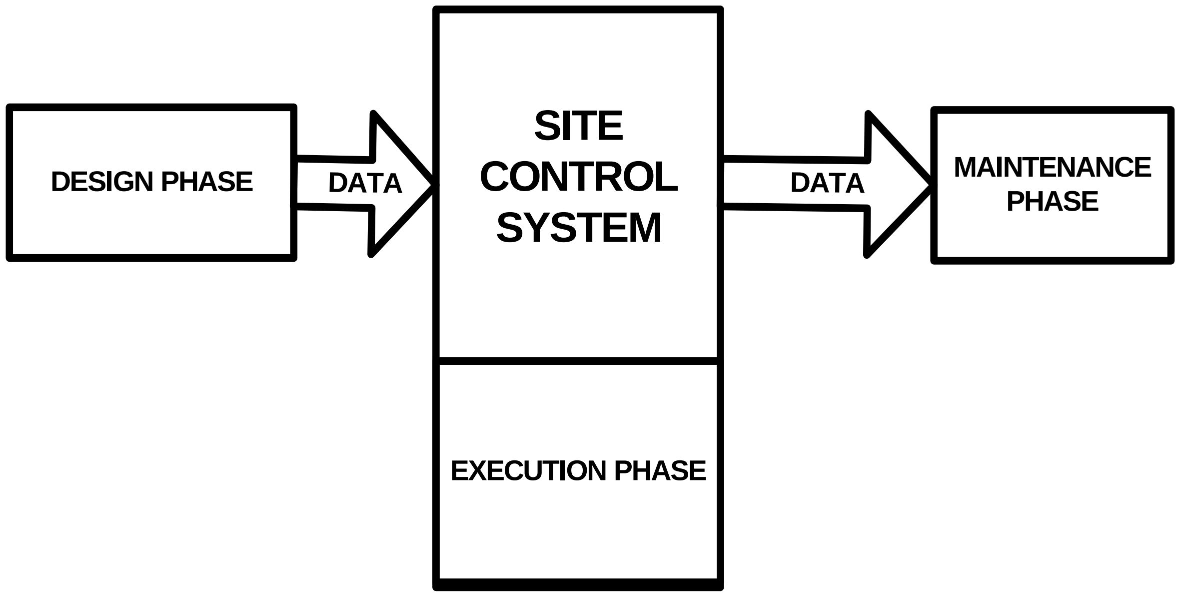

Figure 2. Representation of the stream with the Site Control System .

SITE CONTROL SYSTEM FOR THE MAINTENANCE OF BUILDINGS

Building site activity is carried out through a series of precise operations aiming at erecting a building structure, but also at managing a maintenance intervention on an existing building. The intervention development can be described as a sequence of basic activities characterized by the need for a continuous control of the management of resources. Every sequence and operation produces and manages some information and data, processing those belonging to the other phases. Therefore, every phase and sub-phase produces, collects and gives back data and information about the work. In an intervention on an existing building, the structure of the process needs some rules – which have to control the development of the phases – shared by every actor of the process; a transferring platform in order to guarantee a constant and sure stream of information among the different actors of the process and to own every technical information on the building itself. In order to be able to design and execute an intervention on an existing building, the building site activity needs to be controlled and managed, allowing the final product to have memory of the activity carried out there. In fact, during the building phases, one of the most important nodal points of the process is defined. It concerns the activity of the builder-executer (building enterprise); this figure of the process changes project information in solid elements. Therefore, the passage of information from designer to builder needs to be controlled and safe, in order to avoid mistakes or misunderstandings which may determine negative consequences on the following phases and in particular on the management and maintenance of the final product. Another point of development in the process – which is extremely important for the proper management of the building – is the data and information transfer from the builder to the final user. In fact, in order to maintain and manage the building properly, the user/manager needs to get every information concerning the developed production process without leaving out any data referring to possible introduced changes. In the present research, an informatics platform has been carried out in order to manage information developing during the accomplishment of the building site activities. The features which have been arranged to the developed system, called Site Control System, aim at understanding and filing information coming from the design phase; representing the evolving phases of the building intervention, comparing what has been scheduled in the project with the working progress; and, most of all, providing a support for the maintenance activity in the following management phase of the building. The designed system is a database with an interactive visual user interface for data input and a file system on chronological basis. The database records the working days, comparing the data coming from evolving building works with pictures of the building site, drawings, technical data of the used materials, and identifying the operators of each activity: therefore, the database becomes a digital representation of the building site. Surfing the user interface in the Site Control System is possible to identify the technical data concerning the process in progress, and the required technical details. The developed and tested system has been carried out as an ACCESS suite application (Microsoft) and it is being further developed. The tests carried out on some building sites in the Basilicata region (Italy) have allowed to define functioning devices.

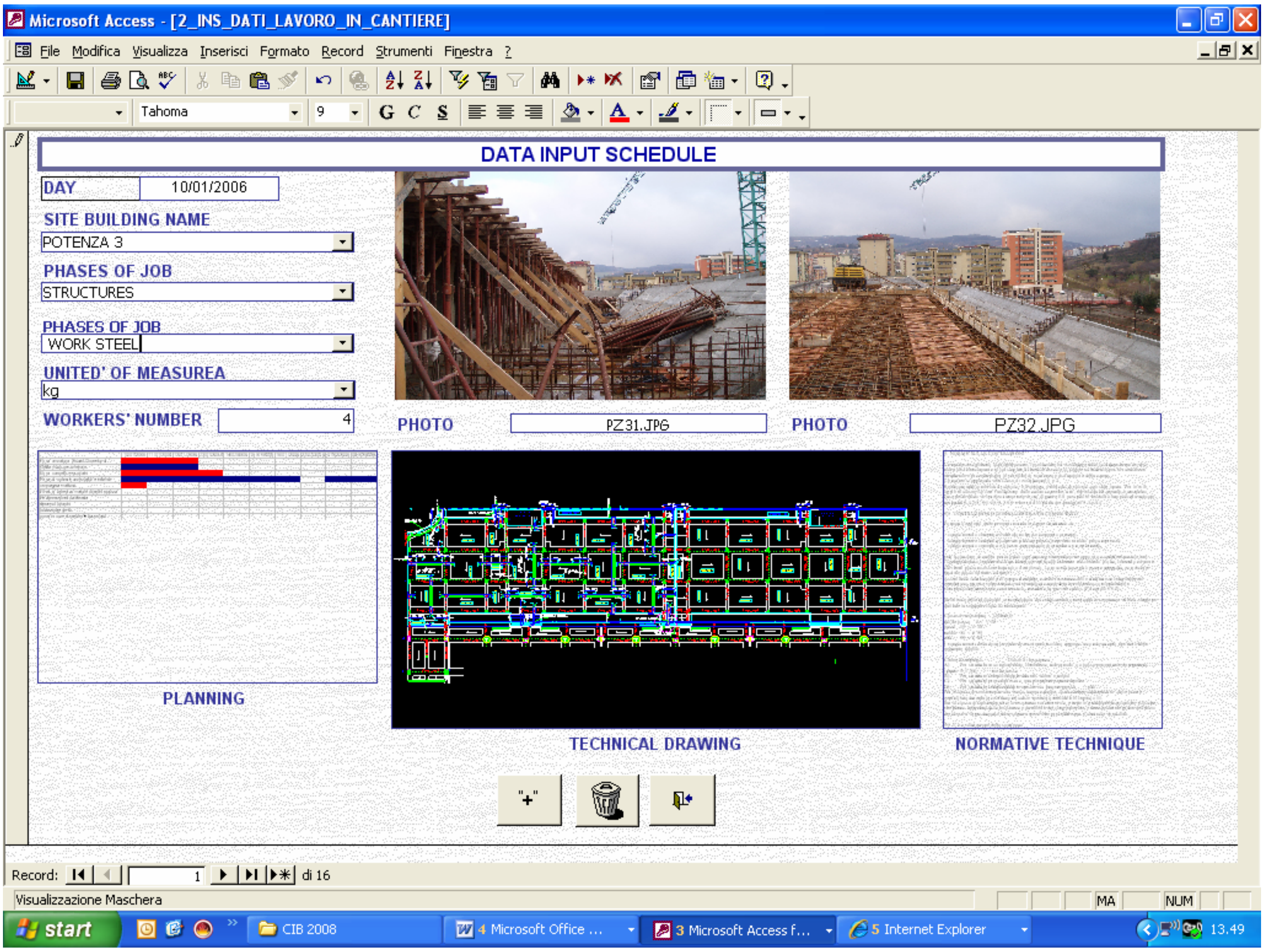

Figure 3. Image of the data input schedule.

Given the current state of the research, the main subject of the present contribution is the possible use of the file created by the database during the maintenance activities following the construction of the building. The use of the system during working days allows the filing of the data referring to, for example, the actual placement of the plants, so that their maintenance will be easier. The system links photographs of the work to the identification code of the workers team which has carried out the work. In fact, one of the most innovative developed aspects is the capacity by the system to manage a photo file of the building site with the other production data such as technical information (graphic items) and features of each component. The use of the system establishes, as already said before, the creation of a file, concerning processing of materials and components as have been actually used, which goes with the building during its useful cycle of life. So a digital file of the building is carried out. Therefore, it turns out to be an interesting instrument for management and following interventions, if it is possible to have available all the data (drawings, calculations, entries) useful to know the building. Further interventions on the building will gradually make the database created by the Site Control System rich. Furthermore, the structure – made up of chronological cards – allows to monitor even in time the development of, for example, products technologies interventions and evolutions.

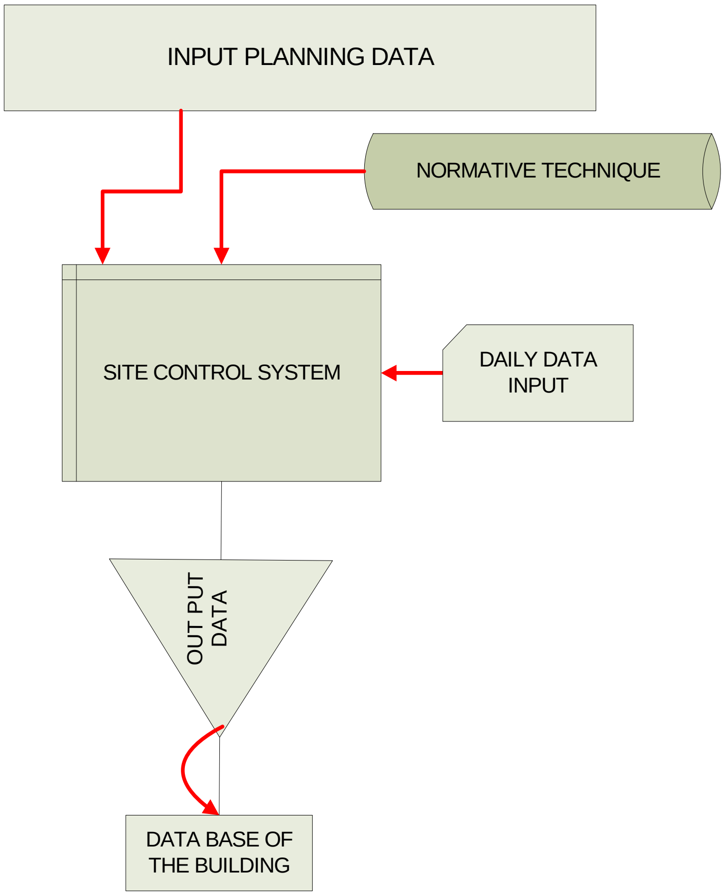

Figure 4. Flow Chart of the Site control System

CONCLUSIONS

The management of a building during its useful cycle of life perceives the necessity of different maintenance interventions. The possibility of carrying out these interventions properly is also linked to the knowledge of the building and its features. But the only knowledge of project documents is not enough because, as illustrated above, activity of the building site both that of new construction and that of interventions on existing buildings, creates information and data essential to manage the building. Informatics has deeply changed many industrial production processes, but it has not exploited its potential in the building sector and, in particular, in the execution phase of the building site. The tweaked process, based on databases technologies, allows to collect these data and to integrate them with those coming from design phase. In this way, it allows to define a digital file of the building which can be updated according to every maintenance intervention, creating a strong instrument which supports decision-making activity in managing the building. Following developments of the research will aim at controlling the operational interface of the system with the many data processing systems typical of the building process concerning: control of quality, structural controls, energy assessments and controls, deterioration models, assessments of environmental sustainability and compatibility levels.

REFERENCES

Albino, V., Costantino, N., Sivo, G. (2000), Le costruzioni,: mercato e impresa, Carocci, Roma.

Antonimi, E. (2003), Costruire con le tecnologie dell'informazione, Temi del Focus Tecnologico Saie, DEI, Roma.

De Luca Picione, M., Guida A. (2004) "Site checks using it (information technologies)", proceedings of XXXII IAHS World Congress on Housing Sustainability of the Housing Projects, September 21-25, 2004, Trento, Italy.

De Luca Picione, M., Guida A. (2004), "Gestione delle fasi esecutive del processo edilizio attraverso l'uso delle information Technologies (it)", proceedings AR.TEC. Primo Congresso Annuale Roma, 3-4 dicembre 2004.

IT in Construction. (1999), Report of the first phase of the IT Working Group Activities; UE, Brussels.

Mecca, S. (2002), Comprendere il cantiere,Edizioni ETS, Pisa.

De Luca Picione, M., Guida A. (2006) "Management of execution phases in a building process using information technologies (IT)" construction in the xxi century: local and global challenges, pp. 134-135 ed. Scientifiche Italiane.

Rigamonti, G., (2001) La gestione dei processi di intervento edilizio, UTET, Torino.

FACILITIES MANAGEMENT, HEALTH AND SAFETY (H&S), AND THE IMPACT OF THE CONSTRUCTION REGULATIONS

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ABSTRACT

Occupants and workers are exposed to buildings - occupants through the use of a building, and workers through construction activities such as new build and maintenance. However, given that there are a number of phases in a building's life, which phases are inter-related and influence each other, the health and safety (H&S) of workers should be considered during the concept and initiation, design and documentation, construction, commissioning, and deconstruction phases, in addition to the use phase. Consequently, clients, designers, facilities managers, project managers and other project stakeholders should consider *inter alia*, the H&S and ergonomics implications of a design, details, and specifications.

A descriptive survey was conducted to determine the manifestations of the impact, if any, of the promulgation of the South African Construction Regulations, which require multi-stakeholder contributions to construction H&S throughout all phases of a building's life.

The salient findings include: cost, quality, and time predominate among project parameters, and the manifestations of the impact are widespread, *inter alia*, increased provision for H&S, financial and other, and increased consideration for / reference to H&S by all project stakeholders.

Consequently, it can be concluded that the Construction Regulations have had the desired impact. Recommendations include that H&S should be included as a project parameter and that H&S related practice notes and guidelines should be evolved for all stakeholders.

KEYWORDS: health and safety, construction, workers

INTRODUCTION

Traditionally, cost, quality and time have constituted the parameters within which projects have been managed. However, increasing awareness relative to the role of H&S in overall project performance and the inclusion of H&S as a project performance measure by *inter alia*, petro-chemical organisations, has engendered focus on H&S by a range of stakeholders. The number of large-scale construction accidents in South Africa during the last decade and more, and the consequential media coverage has further raised the level of awareness. Furthermore, the Construction Regulations promulgated on the 18 July 2003, require a range of interventions by clients and designers.

Given the abovementioned, the general need to assess the impact of interventions, and the passage of time since the promulgation of the Construction Regulations, surveys were conducted to determine the perceptions of member practices and contractor members of associations / institutes regarding: the importance of various project parameters; the manifestation of the impact of the Construction Regulations, and the extent to which the Construction Regulations will impact on various project parameters.

REVIEW OF THE LITERATURE

Statistics

During 1999, the various class of injuries reported to the Compensation Commissioner (2005) in South Africa equate to 1 temporary disablement for every 102 workers, 1 permanent disablement for every 1 041, and 1 fatality for every 3 925. The disabling injury incidence rate (DIIR) 0.98 means that 0.98 workers per 100 incurred disabling injuries, the all industry average being 0.78. The number of fatalities among the workers insured by the Accident Fund (AF) is the equivalent of a fatality rate of 25.5 fatalities per 100 000 full-time equivalent construction workers, which does not compare favourably with international rates.

The statistics provide the humanitarian motivation for the need for: H&S related legislation; promulgation of the Construction Regulations, and multi-stakeholder contributions to construction H&S, facilities managers included.

Cost of accidents (COA)

The COA can be categorised as being either direct or indirect. Direct costs tend to be those associated with the treatment of the injury and any unique compensation offered to workers as a consequence of being injured and are covered by workmen's compensation insurance premiums. Indirect costs which are borne by contractors include: reduced productivity for both the returned worker(s) and the crew or workforce; clean-up costs; replacement costs; costs resulting from delays; supervision costs; costs related to rescheduling; transportation, and wages paid while the injured is idle (Hinze, 1997).

Research conducted in the United States of America determined the total cost of accidents to constitute, *inter alia*, 6.5% of the value of completed construction (The Business Roundtable, 1995) and in the UK approximately 8.5% of tender price (Health & Safety Executive, 1997). Research conducted in South Africa, determined the total cost of accidents could have been between 4.3%, and 5.4% (Smallwood, 2004).

Given that contractors do not segregate the COA and for that matter the cost of non-conformance (CONC) from the cost of conformance, the COA and the CONC are included in contractors' costs. Consequently, when estimating the cost of construction these costs are included and clients effectively pay therefore, hence the relevance of the COA to facilities managers.

Facilities management

Barrett (1995) defines facilities management as "An integrated approach to maintaining, improving and adapting the buildings of an organization in order to create an environment that strongly supports the primary objectives of that organization." Atkin and Brooks (2000) in turn cite the British Institute of Facilities Management's (BIFM) definition: "The practice of coordinating the physical workplace with the people and work of an organization." They then present their own definition adapted from that of Barrett, stressing the contribution that facilities management can make to an organization: "An integrated approach to operating, maintaining, improving and adapting the buildings and infrastructure of an organization in order to create an environment that strongly supports the primary objectives of that organization."

Facilities management and health and safety

Atkin and Brooks (2000) state that the following key issues should be addressed relative to H&S:

- Compliance with H&S legislation relative to the buildings and grounds in which the organization is set;
- The appointment of a competent person or consultant to assist in implementing and complying with H&S legislation;
- The development of a policy statement by the organization and the communication thereof to all stakeholders;
- The development of a system to implement the policy and to assess the effectiveness thereof;
- The development, implementation and review of policies, rules, and safe working procedures to ensure compliance with H&S legislation, and
- The addressing of non-legislative issues such as work-related stress.

Relative to risk, Atkin and Brooks (2000) cite failure to take account of relevant H&S legislation at the correct time, leading to excessive cost later, as a risk faced by organizations in their facilities management. A further risk identified is the inappropriate allocation of risks between the client organization and service providers. The allocation of risk, or more specifically transfer of risk, has historically been an issue relative to H&S. Invariably clients transferred the risk.

Furthermore, Atkin and Brooks (2000) identify opportunities arising from greater awareness of potential risks, *inter alia*:

- Identification and allocation of risks on a rational basis to help clarify relationships between contractors and facilities managers;
- Proper allocation of risks, and
- H&S legislation incorporated into facilities management policies at the appropriate time.

Atkin and Brooks (2000) also highlight H&S relative to service specifications, stating that international standards and H&S should be included therein. Further mention is made of H&S relative to continuing professional development (CPD) in terms of facilities managers remaining abreast of developments in legislation especially H&S.

Lin and Mills (2001) state that facility managers are required to deal directly with small firms engaged in the maintenance, alteration and cleaning of physical infrastructure and that their performance reflects on the manager of the facility. Performance includes *inter alia*, H&S, as it is mandatory for all firms to provide a healthy and safe working environment for their workers and subcontractors. Furthermore, due to the fear of prosecution H&S is a major issue.

Legislation and recommendations pertaining to project stakeholders

The Occupational Health and Safety Act (OH&S Act) (Republic of South Africa, 1993) schedules comprehensive requirements for employers. Consequently, in terms of legislation facilities managers must view facilities within the context of H&S. Further, all project stakeholders are employers and therefore need to address H&S within the confines of their organisations. Yet a further aspect is that clients, project managers, designers, facilities managers, and quantity surveyors invariably visit projects, and therefore could be exposed to hazards and risk.

According to the Project Management Institute (2004), all project managers should be proficient with the nine knowledge areas including among other, project integration, project scope and project risk management, in order to meet their client's requirements. These management knowledge areas are concerned with planning, controlling and executing all works required to complete the project, while managing project risk exposure. Although this paper is not project management focused, invariably most of the design disciplines included in the survey reported on in this paper fulfil the function of principal agent, and therefore should follow the principles of project management. However, in terms of the relevance to facilities management, facilities managers may, or rather should become involved in projects at an early stage to engender optimum consideration for H&S to ensure that the H&S of users and those persons that maintain completed facilities are not compromised. Brown (1996) concludes that project managers can mitigate risk exposure by consciously considering the potential H&S implications of any scope or programme changes before and during the construction phase, as well as in the choice of suitable construction methods / materials in the early phases of the project. He suggests the integration of H&S considerations in all project decisions. Lester (2000) developed this theory to propose that the traditional project performance parameters of cost, quality, and time, be expanded upon to include H&S. Hence sub-standard H&S performance will adversely affect overall project performance. The project manager also has to oversee and monitor any design development or any proposed changes to project scope during the construction phase to ensure that H&S is not marginalised in order to comply with budgetary or programme constraints. Consequently, facilities managers have a critical role to play in terms of design, detail, specifications and design development.

The Construction Regulations (Republic of South Africa, 2003) lay down important requirements with respect to clients, designers, and other project stakeholders.

Clients shall, *inter alia*: prepare H&S specifications for the construction work; ensure that principal contractors (PCs) have made provision for H&S costs in their tenders; provide PCs with any information that might affect H&S; appoint PCs for projects; ensure that PCs implement their H&S plans; stop work that is not in accordance with the H&S plans, and ensure that sufficient H&S information and resources are available to the PC where changes to the design or construction are made.

Designers shall, *inter alia*: make available all relevant information about the design such as the soil investigation report; design loadings of the structure, and methods and sequence of construction; inform principal contractors of any known or anticipated dangers or hazards or special measures required for the safe execution of the works; modify the design or make use of substitute materials where the design necessitates the use of dangerous structural or other procedures or materials hazardous to H&S, and consider ergonomics throughout all phases of projects. The aforementioned requirements amplify the need for facilities managers to become involved in projects at an early stage.

Although project managers are not implicitly required to undertake any specific interventions in terms of the Construction Regulations, by virtue of their unique position in the form of managing design delivery, the integration of design and construction, and their monitoring of construction, they need to ensure that many of the requirements are met.

Quantity surveyors are included in the definition of designers as defined by the Construction Regulations. Furthermore, many of the client related requirements such as ensuring that principal contractors (PCs) have made provision for H&S costs in their tenders, may require contributions by quantity surveyors.

Facilities managers are also not implicitly required to undertake any specific interventions in terms of the Construction Regulations. However, given that facilities management is concerned with the optimisation of work places in terms of the coordination thereof with people and work processes, then the implementation of the requirements of the Construction Regulations is important.

Contractors are required to undertake a range of interventions *inter alia*: prepare H&S plans in response to H&S specifications; make financial provision for H&S; appoint an H&S Officer; conduct induction; conduct risk assessments; prepare method statements; prepare fall protection plans; provide safe working procedures; conduct training, and evolve an H&S file.

RESEARCH

Sample stratum and response rate

The sample stratum consisted of member practices of the Association of Construction Project Managers (ACPM), Association of South African Quantity Surveyors (ASAQS), South African Association of Consulting Engineers (SAACE), and the South African Institute of Architects (SAIA), and a group of 'better practice H&S' general contractors who had achieved a first, second or third place in the Building Industries Federation South Africa (BIFSA) national Health and Safety (H&S) competition during the years 1995 to 2004 inclusive. Table 1 presents the size of the sample strata, the number of completed questionnaires included in the analysis of the data, and the net response rates relative to each of the sample strata, including a mean.

Table 1. Response rates for the sample strata

Measure	ACPM	ASAQS	SAACE	SAIA	Contr	Mean
Analysed (No.)	19	67	118	87	9	300
Sample stratum No.)	124	654	892	1 016	26	2 712
Response rate (%)	15.3	10.2	13.4	8.6	34.6	11.1

Table 2 indicates the importance of five parameters in terms of a mean score ranging between 1.00 and 5.00, based upon percentage responses to a scale of 1 (not important) to 5 (very important). It is notable that the mean scores are all above the midpoint score of 3.00, which indicates that in general the respondents can be deemed to perceive the parameters as important. However, given that the mean scores for the top three parameters are $> 4.20 \leq 5.00$, the respondents can be deemed to perceive them to be between more than important to very important / very important. Given that the mean scores for project H&S and environment are $> 3.40 \leq 4.20$, the respondents can be deemed to perceive them to be between important to more than important / more than important. It is significant that the traditional project parameters (time, cost and quality) are ranked in the first three. Furthermore, it is notable that the subject of the study, H&S, has a mean score 0.73 below that of first ranked project cost, which means the latter is effectively 15.8 % less important than the former.

Table 2. Degree of importance of various parameters to respondents' organizations.

Parameter	ACPM		ASAQS		SAACE		SAIA		Contractors		Mean	
	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
Project cost	4.63	2	4.74	1	4.42	2	4.39	2	4.89	1=	4.61	1
Project quality	4.37	3	4.15	3	4.64	1	4.64	1	4.78	3	4.52	2
Project time	4.68	1	4.41	2	4.29	3	4.25	3	4.89	1=	4.50	3
Project H&S	3.95	4	3.65	4	3.97	4	3.43	5	4.33	4	3.87	4
Environment	3.42	5	3.32	5	3.76	5	4.01	4	3.56	5	3.61	5

Table 3 indicates the impact of the Construction Regulations in terms of a mean score ranging between 0.00 and 5.00, based upon percentage responses to a scale of 1 (minor) to 5 (major). Given that effectively a six-point scale ('no impact' linked to a five-point) was used, and that the difference between 0.00 and 5.00 is five, ranges with an extent of 0.83 (5 / 6) are used to discuss the degree of central tendency. Firstly, it is notable that the mean scores for all sixteen manifestations are above the midpoint score of 2.50, which indicates that in general the related manifestations can be deemed to be prevalent.

The manifestations falling within the second range of mean scores > 3.33 ≤ 4.17 - between an impact to near major impact / near major impact, are discussed first. Increased H&S awareness, increased consideration for / reference to H&S by general contractors and project managers, predominates. Increased H&S awareness is a significant manifestation, as awareness is a pre-requisite for commitment and the allocation of resources. Increased consideration for / reference to H&S by project managers is a significant manifestation as project managers in their capacity as project leaders and coordinators, are uniquely positioned to integrate H&S into projects, in particular the design and development, and construction phases (Smallwood and Venter, 2002; Hinze, 1997). Given that project managers coordinate design and / or design delivery, they can influence designers, and therefore increased consideration for / reference to H&S by them should have resulted in increased consideration for / reference to H&S by designers. However, it is notable that the latter manifestation is ranked thirteenth with a mean score of 3.14, which is 21.5% lower than that relative to increased consideration for / reference to H&S by project managers. Fourth ranked review of provision for H&S - other e.g. H&S plan, programme is ranked higher than review of financial provision, ranked eighth, review of forms of contract ranked joint eleventh, and substantially higher than review of procurement practices ranked fifteenth. The ranking of review of provision for H&S is notable, as planning is a pre-requisite for H&S (Hinze, 1997). Furthermore, *inter alia*, enhanced planning for H&S was a desired outcome of the Construction Regulations.

Although fifth ranked improvement in H&S is probably attributable to a qualitative as opposed to a quantitative based opinion, it is nevertheless notable. However, the mean score relative to this manifestation and consequent ranking thereof, is validated by the level of response to and consequent sixth ranking of improved conditions on site – effectively 3.7% lower. Increased consideration for / reference to H&S by subcontractors is ranked seventh, whereas increased consideration for / reference to H&S by general contractors is ranked second. However, on the scale of 0 to 5, the latter mean score of 4.04 is 16.8% higher the former of 3.39.

The third range of manifestations, those with mean scores > 2.50 ≤ 3.33 - between a near minor impact to impact / impact, are discussed below.

The mean score and eighth ranking of review of financial provision, is notable as the Construction Regulations require the client to ensure that the PC has made adequate financial allowance for H&S. This and other requirements explicitly and implicitly require that the PC and SCs be pre-qualified on H&S. Although ninth ranked reduction in accidents is ranked below fifth ranked improvement in H&S, effectively 8.2% lower than the latter, it is nevertheless a manifestation, and the ultimate intention of the Construction Regulations. Tenth ranked more structured / deliberated approach to work, is ranked marginally above joint eleventh ranked change in work practices, the latter essentially being a function of the former. The mean score of the other joint eleventh ranked manifestation, namely review of forms of contract, is notable in that generally references to H&S in standard South African contract documentation can at best described as indirect, hardly coercive and, depending upon the level of commitment, contractors continue to address H&S to varying degrees (Rwelamila and Smallwood, 1999). Given the designer specific requirements of the Construction Regulations, and that design, details, and specification dictate the materials and methods used and adopted, the thirteenth ranking of increased consideration for / reference to H&S by designers is significant. Furthermore, given that the definition of designer includes quantity surveyors, the fourteenth ranking of "surveyor specifying articles or drawing up specifications is significant.

The second last and last ranking of review of procurement practices and last ranking of pre-qualification on H&S respectively, are significant as the Construction Regulations explicitly and implicitly require a range of procurement related interventions, the pre-qualification of PCs and SCs in terms of H&S included. Furthermore, procurement can impact on *inter alia*, H&S, either positively or negatively (Rwelamila and Smallwood, 1999).

CONCLUSIONS AND RECOMMENDATIONS

Despite the promulgation and implications of the Construction Regulations, the traditional project parameters in the form of cost, quality, and time are still perceived to be substantially more important than H&S. This conclusion amplifies the need for all the built environment disciplines to make a paradigm shift in terms of the status of H&S, particularly architects and quantity surveyors. Furthermore, all associations and institutes should engender such a paradigm shift through: the requirement that H&S be addressed in tertiary education and continuing professional development (CPD) programmes, and the provision of H&S related practice notes and guidelines. Given that facilities managers are concerned with the optimisation of work places in terms of the coordination thereof with people and work processes, then they need to engender the enhancement of the status of H&S.

Generally, the Construction Regulations are perceived to have had an impact. The manifestations of the impact are wide spread - the intention of the Construction Regulations; in particular, increased H&S awareness, increased consideration for / reference to H&S by general contractors and project managers. These are important manifestations as they occur 'upstream' and are necessary to influence the downstream process. However, respondents do not perceive there to have been increased consideration for / reference to H&S by designers and quantity surveyors, but to a marginal extent by subcontractors.

Table 3. Manifestation of the impact of the Construction Regulations

Aspect	ACPM Mean score	ACPM Rank	ASAQS Mean score	ASAQS Rank	SAACE Mean score	SAACE Rank	SAIA Mean score	SAIA Rank	Contractors Mean score	Contractors Rank	Mean Mean score	Mean Rank
Increased H&S awareness	4.20	3	3.89	3	4.09	1	3.75	1	4.38	1	4.06	1
Increased consideration for / reference to H&S by general contractors	4.44	1=	3.95	2	3.86	3	3.70	2	4.25	2=	4.04	2
Increased consideration for / reference to H&S by project managers	4.44	1=	3.96	1	3.95	2	3.66	3	4.00	6	4.00	3
Review of provision for H&S - Other e.g. H&S plan, programme	3.53	7	3.70	5	3.71	4	3.16	5	3.88	7=	3.60	4
Improvement in H&S	3.67	5	3.44	7	3.43	7	3.03	6=	4.25	2=	3.56	5
Improved conditions on site	3.56	6	3.32	10	3.17	10	2.98	8	4.13	4=	3.43	6
Increased consideration for / reference to H&S by subcontractors	3.75	4	3.36	9	3.42	8	3.17	4	3.25	11=	3.39	7
Review of provision for H&S - Financial	3.27	12	3.47	6	3.41	9	3.03	6=	3.25	11=	3.29	8
Reduction in accidents	3.36	9=	3.39	8	2.96	12	2.92	10	3.75	9	3.27	9
More structured / deliberated approach to work	3.36	9=	3.12	14	2.93	13	2.43	14	4.13	4=	3.19	10
Review of forms of contract	3.44	8	3.22	12	3.53	6	2.70	12	3.00	14=	3.18	11=
Change in work practices	3.29	11	3.17	13	2.97	11	2.59	13	3.88	7=	3.18	11=
Increased consideration for / reference to H&S by designers	2.86	15	3.27	11	3.65	5	2.94	9	3.00	14=	3.14	13
Increased consideration for / reference to H&S by quantity surveyors	3.00	14	3.80	4	2.66	15	2.72	11	2.88	16	3.01	14
Review of procurement practices	3.20	13	2.92	15	2.80	14	2.37	15	3.13	13	2.88	15
Pre-qualification on H&S	2.69	16	2.69	16	2.53	16	2.32	16	3.38	10	2.72	16

Increased provision for H&S, both other and financial, and review of forms of contract are important 'midstream' manifestations as they also influence the downstream process. Facilities managers of existing facilities and when involved in the early phases of projects should focus on the adequate provision for H&S and the appropriate H&S inclusions in contracts.

Improvement in H&S, improved conditions on site, and reduction in accidents are all significant and 'downstream' manifestations. Consequently, it can be concluded that the Construction Regulations have had the desired 'upstream', 'midstream', and 'downstream' impact.

The mean scores relative to increased consideration for / reference to H&S by quantity surveyors and designers reinforce recommendations emanating from other studies that quantity surveying and design practices should make a paradigm shift in terms of the status of H&S, and that the related associations should engender such a paradigm shift. Facilities managers of existing facilities and when involved in the early phases of projects should implement processes, which engender consideration for / reference to H&S by quantity surveyors and designers.

The findings in the form of the perceived extent to which the Construction Regulations will impact on various project parameters justifies the promulgation thereof, particularly relative to H&S, but to a lesser extent, cost, and also environment, time, and quality.

General recommendations include that H&S be addressed in all built environment tertiary education programmes, facilities management included, and that the related associations provide H&S related practice notes and guidelines, which address the synergy between H&S and the other project parameters. Facilities management H&S related practice notes and guidelines should be specific relative to the management of project stakeholders relative to H&S.

REFERENCES

Atkin, B. and Brooks, A. (2000), Total Facilities Management, Blackwell Science Ltd., Oxford.

Barrett, P. (1995), Facilities Management Towards Best Practice, Blackwell Science Ltd., Oxford.

Brown, P.E. (1996), Total integration of the safety professional into the project management team, In Proceedings of the First International Conference of CIB Working Commission W96: Implementation of Safety and Health on Construction Sites, edited by Alves Dias, L.M. and Coble, R.J., AA Balkema Publishers, Rotterdam, pp. 137-143.

Compensation Commissioner. (2005), Report on the 1999 Statistics, Compensation Commissioner, Pretoria.

Health & Safety Executive (HSE). (1997), The costs of accidents at work, HSE, Norwich.

Hinze, J.W. (1997), Construction Safety, Prentice Hall Inc., New Jersey.

Lester, A. (2000), Project planning and control, Butterworth-Heineman, Oxford.

Lin, J. and Mills, A. (2001), "Measuring the occupational health and safety performance of construction companies in Australia. Facilities", Vol 19 No. 3/4, pp. 131-138.

Project Management Institute (PMI). (2004), A Guide to the Project Management Body of Knowledge, PMI, Newtown Square, Pennsylvania.

Republic of South Africa. (2003), Government Gazette No. 25207 Construction Regulations, Pretoria.

Rwelamila, P.D. and Smallwood, J.J. (1999), "Appropriate project procurement systems for hybrid TQM", In Proceedings Second International Conference of CIB Working Commission W99. Implementation of Safety and Health on Construction Sites, Honolulu, Hawaii, edited by Singh, A., Hinze, J.W. and Coble, R.J., AA Balkema Publishers, Rotterdam, pp. 87-94.

Smallwood, J.J. (2004), "Optimum cost: The role of health and safety (H&S)", In Proceedings International Cost Engineering Council 4th World Congress, Cape Town, edited by Verster, J.J.P, ICEC, Cape Town, CD-Rom Smallwood-J-Optimum Cost-Health & Safety.pdf

Smallwood, J.J. and Venter, D.J.L. (2002), "The influence of project managers on construction health and safety in South Africa", The Australian Journal of Construction Economics and Building, Vol 2 No. 1, pp. 57–69.

The Business Roundtable. (1995), Improving Construction Safety Performance Report A-3, The Business Roundtable, New York.

THE PROBLEM OF FLAT ROOFING SYSTEM IN TROPICAL CLIMATE: CASE STUDY – A HIGHRISE BUILDING IN KUALA LUMPUR, MALAYSIA.

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INTRODUCTION

In tropical climate such as Malaysia, the roof plays an important part in keeping the harsh hot sun and heavy downpours away from building users. Roofs of dwellings and small buildings often have large overhangs to cut off direct sunlight and steep angled pitch to get rid of rainwater as quickly as possible.

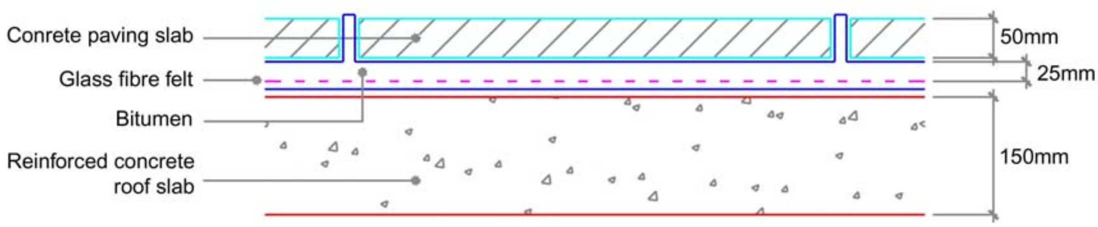
However, this technique is unsuitable for skyscrapers and gleaming new towers of Kuala Lumpur. Philosophically, the Malay style pitched roof is very much disproportionate to any tall building. Moreover, in this day of age the roof on skyscrapers also has to play the role of building services space provider with regards to cooling towers, water tanks and exhaust pipes and pumps.

So almost all skyscrapers in Kuala Lumpur have flat roof to accommodate this role. The same applies to the case study of this research, the Menara Uniasia or formerly known as Menara SEA insurance designed by the Japanese architectural firm, Kenzo Tange.

Situated on the North Eastern corner of Jalan Sultan Ismail and Jalan Raja Laut junction, Menara Uniasia is part of a new skyscraper landmark in Kuala Lumpur as it is part of the Maju Junction development and other adjacent towers with gleaming aluminium cladding, curtain walling and large amount of glazing.

STRUCTURE & MATERIALS

The focus of this study is the roof of the Menara Uniasia and how it was designed to react to the climatic conditions and provide the means of accommodating services. Similar to any skyscraper in Malaysia, the Menara Uniasia is of reinforced concrete columns but with pre-stressed concrete beams to span its fan shaped plan and with single span reinforced concrete floor slabs and roof slabs.



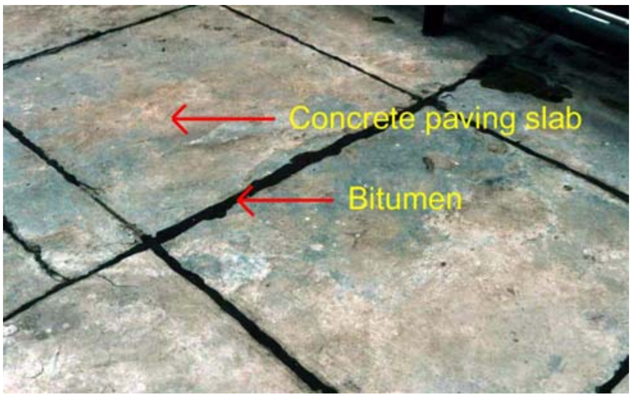
Roof Slab Section not to scale

The roof slab is 150mm thick on 1000mm deep pre-stressed concrete beams fixed jointed to the top of rising reinforced concrete columns and the side of reinforced concrete lift core. The roof was designed structurally to withstand deflection due to heavy building services equipment and weight of rainwater. It is also part of a structural system that can withstand lateral forces in this case the wind. The roof slab acts as structural stabiliser a flange in fact that prevents the columns from bending. Alongside the lift core, the roof is also a part of the whole structure that deals with shear forces created by lateral and live load imposed on the building.

Reinforcements in the form of steel rods were placed in critical areas between the pre-stressed concrete beams where most bending will likely take place. This is to prevent sagging and eliminate the possibility of rainwater ponding and leakage. In fact the roof is not entirely flat as a slope was introduced to ease rainwater flow and discharge. Although the slope is hardly noticeable due to fact that the roof has to be adequately level to locate water tanks and cooling towers easily.

The roof slab is of in-situ cast rapid hardening concrete. It has been normal practice in Malaysia not to install any insulation material on reinforced concrete roofs to ease maintenance and save on overall construction cost. Otherwise, if the roofing material is of metal than insulation is important not only to reduce heat gain but also as sound insulator. Similar to any usual finished concrete surface, this roof surface is smooth, hence easy installation of felt and bitumen and other waterproofing materials. The most obvious advantage of only using concrete is that it has high compressive strength, hence appropriate for foot access and loading.

Concrete is also heavy and dense suggesting high thermal mass, which can help to reduce surface temperature difference. In this case the temperature difference between night and day in Kuala Lumpur would reach near double figures, so the roof slab would not expand and contract as much, hence longevity and high resistance to cracks. In terms of comfort, the building users beneath would of course not feel a thing due to the fact that the interior environment is already fully automated with central air-conditioning, fixed glazing with laminated tempered glass and carpets. However, they should realise that the roof actually helps to fend off much heat gain during the hot afternoons. While at night the roof again helps to keep the temperature underneath up, hence less usage of air-conditioning.



WATERPROOFING

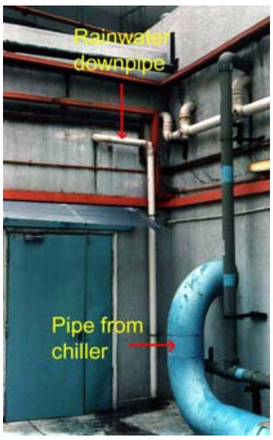
Keeping the rainwater out of the building is an important part of the roof's role. Hence, waterproofing is essential in guaranteeing that the roof is leak-free. User comfort is also the goal here, because leaks can damage property below the roof such as electronic equipment and furnishings.

So, as in any other skyscraper with a flat roof, the roof here has a thin layer of bitumen, applied while hot onto the reinforced concrete roof surface, which was left to harden. Bitumen is a dense, coal-tar mixture or asphalt. In the case of Menara Uniasia, it was unknown to the researcher how long was the period that the slab was left to dry before applying waterproofing materials. However, in normal practice a reinforced concrete slab would be left to harden for at least 21 days. The minimum period is only 24 hours depending on the weather during casting. It is important to point out here that bitumen will not stick to a damp concrete surface. It will be easily torn off instead of being hard and tough. Besides, the roof slab would be subjected to quick damage due to rusting of reinforcements caused by the presence of moisture trapped beneath the bitumen layer while still drying. If the waterproofing material is applied much too early, the slab would in the long run also easily get cracks of various sizes, and this would ultimately increase the cost of maintenance.

Felt is than unrolled onto the thin layer of bitumen. This felt will in the end help to strengthen and stabilise the bituminous layer, hence reduce the possibility of waterproofing layer slippage caused by friction and strong driving winds. At Menara Uniasia, inorganic glass fibre felt was used due to its cost effectiveness and availability. Then lastly another but thicker layer of boiling bitumen is poured onto the surface and left to cool. This waterproofing material will ultimately prevent any water seepages and penetrations that would damage the roof structure and property below.

FIREPROOFING

Before the installation of bituminous waterproof layer, the project architect, structural and construction engineers would have probably inspected the roof surface for any visible cracks. This is an important step during construction in order to prevent the bituminous mixture from seeping through cracks, hence present fire hazards because bitumen is flammable.

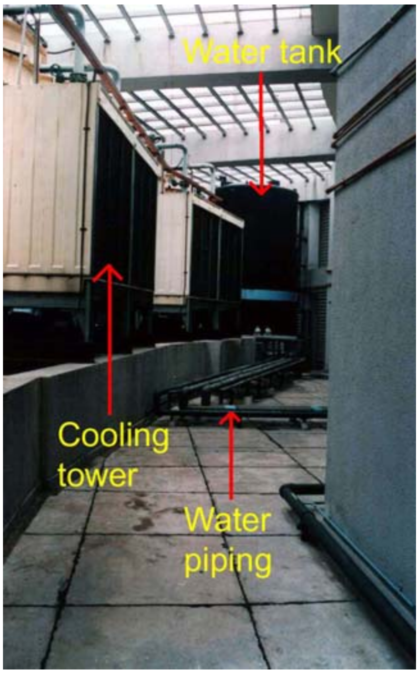


The next step was to introduce concrete paving on top of the waterproof bitumen layer that would prevent any naked fire or spark from the machinery located on the roof from lighting up the bitumen. It was normal practice before to use mineral aggregate in the form of gravel, but nowadays it is much easier and cost-effective to use roughly finished 600x600mm concrete paving slab, especially when one think about safely transporting tonnes of gravel onto the 22nd floor of this tower.

There is an obvious weakness in this method, for once the bitumen is not totally protected as there are gaps between the paving slabs and in this case as visible from the photograph, the gaps between the paving slabs are totally filled with either soft but cooled bitumen after a few hours of application or freshly poured bitumen. So, the possibility of fire exists unlike when using gravel that totally covers the whole bitumen surface. Maintenance wise, a roof with gravel is more durable and need not be maintained as much as a roof with paving slabs.

CONSTRUCTION SEQUENCE

As in normal practice, reinforcement rods and bars were folded and welded on site before hand. Then when it was complete, timber shuttering was constructed to act as a mould or container for semi fluid concrete mix that was to be later poured. The same shuttering that was used for the construction of other floor was probably used to save cost and time.

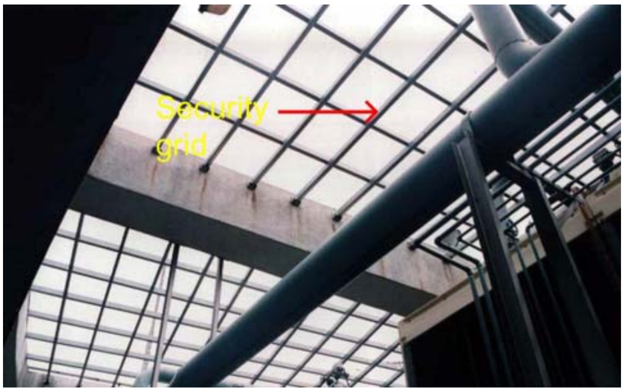


Then by the use of tower crane, buckets of concrete mix were transported all the way up from concrete mix trucks on the ground. Concrete was continuously hauled over this height for more than 24 hours to completely cover the roof area. Over at areas where concrete had already been poured, workmen arduously worked on levelling the concrete mixture while making sure that it slopes at the correct gradient and direction. Only after 21 days that the shuttering was later removed. At that moment the roof slab was already well hardened and ready for loading.

BUILDING SERVICES

Another important role that the roof plays is of a provider of space for building services equipment. The floor area available on the roof is ample to accommodate 3 cooling towers for the air-conditioning system, twelve 3000 litre water tanks for domestic water supply, air-conditioning water supply and haze control. Besides this, ample space is also available for 3 large ventilation duct exhaust fans. All of the water tanks are placed on solid concrete plinth to prevent movement and leakage.

Meanwhile all of the cooling towers, which operate with a constant humming sound, are assembled on reinforced concrete strip footers. These footers elevate the cooling towers to a safe level height of approximately 1000mm from the roof surface. Thick rubber absorbers fitted to the plinths absorbs any vibration caused by the cooling tower operation. The noise caused by the cooling towers meanwhile is either reflected away by the hard surface of the roof floor or absorbed, thus no noise pollution gained through the roof.



All ducting and piping that connects all of the building services equipment on the roof are from purpose built risers provided in the service core. So, no holes were bored that could compromise the roof's water-tightness and integrity. In fact, the only holes that were made were of the rainwater drainage inlets. The rainwater pipes are 200mm in diameter and from the researcher's observation; there were only three inlets visible on the main roof level. This might not be adequate, as it is well known that it rains very heavily in Kuala Lumpur. Most probably all of the other inlets are beyond the perimeter louvered wall. This drainage system is directly connected to the city's drainage system on the ground plane. This system only rely on gravity to discharge collected rainwater. No pumps included along the pipeline, so if there was to be a very heavy downpour, then the system will not be able to cope well, hence temporary flooding on the roof.

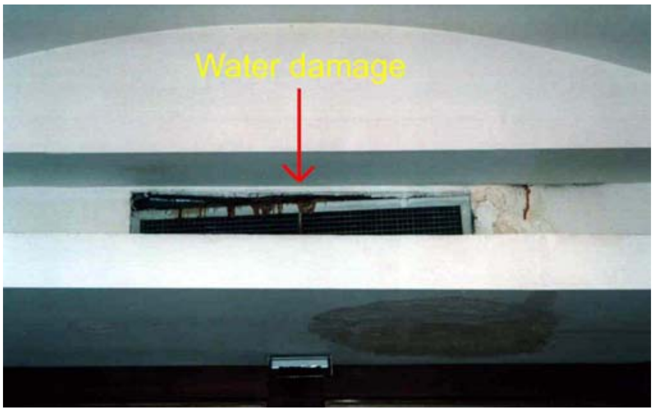
Adequate space for maintenance of building services equipment and circulation was provided. This is important because in case of fire, the maintenance officer can safely reach any of the 2 escape staircases.

SAFETY AND FACADE CONSIDERATIONS

As part of a directive from the local authority or Dewan Bandaraya Kuala Lumpur DBKL, a grid of light steel sections of 100x50mm was introduced to cap the void on the roof. So, in effect the roof is a double height room, which is open to the elements.

As part of the architect's envisioned facade, a perimeter louvered wall was constructed. Both the structural frames and louvers of this wall are of steel. This wall supports a perimeter metal deck roof that crowns the facade of the building. The metal decking roof is of steel cantilevered beams supporting very ordinary steel roof cladding with ceiling underneath. Water spray outlets for haze control runs all along this secondary roof.

The louvered wall in fact, helps to reduce wind exposure that could present a threat of damaging the roof surface and all of the equipment installed. Wind that passes by the building is broken up. It is important to point out here that the sharp tips of this building are orientated from East to West. So, the main facade is not directly exposed to prevailing Easterly winds.



The steel clad metal deck roof partly shades the reinforced concrete roof slab from too much exposure to the harsh afternoon sunlight, hence reduced heat gain.

PROBLEMS AND DEFECTS

It was notable that the top floor experience minor leakage. This leakage is visible in the lift lobby on the 21st floor through the air-conditioning outlet. Attempts were made to rectify the problem, however this leakage is mainly due to the fact that there is a valley on the roof floor toward the junction between the roof slab and lift core. This blunder was probably due to lack of supervision while finishing the roof slab. Generally the slope is in the direction of the main facade.

So, the biggest factor that determines whether a flat roof would fail or not is due to workmanship. If for instance the workmanship is of low quality and supervision, then the roof would be constructed poorly, hence leakages, cracks and other defects. It was also evident that there was stagnant water around the rainwater drainage inlet. This is an ideal condition for growth of fungi that would in the long run damage the roof surface and corrode away the bitumen layer.

REFERENCES

1. Griffin, C.W. (1970). Manual of built up roof systems. New York, McGraw-Hill.
2. Williams, C.D., Cuts, E.C. (1954). Structural design in reinforced concrete. New York, Ronald Press Company.
3. Rogers, T.S. (1964). Thermal design of buildings. New York, John Wiley & Sons Inc.
4. Knab, L.I., Jenkins, D.R., Mathey, R.G. (1980). The effect of moisture on the thermal conductance of roofing systems. Washington D.C., U.S. Department of Commerce.
5. Bassler, B. ed (2000). Architectural graphic standards, student edition. New York, John Wiley & Sons Inc.

DELIVERY OF CONTINUOUS IMPROVEMENT AND INNOVATION: A SURVEY OF FACILITIES MANAGEMENT ORGANISATIONS

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ABSTRACT

In a modern rapidly changing business environment, it is extremely important for business survival to strive and sustain Continuous Improvement and Innovation (CII) by developing internal capabilities and establishing an active collaboration with suppliers and service providers. The main purpose of this research was to analyse the CII capabilities of FM organisations and to evaluate the current CII practices in use in the FM sector. The research also assessed whether FM organisations are realising the true benefits of CII practices by forming collaborative relationships in the supply chain in order to gain competitive advantage as well as to add value in the various aspects and areas of business. The research methodology involved both quantitative methods with the help of a web-based questionnaire and qualitative methods using open-ended questions and semi-structured interviews. The research results show that FM is gradually moving along the path of developing CII values and on an average 44% of the organisations surveyed already have the internal capabilities to manage and sustain CII. A majority of FM respondents have expressed the view that CII is considered as specific criteria during the contract negotiation stage and specific guidelines, methodologies or best practices are being followed in CII implementation. Overall, the surveys show that FM is widely benefiting from implementing CII practices through collaborative relationships. However there is very little evidence to suggest that businesses are truly capitalizing on the CII potential of the FM supply chain.

KEYWORDS: Continuous Improvement and Innovation, Facilities Management Supply Chain, Collaboration, Competitive advantage

INTRODUCTION

Continuous Improvement and Innovation (CII) is argued to be a key mechanism in increasing competitive advantage for organisations. An organisation can catalyse the process of introduction and sustenance of CII practices through collaboration with the supply chain partners. It is widely agreed that Facilities Management (FM) is an inherent part of the organisation and it should be strategically aligned to business needs and objectives (Kaya et al., 2004). With an increasing trend towards outsourcing of facilities services to either single or multiple service providers and awareness of the benefits of supply-chain integration, there is a shift from traditional contracts to ***co-operation*** (fewer suppliers and longer term contracts), ***co-ordination*** (information & business linkages, electronic data interchange linkages), ***collaboration*** (supply chain integration, joint planning, technology sharing), and finally to ***strategic alliance*** (extended long term relationship with emphasis on mutual benefits) depending on the level of interaction, integration, sharing, mutual trust and commitment. This can benefit the supply chain organisations to develop skills, knowledge and processes in order to remain competitive in the market and pave a way for CII (Rackham et al., 1996; Chapman & Corso, 2005; Maqsood et al., 2007). It is well argued that FM can add value to the business by translating its supply chain relationships into collaborative alliances resulting into enhanced CII practices whereas businesses can benefit by incorporating such practices into other areas / aspects for wider benefits. Though much has been written about models of strategic alliance in supply-chain networks, the debate has remained largely at a prescriptive level, and there is very little rigorous empirical research concerning inter-organisational collaboration in facilities practice.

This paper firstly provides an overview of the nature of CII including the historical origin of CII as a methodology and analysis of the definition & philosophy on the basis of review and synthesis of existing literature. It further investigates the various levels of CII capabilities; the relationships between Client-Service Provider; the management tools; and benefits of forming the strategic alliance in Supply Chain. Based on the results of a web-questionnaire and semi-structured interviews, the rest of the paper provides an evaluation of the existing CII capabilities of FM organisations, the CII practices being adopted in FM sector and the areas of positive impact from strategic collaboration in FM supply chain. It further analyses whether the organisations are realising the true benefits of CII practices, by forming collaborative relationships in FM supply chain, in order to gain competitive advantage as well as add value in various aspects / areas of business.

THE NATURE OF CONTINUOUS IMPROVEMENT AND INNOVATION

Historical Background of Continuous Improvement and Innovation

The roots of CII methodology can be historically traced back to 1894 when the first modern CII programme was introduced formally at National Cash Register, Dayton, Ohio with an aim to improve labour-management relationship, encouraging improvement suggestions, and developing employees' capabilities by providing educational opportunities (Schroeder & Robinson, 1991 In: Jha et al., 1996). In the post World War II era in the 1940s, the concept was imported from USA into Japanese culture to rebuild the devastated industry. The methodology gained popularity in Japan especially in manufacturing sector for participation of the workforce in process improvement and refinement, which later developed into a management philosophy. Meanwhile, the CII methodology disappeared from USA for almost two decades before it was revisited in early 1980s to enable companies to compete against their Japanese counterparts. Later in 1990s, following an industrial downturn, it gained worldwide momentum as a means of gaining competitive advantage. Since then, a myriad of studies have been conducted to evaluate the development and use of CII as a means to attain organisational effectiveness, competitiveness, enhanced customer satisfaction and to gain more tangible benefits of cost reduction, flexibility & reduced cycle time (Bhuiyan & Baghel, 2005).

Definition of Continuous Improvement and Innovation

Continuous is defined as 'on-going or extending without interruption or break, unbroken, connected'; *Improvement* is defined as 'increase in value or in excellence of quality or condition' and *Innovation* is defined as 'generation of a new idea and its implementation into a new product, process, or service' (Robson, 1991). In general *Continuous Improvement and Innovation* (CII) can be defined as 'initiatives that increase successes and reduce failures' (Bhuiyan & Baghel, 2005) or 'a new approach of enhancing organisational effectiveness, creativity and competitiveness' (Jha et al., 1996) or 'a company-wide process of focused and continuous incremental / radical improvement and innovation through the involvement of people from all organisational levels' (Bessant et al., 1994; Kinlaw, 1992). Improvement and Innovation should be continuous, participative and intertwined in the culture (way of working) in order to lead towards business excellence (Kinlaw, 1992; Jha et al., 1996).

CONTINUOUS IMPROVEMENT AND INNOVATION IN SUPPLY CHAIN

In modern complex and rapidly changing business environments, organisations continuously strive for sustainable competitive advantage. The aim of business development strategies is to proactively meet the customers' demands and attain a pre-eminent position in the market-place. Inter-organisational collaboration through outsourcing and partnering provides an opportunity to exchange skills and capabilities and to create an extended knowledge base which in turn can help to '*learn from other's mistakes*' or ' *to prevent reinventing the wheel*' and to remain ahead of the game. How fast and how much knowledge any organisation can assimilate through such relationships will depend on its structure, policies, culture, technology and absorptive capacity in alliance learning. It has been argued that organisations can benefit considerably in gaining competitive advantage by introducing innovation and continuous improvement in contracts and supply chain management and by ensuring that they have the necessary capabilities and supportive systems (Kerrin, 2002; Chapman & Corso, 2005).

Strategic Partnering can give both clients and suppliers, a long-term competitive advantage in their respective market places by adopting a more productive and profitable business relationships (higher values and lower costs), which is virtually impossible to compete against with a transactional approach. The three critical factors for forming a strategic alliance are vision, impact, and intimacy (Rackham et al., 1996). Despite of the well known benefits of collaboration within supply chain in other areas of business and organisation, CII remains neglected and marginal in FM industry. The emphasis in major cases lies on the monitoring and managing the performance of service providers and there is little or no effort in delivery of improved and innovative solutions (Alexander et al., 2004; Pitt et al., 2005).

CONTINUOUS IMPROVEMENT & INNOVATION CAPABILITY OF AN ORGANISATION

CII enables the organisation to find new ways of doing things and institutionalise them in the work-culture, in order to achieve and retain strategic advantage. Today it is rarely an option and has become imperative; unless organisations are prepared to improve continually, their chances of survival are seriously threatened. The 4P's of CII are changes in *Product / Services*; *Process* by which they are created and delivered; *Position* by which these are introduced; and *Paradigm* by change in mental models of organisation's core competency (Tidd et al., 2005). The degree to which such changes are introduced, ranging from *Incremental* (steady-state improvement); *Modular* (change in single element within established framework); *Architectural* (reconfiguration of knowledge sources and configurations); *Radical* (complete transformation of perception and usage); to *Discontinuous* (changes where neither the end state nor the ways in which it can be achieved are known); would determine the impact and benefit of CII (Foster, 1986; Webster, 1999; Tidd et al., 2005). Figure 1 shows the various degrees of CII. Ettlie (1999) suggests that only 6-10% of the changes are disruptive or radical; the rest occur in incremental fashion.

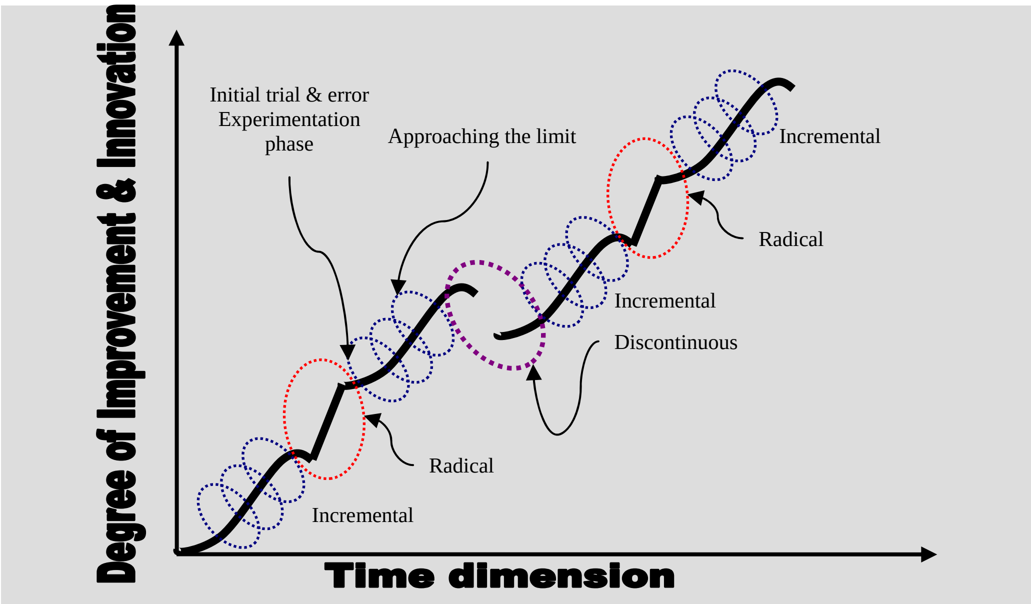

Figure 1. Degree of CII; adapted from: Foster, 1986; and Tidd et al., 2005

CII is a long-term and self-conscious effort of introducing new or improved ways of doing things, which an organisation develops over time till it becomes an integral part of organisational life. Companies have been benefited not only from financial savings or profits but also from increased performance, productivity, quality and delivery. Bessant (2003 & Bessant et al., 1994) identify five levels of ascending CII capabilities in organisations which are depicted in Figure 2:

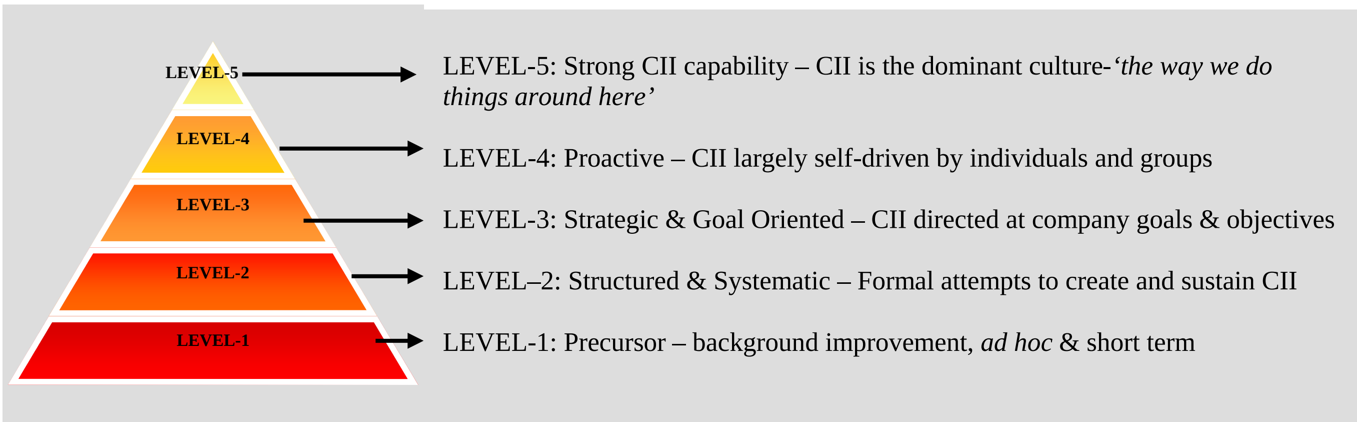

Figure 2. Levels of CII Capabilities in organisation, Source: Bessant, 2003

INTANGIBLE AND MEASURABLE BENEFITS OF STRATEGIC ALLIANCE IN SUPPLY CHAIN LEADING TO CII

Both client and service provider organisations can get mutual benefits by strategic collaboration and integration, and through direct and indirect knowledge sharing. *Indirect learning* is possible by knowing the people and businesses of the other members closely, which would bring new culture, values, management strategies, leadership techniques and hence benefits, which could be enjoyed by every organisation within the integrated alliance (Khalfan et al., 2005). The key areas where strategic relationships can have influence *indirectly* through mutual sharing of expertise and knowledge are organisational climate and culture; Leadership commitment; Organisational structure; External orientation; Strategy; Information Systems; Human Resources practices; and Market Orientation (Bessant, 2003; Tidd et al., 2005; Senior & Fleming, 2006).

Some of the *direct or measurable benefits* from such relationship are Leveraging Core Competencies; Reduction of duplication and waste; Creating new opportunities; Customer Satisfaction; Shared benefits and risks of failures; Reducing Uncertainty; Top-end Quality; Technology transfer; Competitive advantage; and Organisational Learning (Jha et al, 1996; Rackham et al., 1996; Kerrin, 2002; Bessant, 2003; Heywood et al., 2004; Tidd et al., 2005).

Direct knowledge sharing could be facilitated largely by the client organisation through commitment of top management; leadership strategies; initiatives such as participatory workshops, training workshops, moving away from the traditional contract to partnership with higher levels of trust; incentivised payments; and encouraging CII as a part of the service level agreement. The client wins significantly in terms of responsiveness, improved quality, access to expertise, cost effectiveness, efficiency, enhancement of innovative capabilities, increased knowledge base and institutionalised CII. On the other side, the drivers or motives behind investment in such alliance from SPs' side would be better strategic relations; long-term and durable contract partnership; locking out of the competition; incentives for innovation; improved customer satisfaction; and increased competitiveness & organisational learning (Racham et al., 1996; Khalfan et al., 2005; Pitt et al., 2005).

RESEARCH OBJECTIVES AND METHODOLOGY

The aim of this study was to analyse the wider trends in organisations regarding their CII capabilities, CII practices and the benefits being achieved from such practices. The study was therefore designed to follow systematic investigation based on descriptive 'theory-led' approach. It also involved comparison between different levels of supply chain such as client, main service provider, sub-service provider and consultants in order to document the differences, if any, in their CII capabilities and practices. To collect primary data, the web-questionnaire was designed to draw accurate information from the respondents. It is an impersonal survey method and has a number of advantages (such as wider geographic coverage; low cost; easy data recording and analysis; quick turn-around time; reduction in biasing error; and greater anonymity) and disadvantages (such as low response rate; no opportunity for probing; no control over who fills out the questionnaire; and lack of flexibility) that are well discussed in the literature (Sharp et al., 2002; Holliday, 2007).

To further reinforce the results from the survey and address some of the issues generated from questionnaire analysis, a qualitative method of data collection involving in-person, telephonic and web-based interviews was used. Interviews are preferred methods in qualitative data collection as they provide higher quality information that is free from bias than many other methods; provide a good medium to access the material which is not written down; and help to discover how individuals think and feel about a topic. The major disadvantages in interviewing is to find adequate ways of recording all the data obtained; they are time consuming; difficult to structure, interpret and summarise; and present the possibility to be sidetracked by interviewee (Sharp et al., 2002; Holliday, 2007).

RESEARCH RESULTS AND DISCUSSION

The survey was focussed mainly on FM supply chain at 4 levels including Client; Main service providers / suppliers / contractors; Sub service providers / Sub suppliers / Sub contractors; and FM consultants. A pilot-test was performed to validate the formulations of questions in the questionnaire and avoid possible misunderstandings that might lead to misinterpretations of the answers. The questionnaire request was later sent by e-mail along with a covering letter to 750 FM professionals listed in BIFM website – membership directory, who were either involved in contract or relationship management or have specific title as Facilities Managers or Facilities Directors. A total of 228 responses were received, giving a response rate of 30%. Typical response rate for a web-questionnaire survey is between 20% & 40% (Sharp et al., 2002; Bourque & Fielder, 2003). Later interviews were organised with 8 respondents who provided enough evidence of following good-practices in CII and showed willingness to give further details regarding the issues addressed in the questionnaire. The research results are discussed below.

Corporate internal environment within FM organisations being supportive of CII

In order to achieve desired benefits, the CII behaviours need to be established and reinforced into the fabric of organisational life to the point where they become routines. As mentioned earlier, Bessant (2003) has described 5 stages / levels on the journey towards a successful and sustainable CII culture based on indicators such as strategy, leadership, understanding, consistency and cross-boundary working. Based on these performance indicators, on an average only 11% of the organisations are in level 1 where CII happens as a result of learning-curve effects associated with a particular new process or product & then fades out again; whereas 44% of the organisations are in level 4 and 5 where CII is proactively followed or is an integral part of work life and there are multiple mechanisms in place to ensure high levels of involvement in the learning and knowledge management.

It can be further inferred that FM is gradually on its journey to develop strong CII capabilities and include it in day-to-day activities; however the challenge for majority of the organisations is to push the boundaries towards more widespread and autonomous CII activity of the Level 4 type. The above can be achieved by forming close ties between FM & corporate strategies; generating wider participation and involvement at all levels and institutionalising CII values in every day’s work culture; by developing not just ‘do better’ but also ‘do different’ routines; by creating incentives / rewards based on ideas as well as their success and by supporting inter-firm shared learning.

The areas of positive impact from strategic collaboration between Client and FM Service Providers

Intense global competition, rapid technological change and demanding consumers are changing the business environment today. In this competitive environment many firms are realising that they must form collaborative alliances with suppliers, service providers and contractors not only to share the risks and maintain sophistication in all levels of technology, process / product & distribution markets but also benefit by sharing new ideas, culture, values, management strategies, leadership techniques etc (Khalfan et al., 2005). The evidence suggests that the collaborative alliances in FM supply chain are contributing towards enhanced firm performance and, ultimately, competitive advantage. Three key areas of benefits which the respondents have undoubtedly agreed are *Process improvement,* *Continuous improvement capabilities and Climate & Culture*. The examples of process improvements expressed by respondents include improved paperwork processes, improvements in invoicing process, work allocation and planning, working time management, audit trail for complaints, car parking management, ordering techniques etc. The examples to enhance the continuous improvement capabilities include improvements / changes in Product / Services; Process; Position and Paradigm. Active collaboration between firms bring different organisational climate & cultures together, which can be synchronised to share values, ideas, work practices, behaviours, competencies & capacities and embed them into the organisational work life.

Whilst 41% of the organisations in FM sector indulge into collaborative or alliance relationships; the responses also suggest the presence of contractual relationships in 31% of the organisations. This shows a lack of willingness, mutuality, trust, commitment and openness in substantial minority, which prevents them from benefiting through closer relationships and fostering greater opportunities of embedding CII practices. When asked from the respondents, the factors which the companies deem most important in selection of FM service providers / suppliers / contractors, the factors chosen were: *Partnership contract capabilities, Commitment to quality, Price and Existing relationships / previous experience*. This suggests that FM is giving preference to development of long-term relationships over price. What is required further is to develop joint goals, shared resources, and common vision that are espoused by the collaborative approach.

The enabling & limiting factors in implementing CII through collaboration between client – supplier / service provider / contractor within FM sector

Although Continuous Improvement and Innovation is easy to understand, it has proven difficult to implement successfully. Top three enabling factors, expressed by respondents, in CII implementation are: *making it a part of service level agreement (SLA), Long-term partnership contracts and part of performance measurement*. This shows the emphasis in FM for including CII into formal agreements. What is required next is to shift the focus towards imbibing other values at the heart of CII such as senior management commitment and involvement; Knowledge sharing; Shared risks / failures; Team-work / spirit; Greater equity & focus on relationship and Incentives / reward schemes. The least favoured means are: *support in training and emphasis on future prospects*. This suggests that FM service providers are perceived to have expertise and knowledge in their respective areas; and by forming the long-term relationships or giving them a ‘preferred status’ can itself project the possibilities of future prospects.

The top three limiting factors which the respondents have chosen in CII implementation are: *lack of understanding, insufficient trust and lack of communications*. Although these are argued to be the core threads of a successful relationship, but are proven difficult to implement in practice. Mutual understanding can be created by establishment of common goals & systems, information sharing and ensuring commitment at all levels. Trust is built by involving in joint decision making, joint problem solving and sharing risk & rewards. Open and two-way communication is considered to be the most central prerequisite for successful CII initiatives and it can be facilitated by adopting practices such as regular joint meetings, joint news-letters, data sharing, promotion plans and creating a blame free environment. The two least opted factors are *lack of mandate from individuals and power manipulation*.

How CII is addressed at various stages of contract such as tendering, selection, SLA, KPI; and how it is incorporated into practice to achieve beneficial result

It is widely agreed that CII implementation can be facilitated by using a planned and systematic approach to incorporate it during different stages of the contract (Goyal & Pitt, 2007). On an average, over 50% of the respondents have agreed that CII is considered as specific criteria, formal or both formal and informal, at various stages of the contract such as selection, tendering, contractual agreement, performance measurement and implementation. A relatively very small percentage (< 15%) have expressed that CII is not included or addressed at any stage of the contract. The comments in the open question suggest that most of the respondents agree that CII is essential to bring improvements, changes & new ideas into the company and ensure that '*Evolution take place*'; and it helps FM to add value and enhance competitive stance of the core business. One common view shared by many respondents is that CII is influenced by budget & resources; which sometimes act as a restraint and sometimes a major catalyst. Overall the comments suggest a progressive stage in FM sector, where FM is moving rapidly on the path of CII process and some leading organisations have been able to achieve the integration of CII into their daily activities, the benefits of which is further passed on to their external linkages. Although, the concept of CII is recognised by majority of stakeholders, their interpretations largely depend on where they stand on the S-curve of CII continuum. The organisations on the top end of the curve (level 4 & 5) are able to formulate closer ties with their supply chain partners and achieve change & growth simultaneously by incorporating CII initiatives as a result of such partnership alliances whereas the ones on the bottom end lag behind significantly.

Best practise guidelines, management tools, methodologies, measurement criteria or contractual terms (formal or in-formal) being followed by FM in forming a collaborative relationship with service providers and encouraging CII activities

CII methods have become widely adopted and regarded as providing an important component of increased company competitiveness. These methodologies are based on the basic concept of quality or process improvement / innovation and provide means to the end. The most cited best practices include partnership contract agreements; reward schemes or gain share mechanism; use of formal and informal KPI's; shared training schemes; open discussions; sharing information; and benchmarking in encouraging CII in client or SP. Some specific CII methodologies enlisted mainly by the respondents from manufacturing sector include: 5s – A Japanese philosophy; EFQM; ISO (9000/14001); Business Process Re-engineering; Quality Functional Deployment; Failure Mode Effects & Critical Analysis (FMECA); Quality Management Systems; 6 Sigma; Statistical Process Control (SPC); and AMIS model for innovation, integration, best practice, reporting and alliance with clients (http://www.mcpworldwide.co.uk/). NHS and public sector organisations in addition follow guidelines and best practices promoted by UK government.

Whether Continuous Improvement and Innovation has fulfilled its true potential in Facilities Management Supply Chain i.e. if the organisations are benefiting by incorporating CII practices achieved by FM in other areas of business

The research results have proven that FM strongly believes in the CII values as a means to attain competitive edge and add value to the organisational efficiency and effectiveness. The CII practices are widely popular in FM sector and it is being included as a specific criterion in the contract agreement as well as in the on-going performance measurement. The examples provided by respondents suggest that the collaborative relationships in FM supply chain are resulting into potential benefits in the field of process improvements, technology, Health & Safety, energy & environmental, work practices and relationship building. The responses and the opinions from the FM personnel suggest that the first step on the road has already been taken, where FM is incorporating CII practices as a result of collaborative relationships with supply chain partners and is adding value & substantial benefits to the core business; however, there is still some practical evidence which suggests that very few firms have truly capitalized on the CII potential that can be achieved through FM supply chain partnerships.

To achieve this goal effort needs to come from both levels - FM needs to be more proactive, participative and involved in major strategic & corporate decisions; and board needs to develop such mechanisms to measure the true benefits of CII solutions generated directly or indirectly from FM supply chain partnerships and evaluate the feasibility of using those ideas into other areas / aspects of business.

CONCLUSIONS

Continuous Improvement and Innovation has become imperative for businesses to keep pace with the fast-changing environment. The seven key values required in an organisation to develop high end CII capabilities include: commitment from people at all levels, supportive structure & culture, defined strategy, effective leadership, development of processes and coordination, Cross Boundary participation, and continuous learning capabilities (Bessant, 2003). The research results showed that FM is gradually moving along the path of developing CII values and 44% of the organisations already have the internal capabilities to manage and sustain CII (levels 4 & 5), on the other hand it also suggests that still a majority (56%) of the organisations need to push the boundaries further to institutionalise CII values within their work life. Infusion of CII values requires the development of an explicit behaviour change program with measured improvement targets and a clear reward system (Atkinson, 1994).

It is well argued that a sustainable means of CII comes from external linkages and as the internal efficiencies of the organisations are getting exhausted they are turning towards the supply chain networks to access & internalise the CII skills & capabilities (Rackham et al., 1996; Chapman & Corso, 2005). A majority of FM respondents have agreed that CII is considered as a specific criterion during contract stage such as selection, tendering, service level agreement and performance measurement. The opinion also suggests that although it is easy to formalise in the contract, it is difficult to follow thereon either due to cost / resource constraints, lack of willingness or understanding. In order to facilitate CII within supply chain, FM needs to step forward from the contractual relationships to partnerships or alliances with supply chain members involving high levels of trust, openness, commitment and communication. A relative majority of respondents – 56.58% expressed that they follow specific guidelines, methodologies or best practices in CII implementation. All the framework methodologies provide a ‘roadmap’ for positioning and assessment, the process of making the journey is still a major organisational development challenge. The successful accomplishment of this journey would depend on developing and adapting established tools and enablers to generate internal CII capabilities as well as effective supply chain partnerships (Webster, 1999).

The empirical evidence so far suggests that FM is widely benefiting from implementing CII practices through collaborative relationships with supply chain partners; however only a few businesses are truly capitalizing on the CII potential of FM. These fewer organisations have been able to achieve this objective mainly because the in-house FM has close ties with other departments, participates in major strategic decisions and builds collaborative relationships with supply chain members; on the other hand the organisation in itself has a supportive & high involvement work culture. It is further suggested that business need to acknowledge that "CII is a continuous process, a race in which there is no finish line" (Webster, 1999).

In the end, it can be summarised that establishing partnership relationships in supply chain with mutual trust, commitment and open communication is the key to implement CII solutions; on the other hand effective cross boundary working both internally and externally, involvement & knowledge sharing at all levels, and commitment from top management are essential to institutionalise CII activities in everyday work life in order to achieve sustained competitive advantage.

REFERENCES

Alexander, K; Atkin, B; Brochner, J and Haugen, I. T (2004) (Ed.) "Facilities Management: Innovation and Performance", London, Spon Press publishers

Atkinson, C (1994) "Continuous Improvement: The Ingredients of Change", International Journal of Contemporary Hospitality Management, Vol. 6, No. ½, pp. 06-08

Bessant, J; Levy, P; Sang, B and Lamming, R (1994) "Managing successful total quality relationships in the supply chain", European Journal of Purchasing and Supply Management, Vol.1, No.l, pp. T-11

Bessant, J (2003) "High-Involvement Innovation: building and sustaining competitive advantage through Continuous change", England, John Wiley & Sons Ltd publishers

Bhuiyan, N and Baghel, A (2005) "An overview of continuous improvement: from the past to the present", Management Decision, Vol. 43 No. 5 pp. 761 – 771

Bourque, B. L and Fielder, P. E (2003) "How to Conduct Self-Administered and mail Surveys" (2nd Edition), London, Sage Publishers

Chapman, R. L. and Corso, M (2005) "From continuous improvement to collaborative innovation: the next challenge in supply chain management", Production Planning and Control, Vol.16, No. 4, pp. 339-344

Ettlie, J (1999) "Managing Innovation", New York, John Wiley & Sons publishers

Foster, R (1986) "Innovation – the attacker's advantage", London, Pan Books publishers

Goyal, S and Pitt, M (2007) "Determining the role of innovation management in facilities management", Facilities, Vol. 25, No. ½, pp. 48 – 60

Heywood, C; Smith, J; Brawn, G and Missingham, G (2004) "Innovation In Facilities Management Practice Using a Performance Approach", COBRA 2004- The international construction research conference of the Royal Institution of Chartered Surveyors, 7-8 September, Leeds Metropolitan University

Holliday, A (2007) "Doing and Writing Qualitative Research" (2nd Edition) London, Sage Publishers

Jha, S; Noori, H and Michela, L. J (1996) "The dynamics of continuous improvement: Aligning organizational attributes and activities for quality and productivity", International Journal of Quality Science, Vol. 1 No. 1, pp. 19-47

Kaya, S; Heywood, A. C; Arge, K; Brawn, G; and Alexander, K (2004) "Raising facilities management's profile in organisations: Developing a world-class framework", Journal of Facilities Management, Vol. 3 No. 1, pp. 65 – 82

Kerrin, M (2002) "Continuous Improvement along the supply chain: the impact of customer-supplier relations", Integrated Manufacturing Systems, Vol. 13/3, pp. 141-149

Khalfan, M. M. A; McDermott, P; Tzortzopoulos, P; and Aouad, G (2005) "Achieving supply chain integration through knowing the supply chain participants", May, CIB W102 Conference on Information and Knowledge Management in a Global Economy, Lisbon, Portugal

Kinlaw, C. D (1992) "Continuous Improvement and Measurement for Total Quality: a team-based approach", San Diego, Pfeiffer & Company publishers

Maqsood, T; Walker, D and Finegan, A (2007) "Extending the 'knowledge advantage': creating learning chains", The Learning Organisation, Vol. 14 No. 2, pp. 123-141

Pitt, M; Goyal, S; and Sapri, M (2005) "Innovation as a Facilities Management Tool", Proceedings from 21st Annual Conference, London, Reading: ARCOM (Association of Researchers in Construction Management)

Rackham, N; Friedman, L and Ruff, R (1996) "Getting Partnership Right: how market leaders are creating long-term competitive advantage", NY, McGraw-Hill publishers

Robson, D. G (1991) "Continuous Process Improvement: simplifying work flow systems", NY, The Free Press publishers

Senior, B and Fleming, J (2006) "Organizational Change" (3rd Edition), London, FT Prentice Hall publishers

Sharp, A. J; Peters, J and Howard, K (2002) "The Management of a Student Research Project" (3rd Edition) England, Gower publishers

Tidd, J; Bessant, J and Pavitt, K (2005) "Managing Innovation: integrating technological, market and organisational change" (3rd Edition), England, John Wiley & Sons Ltd publishers

Webster, A (1999) "Continuous improvement improved", Work Study, Vol. 48 No. 4, pp.142 – 146

CLEANING MANAGEMENT OF OWNER-OPERATED REAL ESTATE

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ABSTRACT

All cleaning cost of owner-operated buildings account for approximately 20%, or one-fifth, of the overall operating cost, thus representing a substantial cost factor for real estate management. Hence, both cleaning cost indicators and relevant drivers of cleaning costs will be focussed on. This study consists of two parts, namely, a theoretical analysis of specialist literature, revealing relevant drivers of cleaning costs, and data collected in an empirical study of over 100 owner-operated office buildings in Switzerland.

With regard to cost drivers, it was established that both building characteristics and usage significantly influence the costs. However, the decisive drivers are the management strategies (such as the degree of outsourcing of property management) and the owner's main objectives. Management strategies proved to be specific to the individual project partners. The causal relationships between strategies (e.g. outsourcing strategies) and costs may be considered to be well substantiated hypotheses which require verification by means of future analysis.

KEYWORDS: cleaning costs, indicators, office, Switzerland

INTRODUCTION

The costs for cleaning of real estate are often regarded as a minor factor of a building's operating costs. They are typically calculated as a subcategory of facility management and are not considered significant. This approach needs to be reviewed, as a study collecting data in Switzerland shows quite clearly (Stoy, 2005). According to Macsporran and Tucker in 1996, the cleaning costs of publicly used buildings can reach 20% of the overall costs of facility management and thus are nearly as high as energy costs. In effect this means cleaning costs have to be treated with the same importance as energy costs when planning the operating costs of a building.

As a result of this cost relevance, especially for the ever increasing need to cut cost for real estate management, cleaning costs are increasingly coming into focus. This study will cover the search for the significant cost factors to create a solid base for facility management on the one hand and on the other hand make it possible to minimize cleaning costs. The following text will show which factors are important contributors to, and what influence they have on, cleaning costs by using an analysis of data from Swiss owner-operated office buildings as an example. Furthermore it is to be shown - with examples from the Swiss study- that cleaning costs represent an important part of facility management and so increase the economic pressure on real estate divisions.

This paper aims to provide answers to the following questions, using a primary data set and regression analysis as its foundation:

- What are cleaning cost indicators?
- What are drivers influencing the cleaning cost indicators?

For the purposes of answering the second question, this study relies primarily on studies from the English-speaking region, such as the BMI Building Maintenance Information (2003) which identifies the relevant drivers of cleaning costs, based on a secondary data set, as follows:

- Size, shape and layout
- Intensity of use
- Location

The first section of this paper will take a closer look at the Swiss data survey, and will outline the definition of costs and area types. In addition, the studies outlined above, which provided the – from a theoretical perspective – relevant cost drivers, are once again described in greater detail. The second section presents the survey sample and the results from the data analysis and, finally, the paper concludes with a discussion of the insights gained.

DEFINITIONS AND POTENTIAL COST DRIVERS

Definition of cleaning costs pursuant to DIN 18960

DIN 18960 (1999) attaches the cost of cleaning services for the entirety of building and land to the cost type of "cleaning". This item goes beyond building cleaning services, which is of particular relevance for the office usage under review.

Figure 1: Classification and structure of cleaning costs pursuant to DIN 18960 (1999)

Operating costs pursuant to DIN 18960 (1999)	Utility and waste disposal	
	Cleaning	
		Façades and roofs (cost group 321) Floors (cost group 322) Walls and ceilings (cost group 323) Doors and windows (cost group 324) Water, heating installations and air systems (cost group 325) Power installations and building automation (cost group 326) Furniture and fittings (cost group 327) Ground surfaces, hard surfaces Cleaning and general maintenance, other
	Operation of technical installations Inspection and servicing of technical installations Inspection and servicing of structure Security measures Levies and contributions Operating costs, other	

It should be emphasised that the cleaning costs are part of the (building) operating costs (see Figure 1). DIN 18960 (1999) defines the operating costs as “the ongoing costs for services rendered by a third party or for own work, as well as human resources and equipment, incurred through the intended use of the building or the business entity, the ancillary buildings, plants, equipment and land.” The definition is also relevant to the cleaning costs, which are incurred due to the intended use of the building, its parts and the land.

DIN 18960 (1999) uses the classification of construction elements, similar to DIN 276 (1993), for the structuring of cleaning costs (see Figure 1). However, it should be noted that such cost type structuring (based on the structuring of building construction costs) is rarely applied in practice, as it is quite difficult to allocate the individual items/services and costs to specific cost types. For instance, the standard interior cleaning services of an office need to be broken down into a lot of different cost types (see Figure 1). This shows just how unsuitable DIN 18960 (1999) is for practical application in real estate management. In fact, such a structure is hardly feasible. Nonetheless, DIN 18960 (1999) may be used for the purposes of the present study, as it permits the definition of the dependent variable “cleaning costs”. A further breakdown of this variable is not required within the framework of this study, as the cleaning costs are examined only in their entirety. However, in the context of such an examination it is important to ensure that all cost data relates to the same point in time. For the present study, the cleaning costs are defined in accordance with DIN 18960 (1999) and relate to the year 2001. A full year was chosen as the period under review in order to cover an entire accounting period and the cleaning costs incurred. “m² usable floor area and year” was selected as the functional unit of costs since the provision of usable floor area (defined as per DIN 277-2, 1987) is the chief function of an office building.

Potential drivers of cleaning costs

The potential cost drivers were defined prior to the data survey, based on literature studies and interviews with experts. The study of the relevant specialist literature (see Table 1) assisted in identifying a number of cost drivers which had already been described by other studies. Therefore, the current studies of the BMI, which focus primarily on the influence of the amount of utilisation (usable floor area per workplace, duration of utilisation, share of vacant space) and the location (wage level), merit particular mention.

Table 1: Potential drivers ascertained through study of relevant literature

Study	Data pool	Cost drivers
Siegel and Wonneberg (1977)	110 office buildings	Share of façade area Interior Layout Share of surrounding area
BMI (2000)	2 office buildings	Property size
pom+Consulting AG and ETH Zürich (2003)	132 office buildings	Cleaning intervals
BMI (2003)	Secondary suvery (office usage and other types of usage)	Usable floor area per workplace Duration of utilisation Share of vacant spaces Wage level

The cost drivers outlined above were then reviewed during interviews with experts (16 real estate owners, managers and planners), giving the interviewees the opportunity to decline individual drivers as being of little relevance. In addition, the respondents were invited to put forward additional drivers which, in their experience, should be taken into consideration as part of the survey. This enabled the identification of a further six drivers as well as the confirmation of the above-mentioned drivers:

- Outsourcing degree of property management
- Main objective of the owner
- Main objective of the manager
- Share of circulation areas
- Share of vehicle parking area
- Share of leased areas

Theoretically relevant causal relationships

Overall, a total of 15 relevant cost drivers were derived from literature studies and expert interviews. The measurability of the individual drivers and their effect on the cleaning costs will be briefly explained below.

Share of façade areas $[m^2_{façade\ area} / m^2_{usable\ floor\ area}]$

As the costs of cleaning contain also that of the façade, their sensitivity to driver variations must be examined. Siegel and Wonneberg (1977) observed that an increase in façade areas is associated with greater cleaning costs (c.f. Macsporran and Tucker, 1996).

Interior layout $[\%_{office\ cubicles}, \%_{group\ offices}, \%_{open\text{-}plan\ offices}, \%_{combi\ offices}, \%_{modern\ office\ designs}]$

Different office layouts also impact on cleaning costs. According to Siegel and Wonneberg (1977), open-plan offices require, in principle, less cleaning effort than office cubicles. This is due to the small surfaces of office cubicles, which impede or even prevent efficient cleaning and the use of machinery (c.f. Butler, 1991). In addition, small-sized floor plan layouts are usually characterised by a larger proportion of wall surfaces and a lot of corners, which is in turn associated with a more time-consuming cleaning process.

Share of surrounding areas $[m^2_{surrounding\ area} / m^2_{usable\ floor\ area}]$

As with the façade cleaning costs, those of the surrounding areas are part of the overall cost of cleaning. It can therefore be assumed that an increase in surrounding areas will lead to an increase in cleaning costs (c.f. Siegel and Wonneberg, 1977).

Property size $[m^2_{of\ usable\ floor\ area}]$

The influence of the absolute property size on cleaning costs is determined on the basis of the usable floor area. BMI (2000) operates on the assumption that the costs decrease as the property size increases (c.f. Ambrose et al., working paper # 358).

Office cleaning intervals per week [cleaning intervals/week]

The impact of the cleaning interval is direct and easy to identify (pom+Consulting AG and ETH Zurich, 2003; also see Pratt, 2003). So, it must be assumed that an increase in intervals will result in an increase in costs. This applies in particular to the cleaning of offices.

Usable floor area per workplace [$m^2_{usable\ floor\ area}$*/number of existing workplaces]*

It is assumed that the time spent on cleaning is largely dependent on the number of employees working in the building or within the area to be cleaned. The time associated with cleaning and thus the cost will be reduced in proportion to the ratio of the usable floor area to number of existing workplaces (BMI, 2003). While the definition of the usable floor area is based on DIN 277-2 (1987), the existing workplace is defined based on SIA D 0165 (2000).

Duration of utilisation [hours of utilisation/week]

The duration of usage is viewed as a potential cost driver (c.f. BMI, 2003), as in a building operating 24/7, the performance of cleaning services would be more difficult, since cleaning and business operations taking place at the same time (c.f. Butler, 1991). This would quite possibly increase the costs per area cleaned. Furthermore, longer durations of utilisation also result in a more time-consuming cleaning process, as there will be a higher accumulation of dust, dirt, etc. (c.f. Dyllick-Brenzinger, 1980).

Share of vacant space [$m^2_{usable\ floor\ area\ vacant}$*/* $m^2_{usable\ floor\ area}$*]*

Areas that are not in use usually do not require cleaning.

Wage level [CHF/month]

From a theoretical point of view, the wage level is a relevant driver, as the cleaning costs are largely made up of personnel expenses (approx. 80% of total cleaning costs) (cf. Bywater, 1990a and 1990b). This study measures the wage level based on the area where the property is located. For this purpose, the properties surveyed were allocated to the regions as defined by the Swiss Federal Statistical Office. The prevalent wage levels of the individual regions have been made available by the Wage Structure Survey (BfS, 2000).

Outsourcing degree of property management services [low, mostly low, mostly high, high]

In particular the real estate managers interviewed ascribed a cost-reducing effect to the outsourcing of services, citing primarily cleaning services as an example. This is attributed to the high degree of professionalism of the services provided by outsourcees. With regard to the definition of the term "outsourcing", this study follows the definition provided by McDonagh and Hayward (2000), who describe outsourcing as "the partial or total contracting out of a business task, function or process to an external service provider. It involves replacing the internal provision of those services and includes out-tasking, strategic alliances and partnership arrangements".

Main objective of the owner and the manager [maximisation of benefits vis-à-vis the occupant, maximisation of benefits vis-à-vis third parties (the public, for example), cost minimisation]

The interviewees cited the main objectives of the owner and the manager as factors having a direct impact on the costs. The cost minimisation objective is perceived as having a negative effect on the cleaning intensity and therefore a reducing effect on the costs.

Share of vehicle parking areas [$m^2_{vehicle\ parking\ area}$/ $m^2_{usable\ floor\ area}$]

The experts cited a number of different types of area utilisation which they believe to have a positive or negative effect on the cleaning costs. In any case, vehicle parking areas require less input in terms of cleaning than office areas (c.f. Bywater, 1990a and 1990b). This study defines vehicle parking areas in accordance with DIN 277-2 (1987) as “car parks and garages of all types; sheds and hangars for track vehicles, road vehicles, water craft, air craft and agricultural machinery”.

Share of circulation areas [$m^2_{circulation\ area}$/$m^2_{usable\ floor\ area}$]

Unlike vehicle parking areas, circulation areas require a particularly high input in terms of cleaning, as they will attract more dirt, dust, etc. (c.f. Bywater, 1990a and 1990b). This study also defines the circulation area in accordance with DIN 277-2 (1987) and therefore includes hallways, foyers, staircases and stairwells, transport system shafts and vehicle circulation areas.

Share of leased areas [$m^2_{usable\ floor\ area\ leased}$/ $m^2_{usable\ floor\ area}$]

The share of leased areas is a relevant driver, as these areas generally have lower cleaning requirements and thus lower costs. In the case of the Swiss owner-operated office buildings examined in this study, the leased areas mostly entail minor residential use, which has a cost-reducing effect.

In conclusion, from a theoretical perspective, a broad range of drivers exist that have influence on the costs of cleaning.

ANALYSIS OF COST DRIVERS

Data pool of the study

A data set collected from 113 owner-operated office buildings in Switzerland enables the examination of theoretically relevant causal relationships. The composition of the data set is limited to four project partners, Crédit Suisse (76 properties), City of Zurich (11 properties), SwissRe (9 properties) and UBS (17 properties). All of the above project partners, with the exception of the City of Zurich, are large corporations that are part of the banking and insurance industries. No additional partners were included, as the provision of data (usable floor area, for example) by any additional partners could not be ensured.

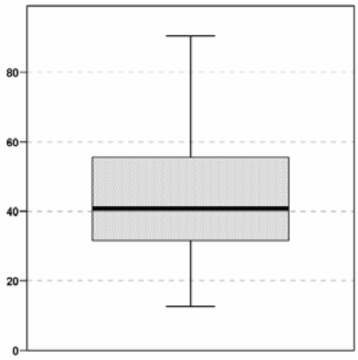
The properties within the survey sample are located throughout Switzerland, with a high degree of clustering in the Zurich metropolitan area. The age structure is highly heterogeneous and ranges from 1 to 200 years. The average property age is 56 years. The property size is also heterogeneous, ranging from 337 to 26154 $m^2_{usable\ floor\ area}$ (average value of 3830 $m^2_{usable\ floor\ area}$). The Annex contains an overview of the characteristics of the theoretically relevant drivers (c.f. Table 4 and Table 5).

The data quality can be classified as high with regard to the cost data as well as the relevant drivers. Both can be exactly matched with each individual property. In addition, all of the theoretically relevant drivers recorded were verified based on planning documents, building accounting records, interviews with the responsible managers as well as property inspections.

Empirically confirmed causal relationships

The purpose of this study was to identify both indicators and relevant drivers of cleaning costs. To this end, this study collected data from over 100 owner-operated office buildings within Switzerland and examined this data using regression analysis. As a result, the cleaning costs of the examined properties revealed a median of approx. 41 CHF/m² usable floor area per year. Furthermore, the minimum and maximum values of 13 CHF/m² and 116 CHF/m² were ascertained as demonstrated by the considerable distribution of costs.

Figure 2: Description of cleaning costs [CHF/m²$_{\text{usable floor area and year}}$] (R=113, costs as at: 2001, exclusive of VAT) (the median, the lower and upper quartiles and the minimum and maximum values are shown)



The analysis of the identified drivers is based on the causal relationships and their inputs, using regression analysis, as described by Boussabaine (2001) as a suitable analytical tool for this task. The regression model for this study was developed using the SPSS 14 program for Windows. This applies the stepwise method of analysis, the basis of which is formed by the theoretically relevant drivers (c.f. "Definitions and potential cost drivers").

Table 2: Coefficients (costs [CHF/m² $_{\text{usable floor area per year}}$], R = 113)

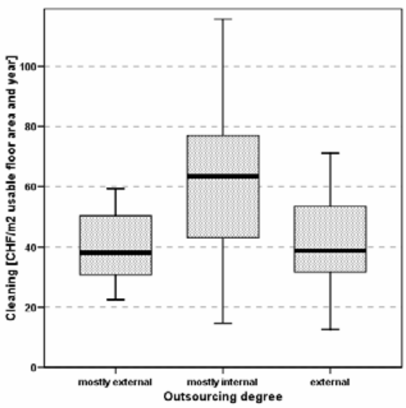
		B	Beta	T-Value	Significance
X_1	Outsourcing degree of property management	-0,235	-0,444	-4,917	0,000
X_2	Share of vacant space	-0,470	-0,354	-4,801	0,000
X_3	Main objective of the owner	0,309	0,297	3,556	0,001
X_4	Share of façade areas	0,363	0,208	2,672	0,009
X_5	Share of circulation areas	0,989	0,270	3,359	0,001
X_6	Share of leased areas	-0,687	-0,244	-3,232	0,002
X_7	Share of vehicle parking areas	-0,353	-0,176	-2,012	0,047
	(Constants)	3,484		16,135	0,000
Y	Costs of cleaning and maintenance [CHF/m² usable floor area per year]				

The survey provides all of the potential cost drivers outlined above. As a result of regression analysis it is demonstrated that seven factors must be included in the linear regression model. The coefficients (c.f. Table 2) and the constant are shown (R = 113):

$$Y = 3.48 - 0.24X_1 - 0.47X_2 + 0.31X_3 + 0.36X_4 + 0.99X_5 - 0.69X_6 - 0.35X_7$$

The explanatory contents of the seven drivers included differ greatly. Using a univariate variance analysis, the greatest explanatory content can be identified with regard to the outsourcing degree of property management. Pursuant to DIN 32736 (2000), this also includes cleaning services. The causal relationship between the costs of cleaning and the degree of outsourcing of property management is illustrated in Figure 3. A relationship exists between the characteristics “mostly internal” and “mostly external” or “external”. The present sample shows an impact, even though it is limited to two characteristics (“mostly internal” and “mostly external/external”).

Figure 3: Causal relationship between the costs of cleaning and the outsourcing degree of property management (R = 113, costs as at: 2001, exclusive of VAT) (the median, the lower and upper quartiles and the minimum and maximum values are shown)



In addition to the assessment of the individual coefficients, the regression must also be examined as a whole. This results in an R-square of 0.448, which is also confirmed by the adjusted R-square of 0.411. This reflects a good degree of adjustment of the regression function to the sample. This, in turn, indicates that the relationships outlined above correspond with the sample.

The significance value expresses the degree of correspondence between the causal relationships within a sample and the overall survey population. In the present case, the significance value is smaller than 0,000. Accordingly, the sample relationships empirically ascertained can also be applied to the survey population.

Discussion of results

The purpose of this study was to identify both indicators and relevant drivers of cleaning costs. To this end, this study collected data from over 100 owner-operated office buildings in Switzerland and examined this data using regression analysis. It was found that the cleaning costs of the examined properties had a median value of approx. 41 CHF/m2 usable floor area per year. Furthermore, the minimum and maximum values of 13 CHF/m2 usable floor area per year and 116 CHF/m2 usable floor area per year, respectively, were ascertained, as demonstrated by the considerable distribution of costs.

With regard to cost drivers, it was established that both building characteristics (such as the share of façade, circulation and vehicle parking areas in the usable floor area) and usage (such as the share of vacancies and leased space in the usable floor area) determine the costs. However, the decisive drivers are, above all, the management strategies (such as the degree of outsourcing of property management) and the owner's main objectives. For the properties surveyed, the outsourcing of cleaning services indicates a negative causal relationship with costs. The cleaning costs are lower for those surveyed properties whose property management has been outsourced.

However, the last statements in particular should be read in the light of an underlying survey sample of four project partners who provided the data. The degree of outsourcing, for example, proved to be specific to the individual project partners; therefore the degrees of outsourcing of the survey sample show little variation. Thus, the relationships identified between degrees of outsourcing and costs could not be confirmed statistically. However, two further results obtained by this study underpin the relationships as presented. Firstly, the interviews held with the experts confirm the above statements. Secondly, the frequency distribution identified for cleaning costs could not be explained as strongly by any other driver within the study. Indeed, the cleaning costs correlate, above all, with the degree of outsourcing. Thus, the causal relationships between degree of outsourcing and costs may be considered to be well substantiated hypotheses which require verification by means of future analyses.

REFERENCES

Ambrose, B. W., Highfield, M. J. and Linneman, P. (working paper #358), Economies of Scale, The Wharton School, University of Pennsylvania, Philadelphia.

BfS Bundesamt für Statistik (Swiss Federal Statistical Office) (2000), Lohnstrukturerhebung (Wage Structure Survey), BfS, Neuchatel.

BMI Building Maintenance Information (2000), Occupancy Costs of Offices, BMI, London.

BMI Building Maintenance Information (2003), Review of Occupancy Costs 2003, BMI, London.

Boussabaine, A. H. (2001) "A comparative approach for modelling the cost of energy in sport facilities", Facilities, Vol 19 No 5/6, pp. 194-203.

Butler, J. (1991) "Setting up and controlling cleaning programmes for complex sites", Property Management, Vol 9 No 1, pp. 18-23.

Bywater, L. (1990a) "Costs and methods to improve expenditure in cleaning", Facilities, Vol 8 No 1, pp. 8-11.

Bywater, L. (1990b) "Cleaning costs: a case study exercise", Facilities, Vol 8 No 6, pp. 16-18.

DIN 18960 (1999), Nutzungskosten im Hochbau (Occupancy costs of buildings), Beuth, Berlin.

DIN 276 (1993), Kosten im Hochbau (Building costs), Beuth, Berlin.

DIN 277-2 (1987), Grundflächen und Rauminhalte von Bauwerken im Hochbau: Gliederung der Nutzflächen, Funktionsflächen und Verkehrsflächen (Netto-Grundfläche) (Plan areas and volumes in building: Classification of utilisation areas, operating areas and circulation areas (net ground area)), Beuth, Berlin.

DIN 32736 (2000), Gebäudemanagement: Begriffe und Leistungen (Property management: terms and services), Beuth, Berlin.

Dyllick-Brenzinger, F. (1980), Betriebskosten von Büro- und Verwaltungsgebäuden (Operating costs of office and administrative buildings), Bauverlag, Wiesbaden.

Macsporran, C. and Tucker, S. N. (1996) "Target budget levels for building operating costs", Construction Management and Economics, Vol 14 No 2, pp. 103-119.

McDonagh, J. and Hayward, T. (2000) "Outsourcing corporate real estate asset management in New Zealand", Journal of Corporate Real Estate, Vol 2 No 4, pp. 351-371.

pom+Consulting AG and ETH Zurich (2003), FM Monitor 2003: Der Schweizer Facility Management-Markt im Überblick (Overview of the Swiss facility management market), pom+Consulting AG, Zurich.

Pratt, K. T. (2003) "Introducing a service level culture", Facilities, Vol 21 No 11/12, pp. 253-259.

SIA D 0165 (2000), Kennzahlen im Immobilienmanagement (Real estate management indicators), SIA, Zurich.

Siegel, C. and Wonneberg, R. (1977), Bau- und Betriebskosten von Büro- und Verwaltungsbauten: Eine Auswertung der Daten von 110 ausgeführten und in Betrieb genommenen Gebäuden (Construction and operating costs of office and administration buildings: an evaluation of data obtained from 110 completed and commissioned buildings), Bauverlag, Wiesbaden.

Stoy, C. (2005), Benchmarks und Einflussfaktoren der Baunutzungskosten (Benchmarks and drivers of occupancy costs), vdf, Zurich.

ANNEX

Data pool: Dependent variable (cleaning costs)

Table 3: Dependent variable [CHF/$m^2_{\text{usable floor area and year}}$] (costs 2001, exclusive VAT)

	Lower Quartile	Median	Upper Quartile	R
Cleaning	-0,235	-0,444	-4,917	0,000

Data pool: Independent variables (cost drivers)

Table 4: Independent variables (metrically scaled)

	Lower Quartile	Median	Upper Quartile	R
Share of façade [$m^2_{\text{façade}}$/$m^2_{\text{usable floor area}}$]	0,57	0,73	0,85	113
Usable floor area [m^2]	1,033	2,120	4,648	113
Share of circulation area [$m^2_{\text{circulation area}}$/$m^2_{\text{usable floor area}}$]	0,33	0,41	0,49	113
Interior layout: Office cubicles [%]	40	70	85	113
Interior layout: Group office [%]	14	29	54	113
Interior layout: Open plan offices [%]	0	0	0	113
Interior layout: “Combi offices” [%]	0	0	0	113
Interior layout: Modern office designs [%]	0	0	0	113
Share of surrounding area [$m^2_{\text{surrounding area}}$/$m^2_{\text{usable floor area}}$]	0,08	0,16	0,32	113
Wage level [CHF/month]	4,608	4,779	4,866	113
Usable floor area per existing workplace [$m^2_{\text{usable floor are}}$/existing workplace]	23	28	38	113
Share of vacant space [$m^2_{\text{usable floor area vac}}$/$m^2_{\text{usable floor area}}$]	0	0	0,05	113
Building utilisation per week [number/week]	5	5	5	113
Share of vehicle parking space [$m^2_{\text{vehicle parking space}}$/$m^2_{\text{usable floor area}}$]	0	0	0,18	113
Share of leased areas [$m^2_{\text{usable floor area leased}}$/$m^2_{\text{usable floor area}}$]	0	0	0,10	113

Table 5: Independent variables (not metrically scaled)

	Spread	R
Outsorcing degree [ordinal scaled]	0% internal 19% mostly internal 15% mostly external 66% external	113
Main objective of the owner [ordinal scaled]	81% maximisation of benefits vis-à-vis the occupant 0% maximisation of benefits vis-à-vis third parties 19% cost minimisation	113
Main objective of manager [ordinal scaled]	46% maximisation of benefits vis-à-vis the occupant 0% maximisation of benefits vis-à-vis third parties 54% cost minimisation	113

USING REPERTORY GRID TECHNIQUE FOR THE APPRAISAL OF LIBRARY SERVICESCAPES

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ABSTRACT

Many studies have shown that a building's physical environment (servicescape) can affect (both positively and negatively) a customer's perception of a service. The perception of servicescapes leads to certain emotions, beliefs and physiological sensations which in turn influence behaviours. As such, they have a significant impact on the way in which user experience needs to be dealt with as a measure of facilities performance. Thus identifying customer needs and preferences is a prerequisite in measuring facilities performance. Within Higher Education Institutions (HEIs), there is ever-increasing acknowledgment of the student experience, which is regarded as an important criterion to focus on when there is a desire for improved organisational performance. This research used the Personal Construct Psychology (PCP) (Kelly, 1955) approach to investigate students' preferences in relation to library facilities in higher education. The Repertory Grid Technique has the potential to provide a very rich data set about the design and functionality of such library facilities. This paper presents the main findings of the research, the implication of the research and its limitations. This is then followed by a discussion on its main contributions to knowledge in the facilities management field of study.

KEYWORD: servicescapes, performance measurement, library facilities, Repertory Grid Technique.

INTRODUCTION

Within HEIs the acknowledgment of the students experience is regarded as an important and useful perspective to be included in the students' satisfaction surveys. However, user experience is indeed a very complex phenomenon. Each user has his/her own assumptions about what they are trying to get out of the experience. Students have their own preferences of the service environment and those can form the basis for facilities performance indicator. Hence, this paper tries to address some of these concerns. This paper presents the background of the study and introduces the process associated with Repertory Grid Interviews. The results illustrate the findings from the qualitative approaches of data analysis. In the analysis, the information obtained from 20 respondents was examined in order to identify library facilities performance criteria which would then form the basis for a facilities performance indicator framework.

BACKGROUND TO THE STUDY

Identifying customer needs, perceptions and evaluations of the facilities performance is fundamental to organisations. However, research and writers in the facilities management (FM) field are yet to investigate the customer as a basis for measuring facilities performance within the service environment, particularly in higher education institution. In higher education institution possessing customer as a tool in measuring business performance is still rare compare to the marketing field. However, customer satisfaction has recently become a concern of academic institutions due to the commercialisation of scholarship (Kelsey and Bond 2001). In the UK higher education, students are considered to be the 'primary customers' of a university (Crawford 1991). Many higher education institutions regularly evaluate the quality of teaching and learning through a survey of students' experience (Aldridge and Rowley 1998). In addition, many higher education also perform some evaluation on other expects of the students experience beyond the assessment of the quality of teaching and learning (Aldridge and Rowley 1998). From the recent research done in the higher education it shows that facilities are an important element that contributes to the overall organisational performance. Further more, all these studies confirmed the fact that students as a customer play an important role in achieving business performance and facilities will influences student satisfaction and productivity of the service provided. Identifying students' needs is significant in the context of achieving organisational objectives and thus contributes to the measurement of facilities performance.

In general, research and writer in the facilities management field are yet to investigate the existence of the customer as a tool in measuring facilities performance specifically in higher education which has been well developed in other fields like marketing. Theories reviewed proved that in service organisation customer rely on facilities in the evaluation of organisation performance and for higher education institution context facilities is among one of the crucial resources in United Kingdom. Therefore, the researcher believes that an investigation into students' preferences may open new avenues of opportunity to achieve higher efficiency and suitability of management of space within the service environment that fulfil customer need. Furthermore, its opens up new potential areas for research that links facilities management functions with organisational goals.

Student's Experience as a Tool in Measuring Performance

The concept of customer experience in service management literature and marketing literature is well established. Within the higher education context, work on the evaluation of the students (as customers) experience can be divided in two overlapping categories (Dawes and Rowley 1999) as follows:

1. Research and practice that focuses on assessing teaching and learning; and
2. Research and practice that seeks to assess the quality of the total students experience

The first category can further being subdivided into work on performance indicators of teaching quality which is driven by the concerns with public accountability (Ramsden 1991) and work on the students evaluation of the quality of the teaching and learning environment (Wilson, 1986, Brinko, 1991). The evaluation of students' experience can be also demonstrated through different behavioural. Lizzio *et al*, (2002) identify that students perceptions of a good teaching environments influence students towards deep approaches to studying. In additions their research discovers that changes in teaching environments may have some impact on students' learning outcomes without necessarily affecting their learning approaches.

The Influence of Physical Environment (servicescapes) Within Higher Education to the Students Experience

The review conducted on retailing literature highlighted that there is a stream of research on the influence of physical environment on consumer experience. In addition to that, research focus into the factors that influence the satisfaction of an individual has been a fundamental part of the theories behind environmental psychology. In order to develop and use one potential resource and to commit to the work, the organisation has to provide a harmonious link between the different need of the individual (Celements-Croome, 2006).

In facilities management and higher educations research the attempt to investigate the physical environment in relation to user experience is only recent. According to Coffey and Steed (2001), students in higher education institution have become more aware as consumers, and asking more of their universities: they want an environment more like the one-stop shopping of the malls they frequent – more convenience, more interaction, and better amenities. In identifying students, roles in higher education Sirvanci (2005) concur with the view that students are internal customers for facilities. He stipulates that students are paying customers for many campus facilities and services such as dormitories, food services, bookstores, libraries, sport facilities, registrar and others. These non-academic facilities contribute indirectly to the quality of the higher education organisational performance.

To Burns (2001), there does appear to be a growing recognition among university officials that the quality of education and the quality of the physical environment of the campus are inextricably related. In the higher education institutions research, Fleming and Storr (1999) state that university facilities can impact positively or negatively upon student perceptions of their academic experience. In addition, university facilities can be essential components of attracting key research personnel and provide the environment for faster knowledge.

RESEARCH DESIGN AND METHODOLOGY

In this research the interview have been considered as a mode of data collection. A number of interview techniques were considered to best explain human's experience. The issue is how do we assess students' need and preferences in deriving the facilities performance criteria? Some might say that identifying the quality retrial is intrinsically simple, as people generally know what they like and dislike. However, according Bartolo (2000), understanding why users like one thing and dislike another is not so easy. Bechtel (1987) advocates the importance of environmental and behaviour research to assess human responses to environments, suggesting that research that relate to the design of the physical environment often required a standard format for measuring how people respond to environments that goes beyond the usual verbal procedure of questions and answer.

After full considerations of the technique mentioned above this research opted for the Repertory Grid Technique (RGT) of interview. The RGT developed by George Kelly in Personal Construct Psychology (PCP) theory was selected as a major tool in enquiring and understanding the essence of experience about how people view their world. The Repertory Grid interview utilised in this research with the intention to identify student's preferences on facilities performance.

Personal Construct Psychology Theory (PCP)

The founder of PCP, George Kelly, presented a theory that gave an account of how people experienced the world and made sense out of their experience. Kelly's generative principle for PCP it expressed in his one and only postulate: "Fundamental postulate: a person's processes are psychologically channelised by the ways in which he anticipates events" Kelly, 1955, p: 46).

In his formal theory, Kelly explored in detail the nature of constructs, the development of a construct systems and the usefulness of seeing the world in this way. He emphasised the importance of human freedom and the unique ways in which people seek to understand themselves and their world. If we can understand someone's construct systems we can not only understand their history, but we can also make some predictions about how they are likely to behave in a given situation. His theory has direct significance for theories on meaning and knowledge and the nature of reality. PCP therefore constitutes an interpretive theory of human behaviour because it maintains that people are constantly engaged in interpreting and reinterpreting their environment, building mental pictures or maps in order to structure and make sense of it, (Burkit, 1991).

The Repertory Grid Technique (RGT)
The Repertory grid technique was established as a psychological technique about 50 years. Fournier (1996) summarises the repertory grid technique as one that allows researchers to explore an individual's construction systems. It is a major tool in enquiring and understanding the essence about how people view their world. According to Smith *et al.*, (1996) the grid provides an excellent means of uncovering and representing understanding and offers a powerful way of quantifying peoples attitudes, feeling and perceptions. Although the PCP was initially applied in clinical experiments, its potential for use in a wide range of non clinical areas and by non-trained specialists has been emphasized (Senior, 1997). Further, and according to Smith *et al*., (1996) RGT can be used as a tool in management development. Senior (1997) used this methodology as an interview technique for measuring individual managers' performance.

Repertory Grid Interview Process
The common way to administer the repertory grid is by conducting a formal interview with the respondents (Boyle 2005). Pope and Keen (1981) listed five major considerations in grid used, such as; Purpose, Choice of elements, Scaling, Construct Elicitation procedure and Method of analysis. Added for consideration in this research were the identification of library facilities photographs and the use of Enquire Within software that are used to assist in setting up the interview. The purpose of the interview was to identify quality criteria for library facilities provided within HEIs. Element(s) set for this consisted of physical environment elements in the library. The procedure used for this strategy was by providing the photograph of library facilities being prepared to the interviewee and the element creation question being asked. The photographs represent the visual of the servicescapes elements in the library within HEIs.

The data were analysed to determine the individual and common themes for the group once all the repertory grids have been completed. According to Boyle (2005), analysis of repertory grid data can be performed using a combination of qualitative and quantitative techniques. For this paper the qualitative analysis of the data were discussed. The qualitative analysis consisted of identifying the content of the constructs known as content analysis. Stewart and Stewart (1982) recommend content analysis to analyse constructs or element that are not well defined base on the meaning of the particular construct. Content analysis involved developing a series of categories that elements or construct may fall into and then assigning the elements or construct to specific category according to the sense of the meaning. The grouping of the constructs in relation to the elements was also examined.

Therefore, in order to make judgements about any qualitative differences in the constructs, it was necessary to content analyse the 255 constructs elicited from the interviews. This method was taken from grounded theory employed by Glaser and Strauss (1967). This method of analysis involved a close repeated reading of the personal construct elicited from each participant, and the identification of categories to which construct could be allocated. This type of analysis is termed as data driven content analysis and has been favoured by authors waling in business or management field (Honey 1979; Stewart and Stewart 1982; Jankowicz 2004; Wright 2004)

FINDINGS

Analysis of the data obtained from the participants provided information that could be use in developing library facilities design criteria. There are three alteration process involve in the content analysis conducted. The first iteration process of constructs was conducted to determine generic library facilities performance criteria. In this stage, five main categories was identified which were space layout, lighting, support facilities, supplementary facilities and other building features. The number of construct that allocated in each main category is still large and therefore second iteration process of content analysis is required. In the second iteration, key indicatives of library facilities performance were identified for each main category. These key indicatives were term as sub-categories in this research. Third iteration process conducted provided some details of library facilities performance criteria for each sub-category. The facilities performance criteria identified are presented in Figure 1.

Categories discussion

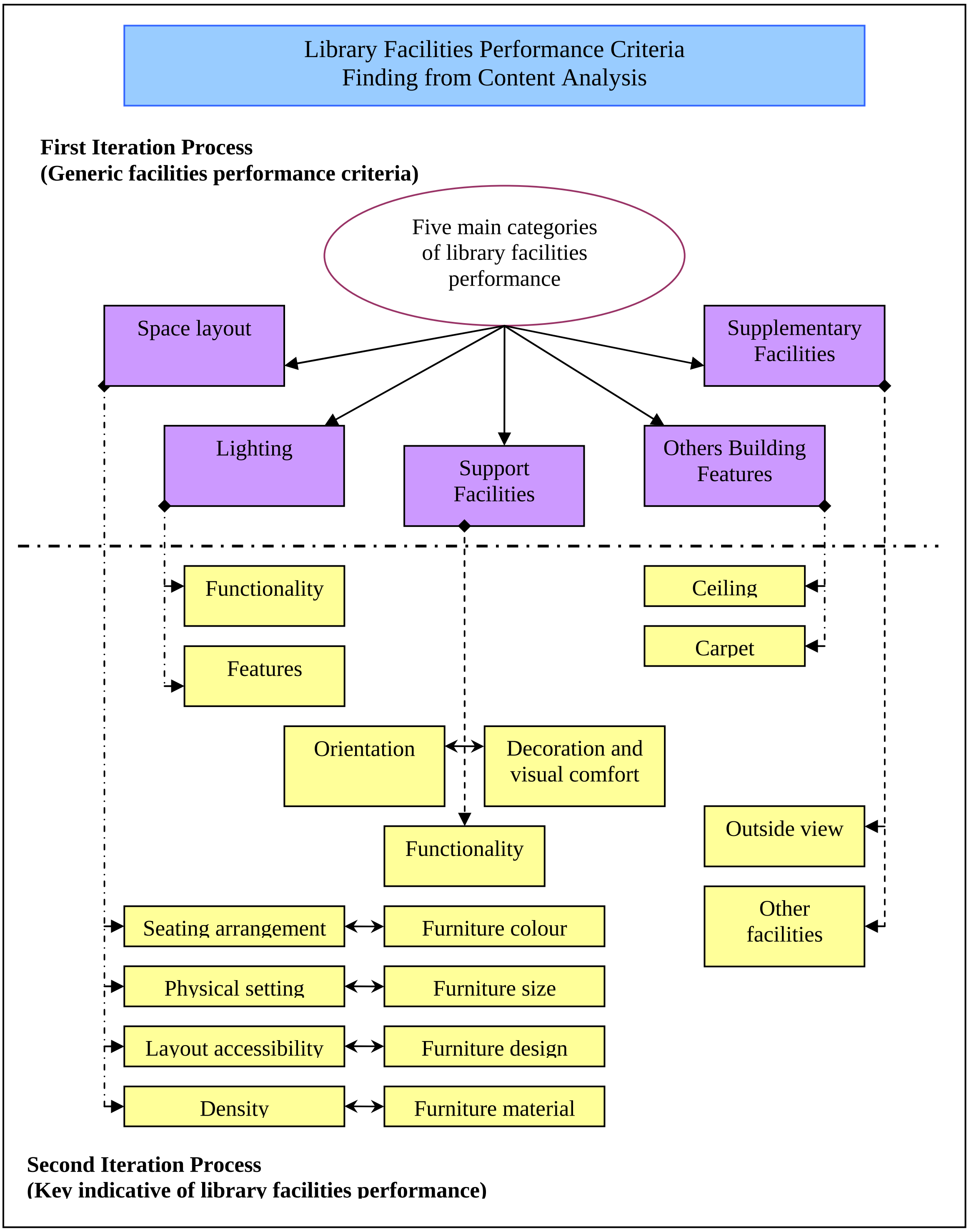
Space layout

The space layout category consists of eight (8) sub categories comprises of design criteria. The criteria are physical setting, layout functionality, density, seating arrangement, furniture size, furniture colour, furniture material and furniture design. This criteria being the major concern to the students as the construct are more frequent in this category and according to Jankowicz (2001) this is one kind of relative importance.

Support Facilities

In this category, the construct elicited base on the availability of the computer within study area. Most of the students preferred to have computer close or within the study area in the library but have some element of privacy.

Figure 1. Library facilities performance criteria



Lighting

The second major consent of the students' preferences on library facilities performance is an element that is associated with lighting. In this category, the type of lighting in the library is divided into two sub-categories, which are the functionality and the features of the lighting. The functionality of the lighting in the library is related to the lights that support visual comfort and which harmonised with its literary environment. The lighting criteria must be able to support learning activity by providing the light that focused at reading/work area within the field of view. In terms of lighting features, the student preferred natural lighting from the window or glass wall rather than artificial ones.

Supplementary Facilities

Three support facilities are described, the orientation, decoration and visual comfort, and the service availability. The main issue which emerged from the orientation is the design that provides the view for outside surrounding by accommodating with appropriate window inside the building or glass wall facing outside the building. Another design criteria which forms students' preferences in this category is that the availability of plant or green area in the building, clear and visible signage and to have an open view in the library.

Other building features

This category is less concern by the student as the frequent number of the construct in this category is the lowest amongst others.

The issue related to this category is about the ceiling height and the colour of the carpet within the study area.

RESEARCH LIMITATION

The approached and the finding in this research, as in all research must be tempered by the limitations. As for the limitation of this research, time is particularly significant problem of the Repertory Grid Technique of interview. It is a time consuming approach as it implies a more comprehensive description than a quantitative approach since the completion of the grid is not always straight forward. The larger and therefore, more reliable the grid, the longer it takes to complete and the greatest the risk of losing the respondent's interest. Even a relatively simple grid takes the major part of an hour to set up and complete the constructs. If there are many interviewees, more time will be needed not only for the interview but also for the analysis. Thus will always be limits to the potential range of interview in any particular study of this nature. In additions, the use of photographs as an element in the Repertory Grid interview has limited the constructs elicitations. The facilities performance attributes that deal with five senses such as odour comfort and temperature cannot be elicited through the photographs. Although the literature review shows that it is among the important features for facilities performance.

CONTRIBUTION TO KNOWLEDGE

The research framework that is developed which are possessing students need as a way in measuring facilities performance in higher education being a major contribution to knowledge in this research. Identifying customer needs contrive as one of effective way in measuring organisation performance. The research establish a step forward in understanding that the customer is the significant element in achieving organisational objective/goals which help to understand the relationship between customer need, facilities performance and organisation performance. Adoption of the Repertory Grid Technique in FM research contributes to the development of knowledge in both areas. This kind of approach can be useful in assuring congruence between facilities function and human need and expectations and in identifying environments that facilitate preferred modes of behaviour.

CONCLUSION

This research commenced with the intention of investigating students views on the criteria of facilities performance particularly with respect to determine the quality design and functionality of the facilities services. Review in the literature reveals that students were considered to be primary customers of a university and contribute in achieving organisation objectives. Therefore, identifying students need is a fundamental in providing facilities services. Repertory Grid Technique has been used as the most suitable approach in eliciting students construct systems. Qualitative technique analysis to the constructs elicitation has identified the facilities performance criteria for higher education services particularly library facilities. This paper has presented a comprehensive review of how students construe their environment from their personal construal to their experience. The students' preference is proposed as a new approach to considering decision-making for facilities management department.

REFERENCES

Aldridge, S. and J. Rowley (1998). "Measuring customer satisfaction in higher education." Quality Assurance in Education **6**(4): 197-204.

Boyle, T. A. (2005). "Improving tean performance using repertory grids." Team performance Management **11**(5/6): 179-187.

Crawford, F. (1991). "Total Quality Management, Committee of Vice-Chancellors and Principals, occasional paper (London, December)." cited in Hill, F.M. (1995), "Managing service quality in higher education: the role of the student as primary consumer", Quality Assurance in Education, **3**(3): 10-21.

Fournier, V. (1996). "Cognitive maps in the analysis of personal change during work role transition." British Journal of Management **7**: 87-105.

Glaser, B. G. (1967). The Discovery of Grounded Theory: Strategies for Qualitative Research, Aldine de Gruyter.

Honey, P. (1979). "The repertory grid in action." Industrial and Commercial Training **11**(11): 452-59.

Jankowicz, D. (2004). The easy guide to repertory grids. Chichester, John Wiley.

Kelsey, K. D. and J. A. Bond (2001). "A model for measuring customer satisfaction within an academic center of excellence." Managing Service Quality **11**(5): 359-367.

Pope, M. L. and T. R. Keen (1981). Personal construct psychology and education. London, Academic Press.

Senior, B. (1997). "Team performance: using repertory grid technique to gain view from the inside." Team Performance Management **3**(1): 33-39.

Smith, M. E., R. Thorpe, et al. (1996). "Using repertory grids in management." Journal of European Industrial Training **20/3**: 3-30.

Stewart, V. and A. Stewart (1982). Business Aplications of repertory grid. London, McGraw-Hill.

Wright, R. P. (2004). "Mapping cognitions to better understand attitudinal and behavioral responses in appraisal research." Journal of Organizational Behavior **25**(3): 339-374.

FEASIBILITY STUDY ON BENCHMARKING INDOOR AIR QUALITY (IAQ) OF AIR-CONDITIONED OFFICES IN HONG KONG

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ABSTRACT

Indoor activities are a big part of modern life. Decision-makers are obliged to optimize resources for IAQ monitoring to proactively safeguard the well-being of building occupants. An easy and practical IAQ labeling system using a simple 'IAQ Index' was proposed in this study for benchmarking IAQ in typical air-conditioned offices in Hong Kong. Notably, the IAQ index was determined from the average fractional dose to certain exposure limits of three selected representative indoor air pollutants, namely carbon dioxide, respirable suspended particulates and total volatile organic compounds. Feasibility of using the IAQ Index was examined through regional investigations of 525 offices, which were categorized into groups of 'Excellent', 'Good' or 'Unclassified' IAQ using the existing comprehensive assessment. Results showed that IAQ benchmarks with the proposed index could distinguish offices of different IAQ as identified by comprehensive assessment and be a good representation of relative IAQ in air-conditioned offices of Hong Kong.

KEYWORDS: Indoor air quality, benchmarks, air-conditioned offices

INTRODUCTION

With growing concern in the past decade over complaints attributed to poor indoor air quality (IAQ), various environmental parameters and surrogate indicators were suggested and adopted for IAQ assessment (Jokl 2000; Kraenzmer 1999; Lee et al. 2002; Montoya et al. 2007; Tchepel et al. 2007; Wong et al. 2006). As it is not practical and nearly impossible to monitor all the air pollutants of a general community for continuous IAQ improvements, assessment parameters are normally selected based on the severity of their adverse effects on human health and the simplicity in measurement for the use of IAQ monitoring.

In Hong Kong, exposure concentrations (i.e. an 8-hour average concentration) of nine common indoor air pollutants, i.e. carbon dioxide (CO_2), carbon monoxide (CO), respirable suspended particulates (RSP), nitrogen dioxide (NO_2), ozone (O_3), formaldehyde (HCHO), total volatile organic compounds (TVOC), radon (Rn) and airborne bacteria count (ABC) are used as the parameters of the 'full' IAQ assessment for workplace IAQ certification in labeling an office IAQ as 'Good' or 'Excellent' (HKEPD 2003). Considerable amount of resources and manpower are needed in such an assessment, such as sophisticated knowledge of the application, calibration and regular maintenance of the appliances, interpretation of the data and on-site operation of the equipment, to name a few. Besides, a number of technical difficulties in implementation have also been encountered (Wong et al. 2006)

An effective and efficient assessment method for describing quality of indoor environment is one of the key elements of good IAQ care for achieving healthy and safe workplaces. To economize on measurement efforts, apart from the representative IAQ parameters, sampling schemes characterized by the required sampling period and sampling point density have been adopted at acceptable levels of measurement uncertainty (Mui and Wong 2004; Mui et al. 2006). However, a clear and simple indicator for IAQ of workplaces that is widely acceptable by the public has not been established yet.

This study proposes a simple IAQ index as an assessment tool to benchmark air-conditioned office with different IAQ labels at a reduced measurement effort. Based on IAQ profiles from a regional survey of 525 air-conditioned offices, an IAQ index using only three 'most representative' (rather than all of the listed nine) common indoor air pollutants was used as a benchmarking parameter to distinguish offices of 'Excellent', 'Good' and 'Unclassified' IAQ. This proposed benchmark could be useful in promoting IAQ with quantitative assessment criterion for air-conditioned offices in Hong Kong or similar environment elsewhere.

IAQ BENCHMARKS

The IAQ objectives regarding health concerns were defined through the regulations or guidelines for the acceptable IAQ and corresponding IAQ assessments with specified exposure limits of some common indoor air pollutants. In general, an indoor environment having any one of the n specified air pollutants exceeding the specified exposure limit, i.e. $\Phi_i > \Phi_{i,e}$, for i = 1, 2, … n, is considered as 'unsatisfactory' IAQ, otherwise the environment with $\Phi_i \leq \Phi_{i,e}$ is rated as 'satisfactory' IAQ (Wong et al. 2006).

A simple, practical and understandable IAQ benchmark related to the IAQ satisfaction would promote the public awareness of the importance of IAQ and its health effects. People directly or indirectly related to the IAQ issue, such as researchers, building owners and maintenance staff will especially be benefited from such easy-to-use benchmarking system. Fractional dose of n surrogate indicators would be used to compile a simple IAQ index and the index was shown to be related to symptoms of office building occupants (Moschandreas and Sofuoglu 2004, Sekhar et al. 2000). This study proposed a simple IAQ benchmark of air-conditioned offices using an 'IAQ index' θ as shown below, instead of a comprehensive measurement. This index θ was determined from the fractional dose of only three representative air pollutants to some exposure limits $\Phi_{j,e}$ in assessing the IAQ satisfactory level for indoor environment (Wong et al. 2006, 2007, HKEPD 2003) where, Φ_j^* is the fractional dose regarding an representative pollutant j, Φ_j is the assessed average representative pollutant level over the exposure time period,

$$\theta = \frac{1}{3}\sum_{j=1}^{3}\Phi_j^* \; ; \; \Phi_j^* = \frac{\Phi_j}{\Phi_{j,e}} \qquad \ldots (1)$$

A factor analysis study of common air pollutants in air-conditioned offices reported that three (i.e., RSP, CO_2 and TVOC) of the nine listed common air pollutants could be selected as ''representative'' parameters for IAQ satisfaction. (HKEPD 2003, Wong et al. 2006, 2007). In a typical mechanically ventilated space, RSP would be transported from the outdoors and is closely related to the filter efficiency of an air-conditioning system. As according to some studies, the RSP level also depends on the indoor activities (Lee et al., 2002). Therefore, the inclusion of RSP could cover issues related to system filtration performance and activities in an office. Indoor CO_2 is generated by occupants and diluted by outdoor air and thus a good indicator for the ventilation rate and occupant load in the space (ASHRAE, 2004). Finally, the inclusion of TVOC can indicate those indoor pollutant emissions dominated by the building materials, finishing, and human activities, e.g. building renovation works (Hoskins, 2003).

In order to use the proposed IAQ index to represent the level of IAQ satisfaction for an indoor environment, validation must be done with some existing IAQ assessment databases (Hui et al., 2006). First of all, an assessed indoor environment is classified into three label groups, i.e. a group of 'Excellent' IAQ Ω_E with an index θ_E, a group of 'Good' IAQ Ω_G with an index θ_G, and another of 'Unclassified' IAQ Ω_U with an index θ_U. The indices θ_E, θ_G and θ_U must be significantly different from each other; and the significance can be determined by statistic pair t-test such that $\overline{\theta}_E \neq \overline{\theta}_G \neq \overline{\theta}_U$ at a confidence level of $p \leq 0.05$.

Taking θ_i as a measure of IAQ for an indoor environment i from n samples, with μ and σ are the average and standard deviation, $\tilde{\theta}$ as the distribution of IAQ indices for all indoor environments of the same type over a region, the IAQ benchmark B_i for i is expressed by,

$$B_i = \int_{-\infty}^{\theta_i} \tilde{\theta}\, d\theta;\ \tilde{\theta} \sim \tilde{\theta}(\mu_\theta, \sigma_\theta) \quad \ldots (2)$$

Among all spaces in the region, an indoor environment with $B_i \leq 1\%$ indicates that it has the 'best' IAQ, i.e., this environment has the lowest exposure concentrations of the air pollutants contributed to the index among the database of the index. On the other hand, an environment with $B_i = 100\%$ indicates the 'worst' IAQ.

IAQ ASSESSMENT IN AIR-CONDITIONED WORKPLACES

A regional cross-sectional measurement of the nine common indoor air pollutants was conducted in 525 independent Hong Kong offices (Hui et al., 2006; Wong et al., 2006, 2007). The sample size was assumed to be large enough to represent the overall picture of local pollutant levels in offices. The samples were randomly picked in a way that they could cover all regions of office development as well as various types and ages of premises and ventilation systems. The samples included a range of open-plan offices from conference rooms to individual small offices. Their sizes were from 10 m^2 to 300 m^2. All instruments were calibrated prior to the measurements. This database was used to evaluate the model constants of the IAQ indices.

Table 1 shows the criterion of the nine common indoor air pollutant levels regarding the labels of 'Excellent' and 'Good' in the HKEPD certification scheme (HKEPD 2003). The distributions of the measured pollutants were tested and would be described by a geometric distribution or a normal distribution as shown. Apart from the arithmetic mean (AM) and the arithmetic standard deviation (ASD), the geometric means (GM) and the geometric standard deviations (GSD) were also determined and shown in Table 1.

It was reported that, among the assessed sample offices, 473 offices could not be awarded the 'Excellent' IAQ label while 167 could not be awarded the 'Good' IAQ label (HKEPD 2003). The fractions of unsatisfactory offices, i.e. rate of failure in obtaining the labels, were also determined and shown with values of confidence intervals CI = 95% (Hui et al., 2006; Wong et al., 2006, 2007).

Table 1: Common indoor air pollutant levels in 525 air-conditioned offices of Hong Kong (Hui et al., 2006; Wong et al., 2006, 2007)

No.	Parameter (unit)	Criterion		Arithmetic average concentration (Arithmetic standard deviation)	Geometric mean concentration (Geometric standard deviation)	Observed unsatisfactory rate (%)	
		Excellent	Good			Excellent (CI = 95%)	Good (CI = 95%)
1	CO_2 (ppm)	<800	<1,000	658 (151)	642 (1.25)	17% (14-20%)	2% (1-3%)
2	CO ($\mu g\ m^{-3}$)	<2,000	<10,000	1105 (4594)	755 (2.41)	0.4% (0-0.9%)	<0.2%
3	RSP ($\mu g\ m^{-3}$)	<20	<180	30 (20)	24 (1.89)	55% (51-60%)	<0.2%
4	NO_2 ($\mu g\ m^{-3}$)	<40	<150	27 (17)	22 (2.08)	17% (14-21%)	<0.2%
5	O_3 ($\mu g\ m^{-3}$)	<50	<120	40 (38)	30 (2.52)	14% (11-17%)	4% (2-6%)
6	HCHO ($\mu g\ m^{-3}$)	<30	<100	48 (103)	27 (2.80)	51% (47-55%)	5% (3-7%)
7	TVOC ($\mu g\ m^{-3}$)	<200	<600	358 (328)	252 (2.46)	65% (61-69%)	13% (10-16%)
8	Rn ($Bq\ m^{-3}$)	<150	<200	46 (39)	32 (2.50)	2% (1-3%)	<0.2%
9	ABC ($CFU\ m^{-3}$)	<500	<1,000	505 (385)	372 (2.28)	39% (35-43%)	12% (9-15%)

RESULTS AND DISCUSSIONS

Taking the pollutant levels criteria for label of 'Good' in the HKEPD certification scheme as the exposure limits (HKEPD 2003), Figure 1 shows the IAQ index θ determined from the CO_2, RSP and TVOC measured in the 525 samples. The samples were classified by the existing IAQ labels from nine parameters into offices of 'Excellent' IAQ Ω_E, 'Good' IAQ Ω_G, and 'Unclassified' IAQ Ω_U, with frequency of 10%, 58% and 32% respectively. It was reported that for 'Excellent' IAQ offices, the range of θ was 0.19-0.39 ($\mu = 0.29$, $\sigma = 0.05$); while for 'Good' IAQ and 'Unclassified' IAQ were 0.19-0.73 ($\mu = 0.42$, $\sigma = 0.11$) and 0.21-1.99 ($\mu = 0.64$, $\sigma = 0.25$) respectively. The expected values of θ determined for 'Excellent' IAQ offices were significantly lower ($p < 0.0001$) than that in the group of 'Good' IAQ, and that for the 'Unclassified' IAQ group were also significantly different from the ones in the 'Good' IAQ groups ($p < 0.0001$). The proposed IAQ index by three representative parameters could distinguish offices with different IAQ labels.

Figure 2 shows the corresponding benchmarks B_j of certain IAQ index θ determined from the regional profiles of office environment $\widetilde{\theta}$. It was reported that the range of IAQ index θ was between 0.91 and 1.99 ($\mu = 0.47$, $\sigma = 0.20$). For benchmarks of offices with the proposed IAQ index to distinguish offices of different IAQ labels, the benchmark levels would be set at the corresponding frequency of the three groups obtained from the 'full' assessment for the 525 offices. The first 10% would be labeled as 'Excellent' IAQ with an IAQ index $\overline{\theta} \leq 0.28$, the next 58% as 'Good' IAQ with an index $0.53 \leq \overline{\theta} < 0.28$, and the last 32% as 'Unclassified' with an IAQ index $\overline{\theta} > 0.53$ respectively.

Using the above levels for judgment, Table 2 illustrates the comparison of the proposed benchmarks with the existing IAQ labels in the 525 offices. The proposed benchmarks by IAQ indices correctly identified 24 'Excellent' IAQ offices, 224 'Good' IAQ and 113 'Unclassified' offices, which were equivalent to 46%, 73%, and 68% of the sample in the group. Overall, the proposed benchmark was effective in labeling 69% of the assessed offices in our sample case. Taking the assessment uncertainties into account, the significant association between the predicted and assessed results show that benchmarking by the IAQ index would be cost-effective and feasibly justified for identify the levels of IAQ, with appropriate benchmarking levels set.

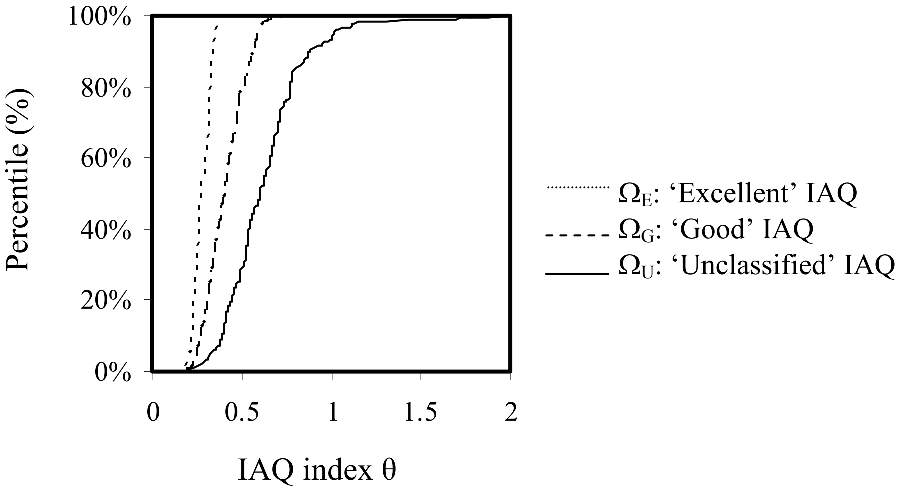

Figure 1: IAQ index θ of 525 Hong Kong air-conditioned offices classified into of 'Excellent', 'Good', and 'Unclassified' IAQ

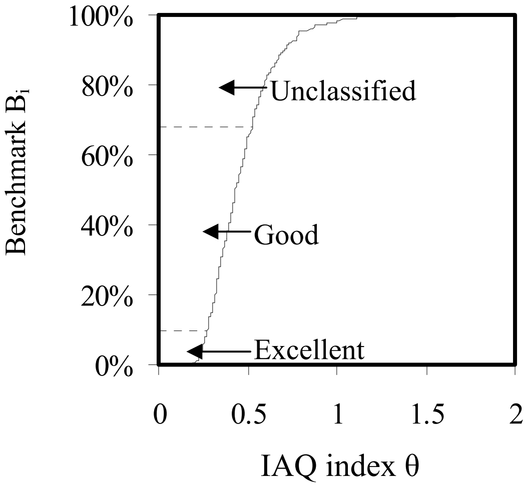

Figure 2: Benchmarks of Hong Kong air-conditioned offices IAQ

Table 2: Comparison of assessed and predicted IAQ labels

Assessed label	Predicted label (counts)			
	Excellent	Good	Unclassified	Total counts
Excellent	24	28	0	52
Good	26	224	56	306
Unclassified	3	51	113	167
Total counts	53	303	169	525

CONCLUSION

Performing a full scale indoor air quality (IAQ) assessment is costly and requires lots of manpower and resources in order to obtain the desired results. Justification of employing a full IAQ assessment is required. Nine common indoor air pollutants were selected as the assessment parameters for many office/public IAQ assessments in Hong Kong and database was available for reviewing the assessment strategy. This study proposes a simple index of IAQ benchmarks for IAQ problem identification and quantification by assessing only three 'representative' pollutants found in air-conditioned buildings of Hong Kong. With the regional cross-sectional measurement at 525 offices in Hong Kong, the IAQ indices of 'Excellent', 'Good' and 'Unclassified' IAQ offices were compiled. The performance of the proposed IAQ benchmark in labeling office IAQ referred to the three groups was compared with that of the full IAQ assessment results. The results show that this simple IAQ index can effectively distinguish offices of different IAQ labels as identified by the full IAQ assessment. This IAQ index would be a useful tool for policymakers, building owners and professionals to quantify IAQ in offices and to make decisions on resources and manpower management for IAQ investigations elsewhere in order to achieve best IAQ control.

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REFERENCES

American Society of Heating, Refrigerating and Air-Conditioning Engineers (2004). ANSI/ASHRAE 62-2004, Design for acceptable indoor air quality. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc 2004.

HKEPD Indoor Air Quality Information Centre (2003). Indoor air quality certification scheme for offices and public places. Hong Kong Environmental Protection Department, the Government of the Hong Kong Special Administrative Region, China.

Hoskins JA (2003). Health effects due to indoor air pollution. Indoor and Built Environment; 12(6): 427- 433.

Hui PS, Mui KW, Wong LT (2006). Feasibility study of an express assessment protocol (EPA) for indoor air quality of air-conditioned offices. Indoor and Built Environment; 15(4): 365-372.

Jokl MV (2000). Evaluation of indoor air quality using the decibel concept based on carbon dioxide and TVOC. Building and Environment; 35(8): 677-697.

Kraenzmer M (1999). Modeling and continuous monitoring of indoor air pollutants for identification of sources and sinks. Environment International; 25(5): 541-551.

Lee SC, Guo H, Li WM, Chan LY (2002). Inter-comparison of air pollutant concentrations in different indoor environments in Hong Kong. Atmospheric Environment; 36(12): 1929-1940.

Montoya T, Gurian PL, Velázquez-Angulo G, Corella-Barud V, Rojo A, Graham JP (2007). Carbon monoxide exposure in households in Ciudad Juárez, México. International Journal of Hygiene and Environmental Health. In press.

Moschandreas DJ, Sofuoglu SC (2004). The indoor environmental index and its relationship with symptoms of office building occupants. Journal of the Air and Waste Management Association; 54(11): 1440-1451.

Mui KW, Wong LT, Ho WL (2006). Evaluation on sampling point densities for assessing indoor air quality. Building and Environment; 41(11): 1515-1521.

Mui KW, Wong LT (2004). Evaluation on sampling period for assessing indoor radon level with a long-term measurement of Hong Kong. Atmospheric Environment; 38(39): 6711-6723.

Sekhar SC, Tham KW, Cheong KW, Wong NH (2000). A study of indoor pollutant standard index (IPSI) and building symptom index (BSI), Proceedings of Healthy Building, Espoo, Finland 2000; 1:145-150.

Tchepel O, Penedo A, Gomes M (2007). Assessment of population exposure to air pollution by benzene. International Journal of Hygiene and Environmental Health; 210(3/4): 407-410.

Wong LT, Mui KW, Hui PS (2006). A statistical model for characterizing common air pollutants in air-conditioned offices. Atmospheric Environment; 40(23): 4246-4257.

Wong LT, Mui KW, Hui PS (2007). Screening for indoor air quality of air-conditioned offices. Indoor and Built Environment; 16(5): 438-443.

COMPUTATIONAL ANALYSIS OF INDOOR VENTILATION TO IMPROVE SUSTAINABLE AIR CIRCULATION IN BUILT ENVIRONMENTS – USE OF WIND CAPTURE

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ABSTRACT

Considering the actual energy conservation needs, it seems to be relevant to look for sustainable solutions for residences comfort, adopting passive alternatives. The natural ventilation study in built environments has grown lately. Building design plays an important role in changing indoor ventilation performance, as the North Africa vernacular architecture has proved through creative systems of passive cooling. In this paper, we study one wind-capture case based on Fathy's writings. We imposed some alterations to the original project openings and analysed numerically the resulting wind field changes. We solved the air circulation problems using a mixed stabilised finite element method to determine the wind fields. The results suggest that the wind-capture use deserves more attention and research, together with optimal opening location to improve ambient conditions. These strategies show good potential in achieving significant air quality with reduced costs.

KEYWORDS: sustainable solutions, residences comfort, natural ventilation, finite element method.

INTRODUCTION

Considering the energy conservation needs the world faces today, it seems to be relevant to look for sustainable solutions for residences comfort, adopting passive alternatives, such as natural ventilation, whenever possible. The study of ventilation in built environments has grown in the last few years. Building design has become recognized as an important factor to change the indoor ventilation performance, taking into account economical and environmental gains. Ventilation is also necessary to maintain the well being of the building occupants in terms of air quality among other aspects. It acts to remove odours and reducing high concentration levels of undesirable substances.

Taking into account that natural ventilation is a climatic factor, a renewable alternative, as well as an important source of comfort, it appears to be pertinent to consider its great potential when applied to architecture, considering economical and environmental gains. It is difficult to think about studying air circulation without mentioning the North Africa vernacular architecture and its ability to create the best solutions to increase the ventilation without any energy consumption, therefore, adopting passive cooling. According to Hassan Fathy (Fathy, 1986) - an Egyptian architect who developed a collection of fruitful works using natural ventilation and local materials - in North Africa ventilation, light and view could not be associated at the same time to a single window because each function demands a different window configuration. Creative systems of passive cooling appeared in these areas. They were created to improve ventilation requirements catching wind from high above, where the air is cooler, stronger and with less sand and other particles, and channeling it down into the building. In Egypt the wind-catch or the malqaf is very developed and its first usage dates back to ancient historical periods.

In this work, based on the writings of Fathy (Fathy, 1986) one case in which wind-catch is used. It is the Q˜a'a of Muhib AdDin Ash-Shf'i Al-Muwaqqi, known as Othmn Katkhud, in Cairo, dated from the fourteenth century A.D. Figures 1-2, extracted from Fathy (1986), show the section through the Q˜a'a of Muhib AdDin Ash-Shf'i Al-Muwaqqi and its plan, respectively. "The Q˜a'a is a central room, usually a living room in a residence or a meeting room in a formal hall" (Fathy, 1986).

Figure 1. Section through the Q˜a'a, from Fathy (1986).

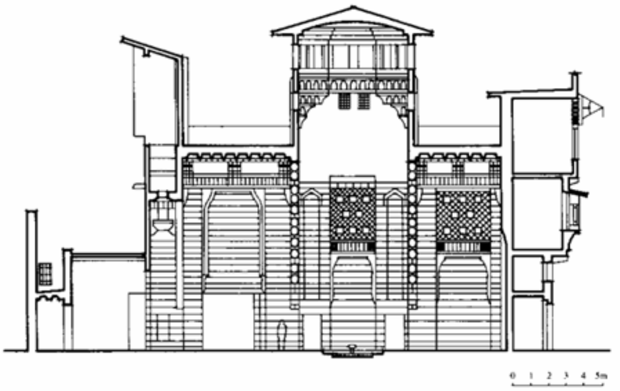
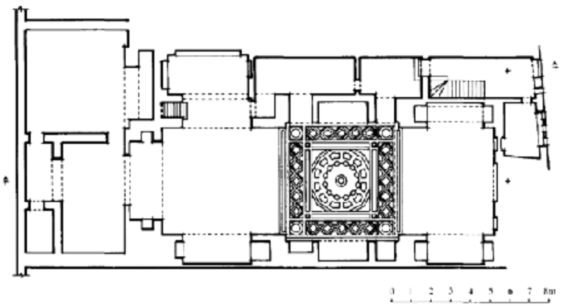
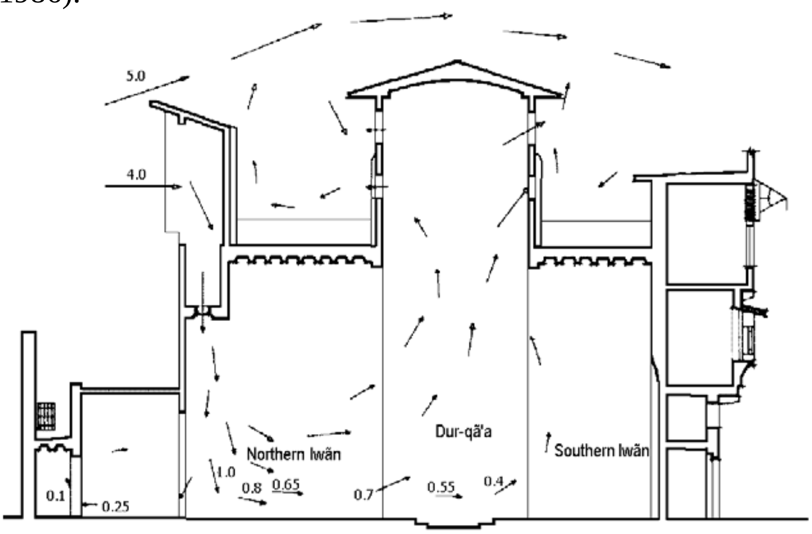


Figure 2. Plan of Muhib AdDin Ash-Shf'i Al-Muwaqqi from Fathy (1986).



The complete climatization system, from which the malgaf is part, is shown in Figure 3. These wind field measurements were made by students from the Architectural Association School, London in 1973 (Fathy 1986).

Figure 3. Section through the Q˜a'a ofMuhib AdDin Ash-Shf'i Al-Muwaqqi - measurements were made by students from the Architectural Association School, London in 1973 (Fathy 1986).



In this study, we imposed some changes to the original wind-catch openings in Othmãn Katkhudã building, and we analysed numerically the wind field changes starting from these interferences.

The results suggest that the use of wind capture, as well as optimal location of openings to improve ambient conditions, deserve more attention and research, since these strategies show good potential in achieving significant air quality with reduced environmental and economical costs in order to achieve sustainability and improve energy efficiency in housing programmes. Sustainable housing is concerned with the large-scale integration of facilities for residential purposes in a sustainable manner. It addresses efforts to integrate systems from the technological, social and economic perspectives.

MATHEMATICAL FORMULATION

The analyses start by solving the air circulation problems to determine the wind fields, using a mixed stabilised finite element method, like Petrov-Galerkin (Brooks and Hughes, 1982), applied to the full Navier-Stokes equations written in velocity and pressure variables (Franca and Frey, 1992). At the end, numerical results are compared to the studies presented in Fathy's work (Fathy, 1986) and some conclusions are presented.

The problem of air circulation can be modelled through mass and momentum conservation equations. Assuming incompressibility, the mathematical formulation for the general problem can be written as: Find $\mathbf{u}$ and p satisfying the following system,

$$div\ (\mathbf{u}) = 0, \text{ in } \Omega \times [0,\mathrm{T}], \qquad (1)$$

$$\rho \frac{\partial \mathbf{u}}{\partial \mathrm{t}} + \rho\ (\nabla \mathbf{u})\mathbf{u} - 2\mu\ div\ \varepsilon\ (\mathbf{u}) + \nabla \mathrm{p} = 0, \text{ in } \Omega \times [0,\mathrm{T}], \qquad (2)$$

With initial and boundary conditions,

$$\nabla(\mathbf{u}).\vec{\mathbf{n}} = 0 \text{ in } \Gamma_v \times [0,\mathrm{T}],\ \mathbf{u}(\mathbf{x},\mathrm{t}) = \overline{\mathbf{u}}(\mathbf{x},\mathrm{t}) \text{ in } \Gamma_u \times [0,\mathrm{T}] \text{ and } \mathbf{u}(\mathbf{x},0)=\mathbf{u}_0$$

where:
$\mathbf{u} = \mathbf{u}(\mathbf{x},t)$ is the velocity vector, p=$(\mathbf{x},t)$ is the pressure, μ is the viscosity, ρ is the density, $\vec{\mathbf{n}}$ is the normal vector, $\varepsilon(\mathbf{u}) = \frac{1}{2}\left(\nabla \mathbf{u} + \nabla \mathbf{u}^T\right)$, Ω is the bounded domain with boundary $\Gamma = \Gamma_v \bigcup \Gamma_u$ and the time $t \in [0,\mathrm{T}]$.

METHODS

The numerical solutions are here obtained by a stabilised mixed finite element method that allows to deal with the problems that come from the equation system. The first problem is the difficulty in constructing approximation spaces for problems with internal constraint. The second is the non-linear nature of the convective type and the last one is the challenge to deal with numerical instabilities when advection effects are dominant. Here, a Petrov-Galerkin type method was implemented and applied to analyse indoor air circulation cases, ensuring stability for dominant advection and for the internal constraint (Karam and Loula, 1992).

Being L^2 and H^1 the usual Hilbert spaces and R_l^h the Lagrange polynomial space of the degree l and class C^0. Then, defining the following approximation spaces

$$V_h = \left\{ \mathbf{u}_h \in (H_0^1(\Omega) \cap R_l^h(\Omega))^2, \mathbf{u}_h(\mathbf{x},t) = \bar{\mathbf{u}}_h(\mathbf{x},t) \text{ in } \Gamma_u \right\} \subset (H^1(\Omega))^2$$

$$V_h^0 = \left\{ \mathbf{v}_h \in (H_0^1(\Omega) \cap R_l^h(\Omega))^2, \mathbf{v}_h(\mathbf{x},t) = 0 \text{ in } \Gamma_u \right\} \subset (H^1(\Omega))^2$$

$$P^h = \left\{ p_h \in (L^2(\Omega) \cap R_l^h(\Omega)); \int_\Omega p_h \partial\Omega = 0 \right\} \subset (L^2(\Omega))$$

with the usual norm

$\|\mathbf{u}\|_1^2 = \|\mathbf{u}\|_0^2 + \|\nabla \mathbf{u}\|_0^2$ of H^1 and $\|p\| = \|p\|_0$ of L^2.

The wind field can be determined by solving the following formulation:

Find $\{\mathbf{u}^h, p^h\} \in V^h \times P^h$ satisfying the following system

$B\ (\mathbf{u}_h, p_h; \mathbf{v}_h, q_h) = 0, \ \forall \ (\mathbf{v}_h, q_h) \in V_h \times P_h$

where:

$$\mathrm{B}\ (\mathbf{u}_h, \mathrm{p}_h; \mathbf{v}_h, \mathrm{q}_h) = \left(\frac{\mathbf{u}_h^n - \mathbf{u}_h^{n-1}}{\Delta t}, \mathbf{v}_h \right) + \left((\nabla \mathbf{u}_h) \mathbf{a}_h, \mathbf{v}_h \right) + 2\nu \left(\varepsilon(\mathbf{u}_h), \varepsilon(\mathbf{v}_h) \right) - \left(p_h, div(\mathbf{v}_h) \right) +$$

$$\left(q_h, div(\mathbf{u}_h) \right) + \left(div(\mathbf{u}_h), \delta_2 div(\mathbf{v}_h) \right) + \delta_1 \sum_{e=1}^{Nel} \left(\frac{\mathbf{u}_h^n - \mathbf{u}_h^{n-1}}{\Delta t} + (\nabla \mathbf{u}_h) \mathbf{a}_h - 2\nu\ div\ \varepsilon(\mathbf{u}_h) + \nabla \mathrm{p}_h, \right.$$

$$\left. \left((\nabla \mathbf{v}_h) \mathbf{a}_h - 2\nu\ div\ \varepsilon(\mathbf{v}_h) + \nabla q_h \right) \right)_{\mathrm{h}} + \gamma \left(\mathrm{p}_h, q_h \right),$$

$$\forall\ \mathbf{v}_{\mathrm{h}} \in V_h^0 \ \ e \ \ q_h \in P_h.$$

with $\gamma << 1$ and δ_1 and δ_2 stabilized parameters suggested by (Franca and Frey, 1992).

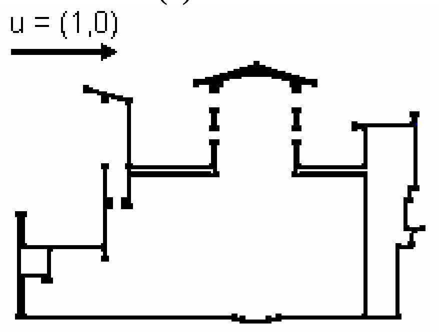
SIMULATIONS

We imposed some changes to the original wind escape openings in Qã'a to test the results of the wind field for different arrangements of openings, called here Qã'a-1, Qã'a-2, Qã'a-3 and Qã'a-4, to simplify the understanding. Meshes for the four cases here studied were generated with linear triangular elements as in Figures 4b (original plan, Qã'a-1), 5b (two left openings were closed, Qã'a-2), 6b (two right openings were closed, Qã'a-3) and 7b (two higher openings were closed, Qã'a-4). The whole meshes comprise areas bigger than the areas of the plans in order to impose the boundary conditions on their borders and to leave unknown the velocities at the entrances that are determined by the solution of the problem.

Arrows in sketch figures indicate the direction and intensity of the outside wind, providing the boundary conditions to the air circulation problem. The absolute value of 1m/s was adopted for the outside wind. According to the Beaufort Scale, used in time forecast, this value corresponds to breeze without wind perception. The value adopted for the outside wind was low with the intention of observing whether a subtle outdoor ventilation would or not interfere with the indoor environment.

Figure 4. Sketch and whole mesh of the original project, called Qã'a-1.

(a) Sketch.



(b) Whole mesh.

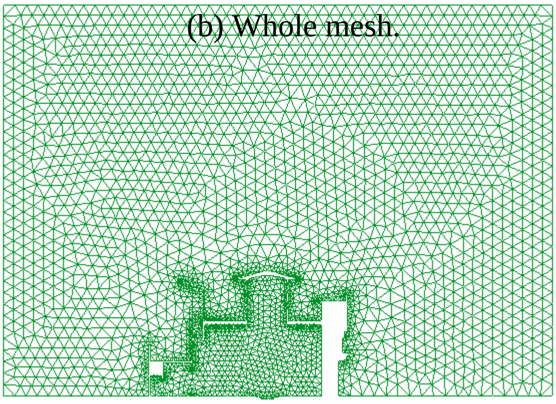
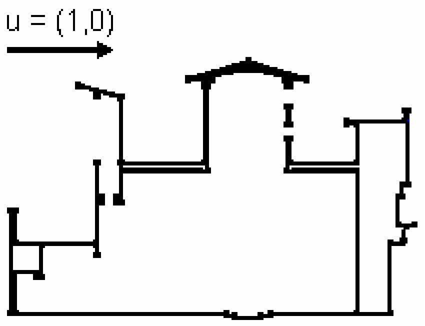


Figure 5. Sketch and whole mesh of the project, called Qã'a-2.

(a) Sketch.



(b) Whole mesh.

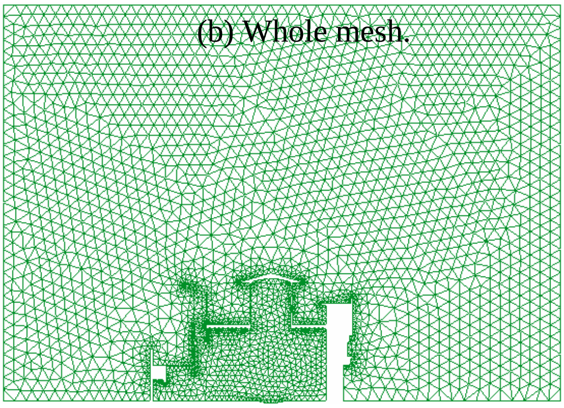
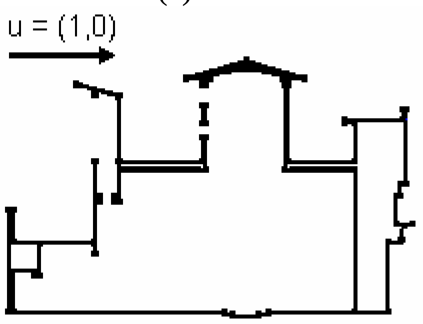


Figure 6. Sketch and whole mesh of the project, called Qã'a-3.

(a) Sketch.



(b) Whole mesh.

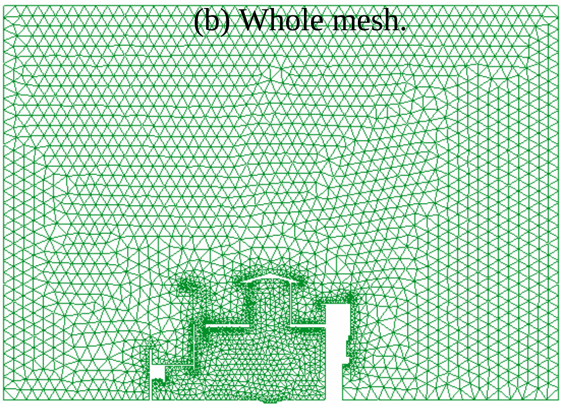
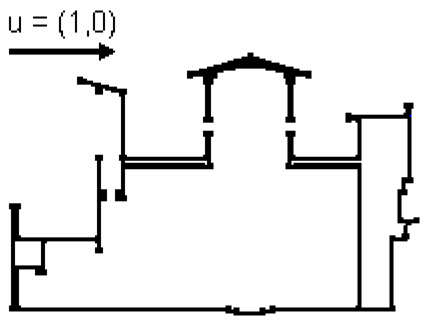
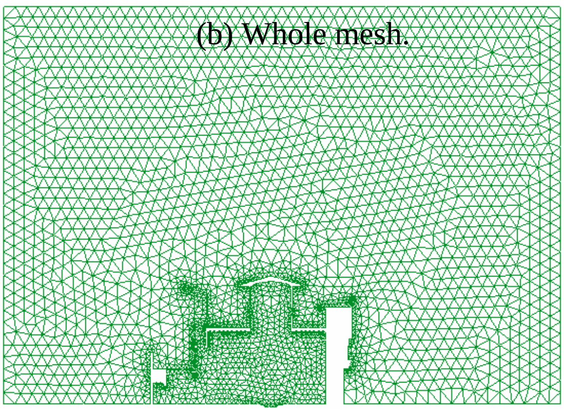


Figure 7. Sketch and whole mesh of the project, called Qã'a-4.

(a) Sketch.



(b) Whole mesh.



Results for the studied case are presented in Figures 8(a) to 11(a) in terms of contour fill of |u| and Figures 8(b) to 11(b) in terms of velocity wind field. All results were taken in a same scale, in other words, including the same wind strip, so that it is possible to compare the alterations made to each change of the openings.

From Figure 8, which represents the original project, we can observe that the velocity results that give the air circulation its patterns not only confirm the global circulation sketches in Fathy's book, see Figure 3, but also show the details of the flow formed inside the Q˜a'a-1 house even when the external wind is low (1m/s). These patterns promote favorable conditions to widely distribute the circulation effects.

Figure 8. Contour fill of |u| and velocity wind field - Qã'a-1.

(a) Contour fill of |u| . (b) Velocity wind field. (c) Scale.

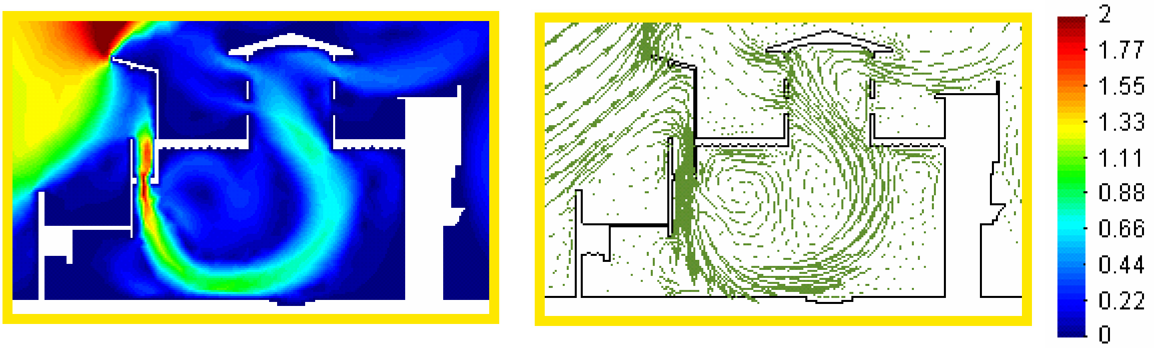


Figure 9. Contour fill of |u| and velocity wind field - Qã'a-2.

(a) Contour fill of |u| . (b) Velocity wind field. (c) Scale.

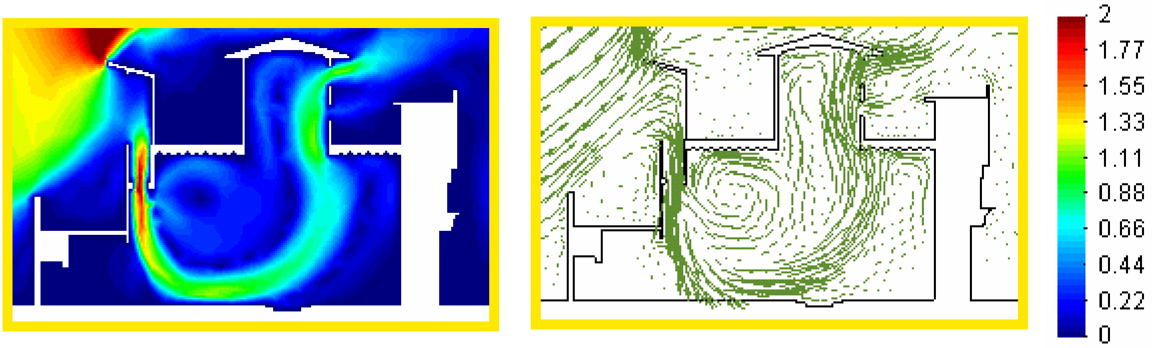


Figure 10. Contour fill of |u| and velocity wind field - Qã'a-3.

(a) Contour fill of |u| . (b) Velocity wind field. (c) Scale.

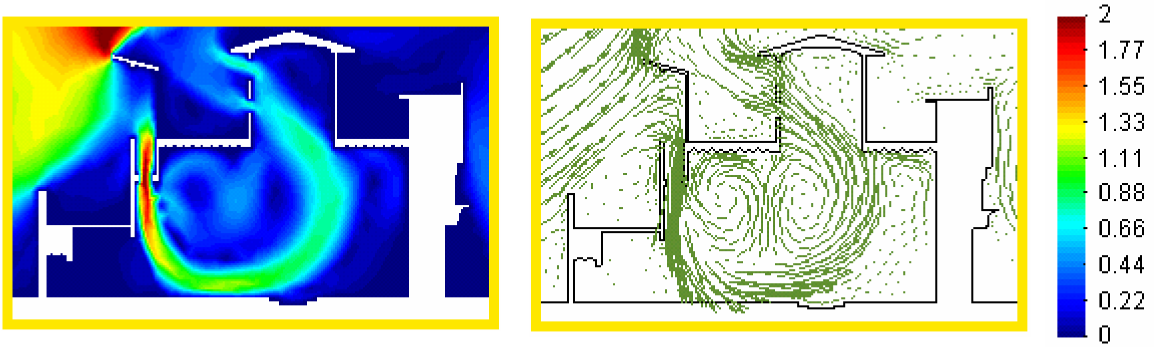
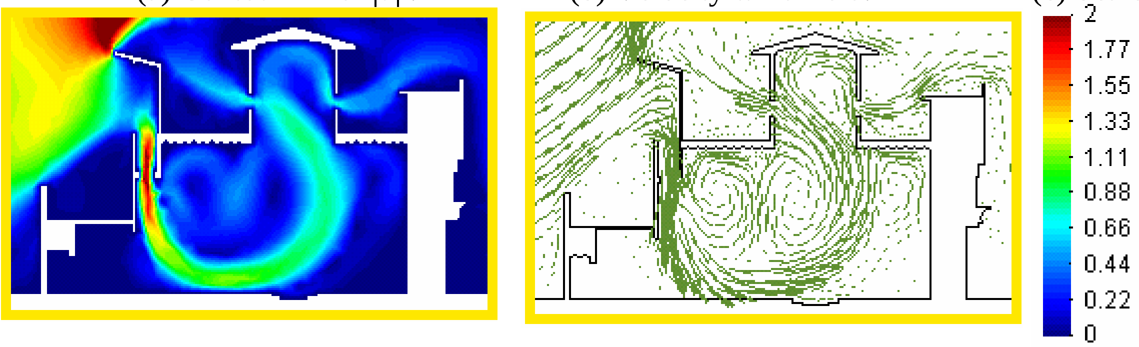


Figure 11. Contour fill of |u| and velocity wind field - Qã'a-4.

(a) Contour fill of |u| . (b) Velocity wind field. (c) Scale.



It is interesting to observe that very intense wind velocities in indoor and outdoor are not always pleasant. Criteria and tables of values of wind velocities exist delimiting what can be pleasant. According to Evans (Evans, 1980), indoor wind values above 1.5 m/s can be unpleasant not only because they generate discomfort but also make doors and windows slam and paper fly.

For a more detailed vision of the air circulation inside the ambient the results are presented now for a scale with a reduced superior value in relation to the one presented previously, in other words, the darkest color will be adopted for superior velocities to 1.5 m/s in the color scale. For the four studied cases we did not observe any strong winds in the central area.

Figure 12. Contour fill of |u| - Qã'a 1 and Qã'a 2.

(a) Qã'a 1. (b) Qã'a 2. (c) Scale.

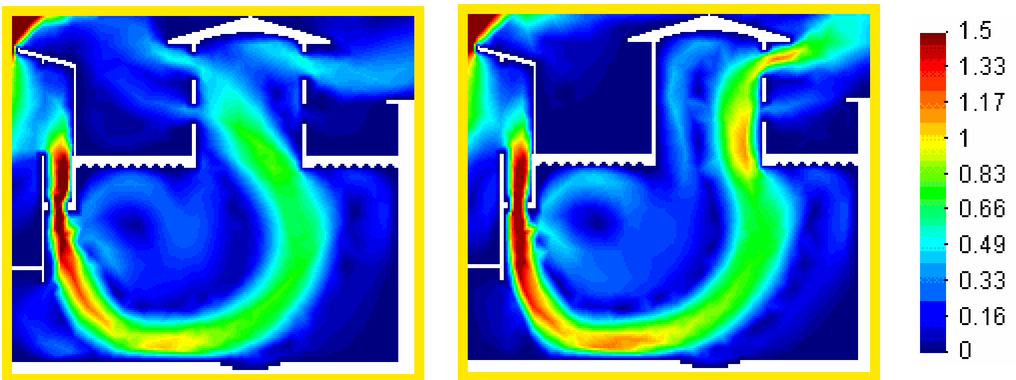
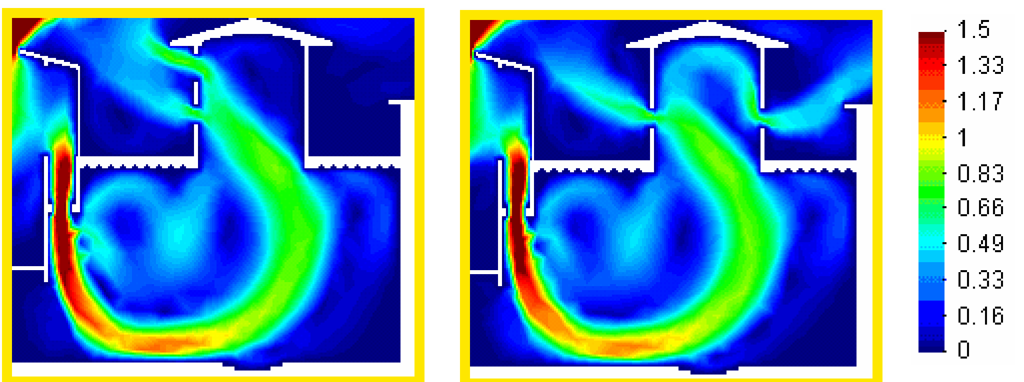


Figure 12. Contour fill of |u| - Qã'a 3 and Qã'a 4.

(a) Qã'a 3. (b) Qã'a 4. (c) Scale.



CONCLUSIONS

Changes are proposed to original internal environments through openings locations to make possible project configuration evaluations and to test the possible improvements aiming at comfort of building environments. These improvements are introduced here by simple changes to the original designs targeting the increase of functional quality in the buildings with low financial and environmental costs.

The results obtained for the four studied cases bring positive results in ventilation terms. Respecting the openings of the original project, Qã'a-1, it is possible to notice that the results in terms of ventilation distribution are larger once it gets to reach even the most hidden areas of the construction. For the others cases, the results between them are similar and they allow us to observe a smaller circulation in the construction corners. We can notice that the alterations imposed to the central tower openings, in spite of the produced alterations in the wind field were not enough to induce great differences amongst themselves (Qã'a-2, Qã'a-3 and Qã'a-4).

The computational velocity results allow us to note the capacity of the system to promote the indoor air circulation even when the outdoor wind is smooth, (1m/s). It also allows us to work with pre and post occupancy evaluation. These facts suggest that the utilization of wind-catch, as well as optimal location of openings are able to improve ambient conditions and they deserve more attention and research since these strategies show good potential in achieving significant quality with reduced environmental and economical costs.

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REFERENCES

Brooks, A and Hughes, T J R. 1982. Streamline Upwind/Petrov-Galerkin formulations for convection dominated flows with particular emphasis on the incompressible Navier-Stokes equations. Computer Methods in Applied Mechanics Engineering. Vol.32. pp 199-259.

Drach, P R C and Karam F., J. 2007. Computational analysis of indoor air circulation and heat transfer in a house ventilated by wind-catch., Proceedings: 2nd PALENC Conference and 28th AIVC Conference, 2007, Greece, 2007. Vol. 1. pp. 284-288

Drach, P R C and Karam F., J. 2004. Análise de circulação de ar em ambientes interiores, via elementos finitos, Proceedings: I-Latin American Conference on Sustainable Building and X-Brazilian Conference on Technology for Building Environment, Vol.1, pp.1-14.

Evans, J. M. 1980. Housing, Climate and Comfort. Architectural Press LTD, London, 1980.

Karam F., J and Loula, A F D. 1992. On stable equal-order finite element formulations for incompressible flow problems. Computer Methods in Applied Mechanics Engineering. Vol. 34, No. 2, pp 655-665.

Fathy, H. 1986. Natural Energy and Vernacular Architecture: Principles and Examples with Reference to Hot Arid Climates. University of Chicago Press, Chicago.

Franca, L P and Frey, S L. 1992. Stabilized finite element methods: II. The incompressible Navier-Stokes equations. Computer Methods in Applied Mechanics Engineering. Vol. 99. pp 209-233.

MANAGEMENT OF AIRBORNE INFECTION ISOLATION ROOMS

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ABSTRACT

Airborne infection isolation (AII) rooms are essential facilities for controlling spread of airborne infectious diseases in healthcare settings. Their proper operation, which is paramount to protecting the wellbeing of healthcare staff, visitors and patients, requires proper planning and management. Although the traditional management role may be thought of as being responsible for the daily operation and maintenance (O&M) of the facilities, many maintenance tasks, which are essentially re-commissioning procedures, are dependent on provisions made for testing and commissioning (T&C) at the design stage. Furthermore, the reliability of the engineering systems and the ability to maintain and repair them without interrupting normal operation of the systems also depend heavily on design decisions. Facility managers should therefore also be aware of design recommendations in addition to actual specifications since any shortcomings will impact on how they can manage and operate the AII facilities. Targeting at managers involved with the design, procurement, and operation of AII facilities, the paper presents the findings of a literature review and observations from practical experience, in respect of the current ventilation design recommendations for AII facilities including design features that would allow maintenance tasks to be performed safely without interrupting the operation of the AII rooms. Some of the procedures a facility management team can perform to verify if AII rooms are functioning correctly are then described, together with the identification and causes of potential problems.

KEYWORDS: AII Room, ventilation, management, O&M.

INTRODUCTION

Airborne infection isolation (AII) rooms are essential provisions in healthcare settings to safeguard healthcare workers (HCWs), maintenance staff, patients, and visitors from potential cross-infection. To achieve this, the mechanical ventilation systems of AII rooms must be properly designed, operated and maintained to ensure achievement of the required isolation performance, and be able to function reliably and continuously, except when necessary maintenance works are carried out. In this paper, the operation principles of AII rooms and the ventilation design guidelines are summarised. Some of the procedures that a facility management team can perform to verify correct functioning of AII rooms, and to identify causes of potential problems are described.

PRINCIPLE OF OPERATION OF AII ROOM

A patient who has contracted an airborne infectious disease, such as tuberculosis (TB) or severe acute respiratory syndrome (SARS), should be placed in a negatively pressurised AII room. The room exhaust is greater than the supply so that make up air is drawn from adjacent spaces, thus preventing leakage of any potentially contaminated air. The pressure difference achieved is dependent on the air tightness of the construction, which may be quantified by the equivalent leakage area (ELA), as shown in Equation 1 (Hayden et al., 1996).

$$A_E = 0.01138\left(\frac{\Delta Q^{1.170}}{\Delta P^{0.602}}\right) \qquad \text{Equation 1}$$

Where A_E = is the ELA (square inches), ΔQ the differential airflow rate (cfm) and ΔP the differential pressure (inches water gauge).

The Centers for Disease Control (CDC, 2003) recommends a supply-exhaust imbalance of 100 cfm ($\approx$ 50 l/s) to give a differential pressure of -2.5Pa. Using the SI equivalent of equation 1 yields an ELA $\approx$ 400 cm^2, which we found in previous measurements to be representative of an average standard of construction of isolation rooms in Hong Kong. More stringent differential pressures are specified elsewhere, for example -15Pa in the UK (RACCDC, 2004) to -30Pa in Australia (SCIC, 1999). Lower differential pressures, in the range of -0.25Pa (AIA 1996) to -0.5Pa (Decker, 1995), may be sufficient to prevent leakage of contaminated air under door closed conditions, but such small pressure differentials may be disturbed by climate effects (temperature differences and wind pressure), or operation of nearby ventilation systems. Decker (1995) also showed that for an isolation room that achieved a differential pressure of -0.5Pa when the door was closed, leakage of air out of the room became detectable within 3 minutes once its door was opened.

Ingress and egress of HCWs will entrain contaminated air into clean areas. Alevantis et al. (1996) showed that a pressure difference of around -7Pa (with closed door) could ensure that only 1% of the room air could be found in adjacent spaces. Our walk through measurements using CO_2 as a tracer gas showed that concentrations in adjacent spaces were of the order of 5% – 8% of room concentration for differential pressures of -3Pa to less than 1% at -8Pa. In Norway, 4 isolation rooms were tested using sulphur hexafluoride (SF_6), where the corridor-anteroom and corridor-patient room pressure differences were -15Pa and -30Pa respectively (Rydock and Eian, 2004). In each case SF_6 was detected in the corridor, although at much lower concentrations than in the ante room.

Increasing the pressure difference would cause greater air movement on opening the door which helps reduce the amount of contaminated air entrained with the person. This can be achieved by increasing the supply-exhaust flow rates differential. A differential pressure in the range 8–10Pa can be readily achieved provided attention is paid to the air tightness of the construction. Air transfer grilles with automatic dampers between the corridor and anteroom and between the ante room and the AII room are needed as pressure stabilisers.

Achieving the required level of air tightness requires, among other things, all windows to be well sealed; walls to be extended from floor to structural ceiling and be applied with impervious surface finishes; doors to be well sealed except for purposely provided door undercuts in the range 3 – 12 mm (CDC, 2004), or be fitted with door louvers; and ceilings to be air tight with any openings for services well sealed around the edges. This includes pipe work, light fixtures, electrical light switches, fire services and any access doors. Ceiling mounted furniture such as curtain rails should not obstruct access to ceiling mounted air terminals to permit measurement of flow rates using flow hoods or similar devices.

The previous discussion points to the need for an ante room to act as a buffer between the AII room and the corridor with the pressure from the corridor through the anteroom to the AII room being increasingly negative. A potentially hazardous situation will emerge when the relative pressure between an isolation room and any one of the surrounding spaces is reversed. Therefore, differential pressures sensors are installed such that whenever abnormality is detected, an alarm will be signalled. For providing an effective air lock, the two ante room doors should be interlocked to prevent them from being opened at the same time (SCIC, 1999). Care should be taken to avoid the interlock from being inadvertently overridden. Sliding doors are preferred to swing doors for minimization of undesirable air movements (Tang et al., 2006).

Ventilating the ante room at the rate of 12ach will achieve 99% and 99.9% removal efficiencies in 23 and 35 minutes respectively CDC (2005). Similarly it can be shown that at a ventilation rate of 10ach, a removal efficiency of 50% can be achieved after 4 minutes. HCWs should therefore stay in the anteroom for a few minutes to allow significant dilution of any entrained contaminated air. This time can be used effectively if a hand wash basin is provided and if PPE is stored in the anteroom, to allow changing. Higher contamination dilution efficiency would be achieved by increasing the air change rate.

Each isolation room must be provided with a dedicated washroom (or ensuite) to minimise the need for taking the patient outside. The washroom and the isolation room are to be ventilated by the same mechanical ventilation system. Any foul air extracted from the washroom will be replenished by air induced to flow from the isolation room into the washroom through the door gap or a transfer grille in the washroom door. The washroom exhaust rate should be 10ach at minimum, which should be capable of maintaining a 2.5Pa pressure difference between the washroom and the patient room when the door is closed.

Ideally, each isolation room should accommodate only one patient at any one time. At times of serious epidemics, however, shared use of isolation rooms may become a necessity. This is acceptable provided that patients staying in the same room are all confirmed to have contracted the same infectious disease, and the same strain of multi-strain infections; there should be 1-2m separation between beds (WHO, 2004) and curtains should be drawn around a patient to limit the travel of droplets emitted when a patient coughs or sneezes. Until diagnosis is confirmed, each *suspected* patient must be lodged in a single room.

When an AII room is idle, it may be used for accommodating non-infectious patients and be operated under neutral pressure, provided the room has been cleansed and has remained unoccupied with the mechanical ventilation kept running to purge away any residual infectious diseases in the room. Dual purpose rooms, which can operate in either negative or positive pressure, are no longer acceptable, due to the risk of incorrect mode selection.

Two or more AII rooms may be positioned side-by-side. In this case, the adjacent anteroom and AII room pressures must be closely balanced, otherwise, cross infection may arise if air leakage paths exist between adjacent spaces. It may be thought cost-effective to have adjacent AII rooms sharing an ante room. This, however, is undesirable, because shared anterooms could lead to incorrect air flow direction (Pavelchak et al., 2000). In addition, contaminated air from one AII room could be entrained into the anteroom, which could be induced to flow into the adjacent AII room by the anteroom-AII room pressure difference.

In order to maintain sufficient distance between beds, allow easy access for bed making or cleaning and to permit the use of wheelchairs and patient hoists, a single bed isolation room should have, at minimum, a floor area of 16m^2 (SCIC, 1999) and a 4-bed room 58m^2, excluding the clinical support and ensuite area (NHS Estates 2005).

Supply and exhaust arrangement

For new facilities, the supply air should be 100% outdoor air (SCIC, 1999); for other cases, an absolute minimum of 2ach of outdoor air should be provided (CDC 2003). Whilst ventilation rates are commonly expressed in number of air changes per hour (ach) referenced to the room volume, the figures should be interpreted with caution. For a given contaminant source strength (e.g. one infectious patient), a ventilation rate of 12ach will yield a lower contamination concentration in a large room than in a smaller room. Attention, therefore, should also be paid to the absolute ventilation rates (e.g. in l/s), particularly for small rooms (less than $43m^3$ volume).

The recommended minimum supply flow rate for a single person AII room is the greater of 12ach or 145*l*/s (SCIC, 1999). For a multiple patient AII room, the supply air flow rate should be increased pro-rata; otherwise the contaminant concentration will be higher thus exposing HCWs to a higher risk of infection. This is important for AII rooms that would normally house one patient but would be used to house more under surge conditions. The supply air flow rate for an AII room should be determined based on the design sensible cooling load of the room without reheat under the design condition. The exhaust flow rate should be equal to the sum of the supply and the leakage flow rate. As the leakage characteristics of a room will remain uncertain until the room has been built and testing and adjustments are done, allowances should be made in determining the exhaust system capacity and use of adjustable supply and exhaust fans is desirable. Our measurements suggest that fans are typically 20% oversized.

The design indoor air condition should be 21–24°C and 40–70% RH (ASHRAE, 2003). Each patient room should be fitted with its own thermostat control (ASHRAE, 1999). The supply air system must be all air, constant air volume (CAV) system (SCIC, 1999). Ideally, each AII room should be served by a dedicated system with its own air-handling unit (AHU) although a common AHU may be used to serve multiple rooms located together, provided design provisions are made to prevent one room’s pressure characteristics from affecting another’s. Similarly, each AII room should have a dedicated exhaust and when an exhaust system is used to serve multiple rooms, provisions must be made to prevent one room’s pressure characteristics from affecting another’s (Standards Australia, 2003). Exhaust fans should be located as near to the discharge point as possible such that all exhaust ductwork inside the building is maintained under negative pressure (Standards Australia, 2003).

Both supply and exhaust fan systems should be backed-up by stand-by units with automatic changeover, so that either fan can be shut down for maintenance or filter changing (SCIC, 1999). The supply fan(s) should be fitted with automatic cut-outs in case of exhaust fan failure or in the event that negative pressure is not achieved in the room (Standards Australia, 2003). The exhaust system should be designed so that filters can be changed without compromising the safety of maintenance staff (SCIC, 1999). Supply and exhaust fans should be provided with essential power supply (RACCDC, 2004).

Although a high level of mixing and contaminant dilution is desirable, a general flow pattern where the clean air from the supply air terminal passes over the HCW, then over the patient and is finally exhausted will help lower the exposure of health care workers to infectious diseases (Standards Australia, 2003). The supply air grilles are typically ceiling mounted with low level exhaust grilles located either at each side of the patient’s head (Streifel, 1996) or 150mm above the floor (SCIC, 1999). Ceiling mounted supply terminals should be of the perforated plate type (CDC, 1994), located near the door but the supply airflow should not disturb the differential air pressure relationship with the ante room (Pavelchak et al., 2000). Supply and exhaust terminals should be located to prevent short circuiting (CDC, 2005). Room furniture and other fittings should not obstruct the airflow paths.

The air inside an isolation room should contain as few as possible contaminants, especially bacteria and viruses, which requires a high standard of supply air filtration. Although UVGI disinfection systems can reduce the number of airborne bacteria and micro-organisms, there is a lack of documented evidence to quantify their effectiveness and to provide detailed guidance on the placement, lamp intensity and air flow rate through these devices.

HEPA filters must be fitted in renovated facilities where air is recirculated from the AII room. The use of terminal HEPA filters should be considered in situations where supply and exhausts to/from AII rooms are shared in order to prevent back draughts (SCIC, 1999). HEPA filters should be housed in metal frames, with the filter and frame sealed with well fitting rubber gaskets (DoHS, 1996). To maintain continuous operation, duct mounted HEPA filters should be fitted in a parallel duct arrangement. HEPA front access filters should be fitted at each room exhaust point; a duct damper with edge and blade seals should be provided immediately downstream of each HEPA filter to allow for duct isolation prior to HEPA filter removal and room cleaning (Standards Australia, 2003). The life of HEPA filters can be prolonged if pre-filters are used (CDC, 2003). All filters should be fitted with manometers or pressure gauges (DoHS, 1996).

COMMISSIONING

An Infection Control Risk Assessment (ICRA), following the American Institute of Architects' (AIA) requirements, should be prepared by a multi-disciplinary body of experts from the fields of infection control, risk management, facility design, construction, ventilation, safety and epidemiology (AIA, 2001). AII rooms should be commissioned by an independent third party commissioning authority (CA) (AIA, 2001). The CA should be appointed early so that necessary provisions such as variable flow fans, volume control dampers (VCDs) are specified correctly and actually installed.

The AII room should be inspected to ensure that all the recommended arrangements stated in the preceding section are adequately provided. Consideration should be given to carry out containment testing using tracer gas and verification of airflow patterns. The ventilation system should be tested and balanced according to recognised commissioning codes or standards e.g. ASHRAE, (1996 & 2005) to ensure specified design differential pressures are achieved while satisfying minimum ventilation flow rate criteria. All alarms and gauges should be commissioned to verify the airflow direction and pressure readings. In particular, checks should be made to ensure that there is no bi-directional airflow over the door.

The client should ensure that the commissioning team are in possession of the most up to date design information. After handover, the owner shall keep documentation and records as specified by ASHRAE (2007). Training should also be provided to the owner's O&M staff in conformity with, but are not limited to, the requirements of ASHRAE (2007). Furthermore, sufficient training and instruction should be given to HCWs so that they are able to read and interpret the monitoring instruments and also carry out the required action plan in the event of an AII room being found to be performing incorrectly.

MAINTENANCE

Maintaining proper air flows (in both magnitude and direction) in an AII room is crucial to its proper functioning. However, the performance of any complex system will degrade over time. For a mechanical ventilation system, continuous use will result in increasingly loaded air filters and loosened fan belts (Pavelchak et al., 2000), lint build up on fan blades and in low level exhaust grilles (Streifel, 1996), and worn motor bearings; all of which will reduce the airflow and compromise the effectiveness of the AII facility. Only qualified engineering staff should carry out maintenance tasks or make changes to the ventilation system. All replacement parts should conform to the original design specification.

Regular maintenance tasks on the ventilation system should include checks or measurements on the air change rate, supply air and exhaust flow rates, supply air diffuser or registers, return/exhaust grilles and ductwork, supply and exhaust fans and dampers, room pressure gauges and alarms (Standards Australia, 2003). The maintenance interval should be 13 weeks, or some other interval determined by condition based monitoring procedures such as filter pressure drops, daily records of room pressures etc (SCIC, 1999). Appropriate re-commissioning checks should be performed after completion of maintenance tasks to ensure that the correct flow rates and pressure relationships are re-established.

HEPA filter replacement intervals should be determined by the filter pressure drop readings or, if a prescribed time interval is preferred, once every 4 months (13 weeks) (SCIC, 1999). HEPA filters should only be removed after a minimum of 7 days of being isolated from the duct air stream (Wang et al., 2003). In some cases this period may need to be longer – WHO guidance states that the SARS virus remained viable at 4°C for 3 weeks. HEPA filter replacement should be performed when the room is vacant. The time period should be a minimum of 10 minutes to allow droplets to settle (DoHA, 2004), however a longer interval is likely to be required based on CDC (2005) data for ventilation rate and required removal efficiency. Where HEPA filters are not designed on a duty and stand by basis, the filter should be changed before admitting an infected patient to the room if it has less than 2 weeks operational life left (Wang et al., 2003). This would interrupt the operation of the room. HEPA filters may be sterilised with a 10% bleach solution before removal (CDC, 2005). Maintenance staff should wear a respirator (CDC, 2005) and disposable gloves and follow safe maintenance practice such as given in USEPA's air-quality guidelines (Striefel, 1996).

With some diseases, e.g. SARS, HEPA filters should be disposed of as clinical waste (DoHA, 2004). If pre-filters are used they should be treated in the same way as HEPA filters (CDC, 2005). Maintenance personnel should thoroughly disinfect themselves upon completion of replacement. Carts and trolleys should be disinfected before leaving the isolation room. Waste bags and containers should be completely sealed to prevent any virus becoming airborne due to air movement from the ventilation system.

OPERATION

Daily testing of air flow movement using smoke tubes should be carried out by releasing smoke around all four door edges to confirm that two directional airflows are not present over the door (CDC, 2005). If manual gauges are fitted they should be read daily with the reading recorded. It must be ensured that doors and windows are kept closed to maintain pressure relationships. Filter pressure drop readings should be made weekly and the results recorded. If the AII room has been in use as a general treatment room during non-outbreak conditions, consideration of the HEPA filter loading is still of importance (Rydock, 2002). When returning the room to AII use the filter pressure drop should be compared with historical records to determine whether the HEPA filter should be replaced.

An intercom, CCTV, or similar communications system should be provided which will allow staff to communicate directly with the patient and vice-versa, without the need to enter the room and also allows staff present in the room to communicate with people outside the room without leaving the room (Standards Australia, 2003). Appropriate warning signs should be placed on the entry doors to the anteroom and patient room warning of semi-contaminated and contaminated areas respectively. A biohazard logo on the door to the AII room can raise HCW awareness and assist in ensuring additional precautions. If it is not feasible to have signage then suitable markings should be made on the floor.

Room cleaning should be carried out after an AII room has been vacated by a patient. The room should be ventilated for an appropriate period as determined for HEPA filter replacement. Cleaning personnel should wear rubber gloves, a disposable gown, goggles/visor/shield and a P2 (N95) mask/respirator (DoHA, 2004). Surfaces should then be cleaned with detergent and water, and disinfected with a broad-spectrum disinfectant with proven antiviral activity (e.g. sodium hypochlorite 500 ppm, (1 in 100 dilution of household bleach) or 60-70% alcohol). All reusable equipment should be reprocessed in accordance with manufacturer's instructions.

CONCLUSIONS

AII rooms depend on their mechanical ventilation systems for effective control of airborne infection transmission. The systems' performance can be degraded over time through normal continuous use, resulting in potentially increased risk of infection transmission. Appropriate design decisions and facility management procedures coupled with appropriate training can result in a facility which can be maintained and operated safely without compromising the safety of healthcare & maintenance staff, patients and visitors.

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REFERENCES

AIA, (1996), Guidelines for design and construction of hospital and health care facilities, The American Institute of Architects, Washington D.C.

AIA, (2001), Guidelines for design and construction of hospital and health care facilities, The American Institute of Architects, Washington D.C.

Alevantis, L. E., Offermann, F. J., Loisselle, S. and Macher, J. M., (1996), "Pressure and ventilation requirements of hospital isolation rooms for tuberculosis (TB) patients: Existing guidelines in the United States and a method for measuring room leakage" in Maroni, M. (Ed.), Ventilation and Indoor air Quality in Hospitals, Kluwer Academic Publishers, Netherlands.

ASHRAE (1996), Guideline 1 -1996. Commissioning of HVAC Systems., ASHRAE Handbook HVAC Applications, American Society of Heating, Refrigerating and Air-conditioning Engineers, Atlanta GA.

ASHRAE (1999), Chapter 7. Health Care Facilities. ASHRAE Handbook HVAC Applications, American Society of Heating, Refrigerating and Air-conditioning Engineers, Atlanta GA.

ASHRAE (2003), Special Project 91. HVAC design manual for hospitals and clinics, Ed. Geshwiler, M., American Society of Heating, Refrigerating and Air-conditioning Engineers, Atlanta GA.

ASHRAE (2005), Guideline 0 -2005. The Commissioning Process, American Society of Heating, Refrigerating and Air-conditioning Engineers, Atlanta GA.

ASHRAE (2007), Proposed New Standard 170P. Ventilation of health care facilities. Third Public Review, American Society of Heating, Refrigerating and Air-conditioning Engineers, Atlanta GA.

CDC, (2003), Guidelines for environmental infection control in healthcare facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC), Centers for Disease Control and Prevention and Healthcare Infection Practices Advisory Committee, U.S. Department of Health and Human Services, Atlanta, GA.

CDC, (1994), Guidelines for preventing the transmission of Mycobacterium tuberculosis in health care facilities, MMWR 43 No. RR13. Centers for Disease Control and Prevention, Atlanta, GA.

CDC, (2005), Guidelines for preventing the transmission of Mycobacterium tuberculosis in health care settings, MMWR 54 No. RR17. Centers for Disease Control and Prevention, Atlanta, GA.

Decker, J. (1995), "Evaluation of isolation rooms in health care settings using tracer gas analysis", Applied Occupational & Environmental Hygiene, Vol. 10 No. 11, pp 887-891.

DoHA, (2004), Interim Australian infection control guidelines for Severe Acute Respiratory Syndrome (SARS). Section 2. Healthcare Facilities, Department of Health and Aging & Communicable Disease Network Australia .

DoHS, (1996), "Capital works guidelines. 6.3. Air conditioning in health care buildings", Department of Human Services, Victoria, available at: http://www.health.vic.gov.au/infcon/ic/acon.pdf

Hayden II, C. S., Fischbach, T. J., Johnston, O. E., Hughes, R.T., and Jensen, P. A., (1996), A model for calculating leakage areas into negative pressure isolation rooms, CDC, U. S. Department of Health, Cincinnati.

NHS Estates, (2005), "Ward layouts with single rooms and space for flexibility", available from: 195.92.246.148/knowledge_network/documents/Ward_layouts_20050517165909.pdf

Pavelchak, N., Depersis, R. P., London, M., Stricof, R., Oxtoby, M., Diferdinando, G. Jr., and Marshall, E., (2000), "Identification of factors that disrupt negative air pressurization of respiratory isolation rooms", Infection Control and Hospital Epidemiology, Vol. 21 No. 3, p191.

RACCDC, (2004), Isolation rooms (including mechanically ventilated rooms): Best practice standards for capital planning, Regional Advisory Committee on Communicable Disease Control, Belfast.

Rydock, J. P. (2002), "A simple method for tracer containment testing of hospital isolation rooms", Applied Occupational & Environmental Hygiene, Vol. 17 No. 7, pp 486-90.

Rydock, J. P. and Eian, P. K., (2004), "Containment testing of isolation rooms", Journal of Hospital Infection, Vol. 57 pp 228-32.

SCIC, (1999), Guidelines for the classification and design of isolation rooms in health care facilities, Standing Committee on Infection Control, Department of Human Services, Victoria, Australia. Melbourne.

Standards Australia, (2003), HB260-2003. Hospital acquired infections – engineering down the risk, Sydney.

Tang, J. W., Li, Y., Eames, I., Chan, P. K. S., and Ridgway, G. L., (2006), "Factors involved in the aerosol transmission of infection and control of ventilation in healthcare premises", Journal of Hospital Infection, Vol. 64 No. 2 pp 100-114.

Wang, S. C., Wallingford, K. M., Burr, G. A., and Lee, C. H., (2003), "Recommended guidelines for inspection of isolation wards for SARS patients", available from: www.isoh.gov.tw/eversion/sarse.htm

WHO, (2004), "Practical guidelines for infection control in health care facilities" available at: http://www.wpro.who.int/publications/pub_p290222387.htm

INFRASTRUCTURE COSTS IN HOSPITALS: A PROCESS ORIENTED ANALYSIS OF FACILITY MANAGEMENT SERVICES AS BASIS FOR STRATEGIC PLANNING

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ABSTRACT

Through the implementation of the German Diagnosis Related Grouping (DRG) system and the resulting cost pressure, the need for optimized use and operation of the spatial resources in hospitals is growing. In the DRG system, the provision of ready to use infrastructure is treated as fixed costs and is allocated to patient cases by a single cost driver. In reality, very different services are needed to provide ready to use functional space. A primary activity based cost model for Facility Management services in relation to functional space units in the hospital is developed. Using process and cost data of an empiric research study from four German hospitals, a model is developed for a key functional space unit in the hospital, the operation unit. The relevant Facility Management services structured by a product oriented approach are determined by real data. For these services, process figures are derived and implemented in a basic cost estimation model. The cost estimation model is compared to the cost approach of the DRG system. Depending on the time spectrum of operations great differences between the approaches can be determined. One way for hospitals to face the consequences may be the optimization of relevant Facility Management services. The model can be used by hospitals for strategic planning of the Facility management costs and services in relation to the capacity and utilization of the operation unit. The impact of changes of the primary performance portfolio on the utilization of corresponding infrastructure can be simulated. Thus cost data can be made available to support strategic decisions

KEYWORDS: facility management cost, hospitals, primary process relation, strategic planning.

INTRODUCTION

Through the implementation of the German Diagnosis Related Grouping (DRG) system and the resulting cost pressure, the need for optimized use and operation of the spatial resources in hospitals is growing. The link between primary processes and facility management services though is missing. Basis for this research is the investigation of interdependencies between facility management performance and costs, and primary processes in the hospital. A theoretic cost model is being developed and exemplary adapted to the functional area operation based on the data of four German hospitals. The model may be used to estimate facility management costs in relation to the capacity use of functional areas for different scenarios based on real time data. The results can be used for strategic planning in hospitals.

METHODOLOGY

In the first phase, processes in the hospital are being defined. Primary, and infrastructure processes – it is facility management processes – are differentiated and structured hierarchically. In the second phase the functional areas in the hospital are defined and structured in to units in accordance to the German DRG system for cost accounting. Based on these definitions a process oriented cost model for the hospital is developed. Basis of the research is the linkage of infrastructure process costs to primary process parameters. The cost model is tested by using empiric research data for the primary process operation and the connected infrastructure process “provision of the functional unit operation”. The empiric research is based on the cost and performance data of four German hospitals for the period 2005 or 2006.

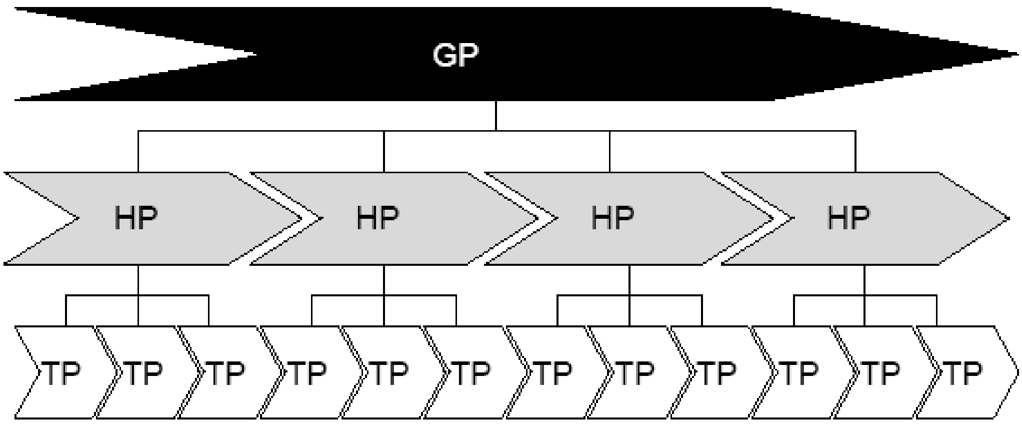
DEFINITIONS AND MODEL

In the following sections, the processes, cost and spaces in the hospital are being defined and set into relation as basis for development of a theoretic model. As the model seeks to derive strategic advice on “the implications on costs by changes of capacity use” the structure of fix and variable costs and processes is being used. (Wöhe 2002, p.1089)

Process structure

Hessel defines, in accordance with Horváth, a process „as a chain of essential activities. These activities result in a service for a (either internal or external) client.” (Hessel 2004, p.27) A client oriented process identification has been already described by the work of Gaitanides. (Gaitanides 1994, p.44) Further, Hessel suggests for hospitals a hierarchical process structure containing core processes, main processes and sub processes as can be seen in figure 1. This structure is used for the research described in this paper.

Figure 1. Hierarchic process structure with core processes (GP), main processes (HP) and sub processes (TP) (Hessel 2004, p.30)



Process identification – distinction between primary and infrastructure processes

Using a client oriented process model for an enterprise, the first question is the enterprise’s purpose. Hessel translates this approach to hospitals and defines primary processes as “such processes that directly influence a patient’s state of health (for example performance of an operation). Infrastructure processes (though) are relevant for the provision of necessary resources (i.e. personnel, materials) as well as responsible for the functionality of primary processes (for example maintenance).“ (Hessel 2004, p.33).

Following this approach, the model described in this paper is structured into primary processes and infrastructure processes. Thus, the structure is compatible to the definition of infrastructure performance by the German Institut für das Entgeltsystem im Krankenhaus (InEK), which is responsible for the DRG data and pricing system. **Error! Reference source not found.** 1 shows the primary core processes on the basis of Hessel for hospitals (Hessel 2004, p.35). In contrary to Hessel the primary core processes and infrastructure core processes are separated into two categories. Sterile goods supply for example are not a primary core process and thus not displayed in table 1 but defined on the level of main processes within the infrastructure core processes (compare table 3)

Table 1. Primary core processes (on the basis of Hessel (Hessel 2004) p.35)

Primary core processes	
Number	Name
1	Admission
2	Diagnosis
3	Operation
4	Ward round
5	Care
6	Conservative treatment
7	Dismissal

Any cost in the German DRG system is allocated to the patient only by performance figures of eleven direct cost accounts (DKG (2002) p.125). The cost accounts can be translated into functional space units. The provision of these ready to use functional space units is defined as eleven infrastructure core processes, as can be seen in table 2. Provision of ready to use functional space units includes cleaning, maintenance and all services and provision of materials that are needed to perform the primary core process. Table 3 gives an overview of all possible infrastructure main processes that may be part of any of the infrastructure core processes. The definition of these processes is part of the research project OPIK, Optimization and Analysis of Processes in Hospitals by Abel (Abel, 2005).

Table 1. Infrastructure core processes

Infrastructure core processes	
Number	Name
1	Provision of functional unit ward
2	Provision of functional unit intensive care
3	Provision of functional unit for kidney dialysis
4	Provision of functional unit operation
5	Provision of functional unit maternity room
6	Provision of functional unit anaesthesia
7	Provision of functional unit cardiology/therapy
8	Provision of functional unit for endoscopic surgery /therapy
9	Provision of functional unit radiology
10	Provision of functional unit laboratories
11	Provision of functional unit for other diagnost./ therapeutical use

Table 3. Main processes of infrastructure core processes

Main processes of infrastructure core processes			
No.	Name	No.	Name
1	Waste disposal	16	Mailing services
2	Outside facilities	17	Cleaning
3	Facilities operation	18	Braodcasting and TV services
4	Bed conditioning	19	Pest control
5	Office materials	20	Security
6	IT-services	21	Catering
7	Car pool	22	Sterile goods supply
8	Technical services	23	Electricity
9	Hygienic advice	24	Telephone services
10	Building maintenance	25	Transportation services
11	Maintenance of biomedical equipment	26	Relocation services
12	Maintenance of technical equipment	27	Heating
13	Cooling services	28	Laundry services
14	Base rent	29	Water supply
15	Copy and printing services	30	Administration/controlling/other

Interdependencies between primary and infrastructure core processes - model

Functional unit and direct cost account defined by InEK form a spatial entity. To each entity exactly one infrastructure core process is assigned. On the level of the primary core processes, none, one or several core processes may be assigned to each entity depending on the patient's treatment (clinical path). In figure 2 this scheme is displayed. The patient's way through the hospital follows a certain path, symbolized by the black line. Along this path the patient is using the specific functions of the different entities. In relation to the function of each entity infrastructure services are used to a certain amount, symbolized by the grey circles. On the level of space, primary and infrastructure processes are linked through the functional units. The focus is set on the patient and his presence in the functional unit. Any performance is related to his person. This relation can be described in the following formula:

$$\sum CostCP = \sum_{k=1}^{7} CostCPP_k + \sum_{j=1}^{11} CostCPI_j$$

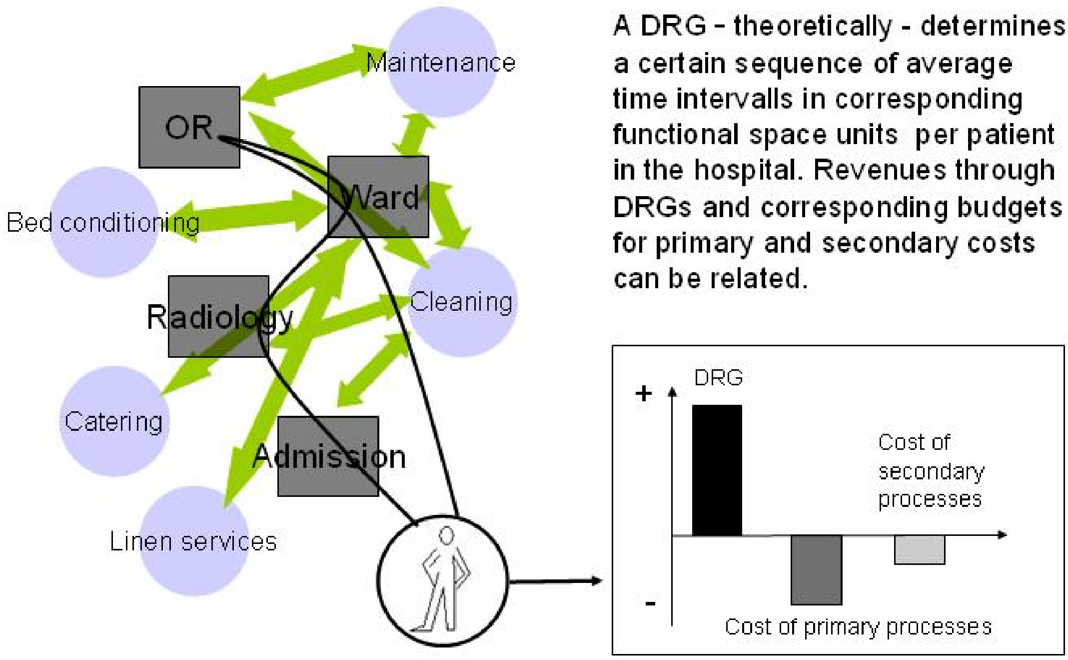
with CP = Core process
CPPk = Primary core process k є K; K = {1,2,…,7}
CPIj = Infrastructure core process j є J; J = {1,2,…,11}

Any primary core process a patient is obtaining can be structured on the level of main processes. The analysis of the primary main processes leads to primary process parameters P_k. To each primary core process a process parameter P_k with a value of $P_{k'}$ can be related. All pathways of a hospital's patients as a whole result in a primary process profile P. P can be specified mathematically as a map of the primary processes CPPs' sum:

$$\sum_{k=1}^{7} CPP_k \rightarrow P$$

with CPPk = Primary core process k ϵ K; K = {1,2,…,7}
P = profile of primary process parameters

Figure 2. Patient's path through the hospital



The model's quintessence is the description of the relation of all infrastructure core processes to a primary process profile P. Thus a value P' must be assigned to each relevant main infrastructure process. The following chapter shows the development of the model for the infrastructure core process „provision of functional unit operation" on the empiric data basis of four German hospitals.

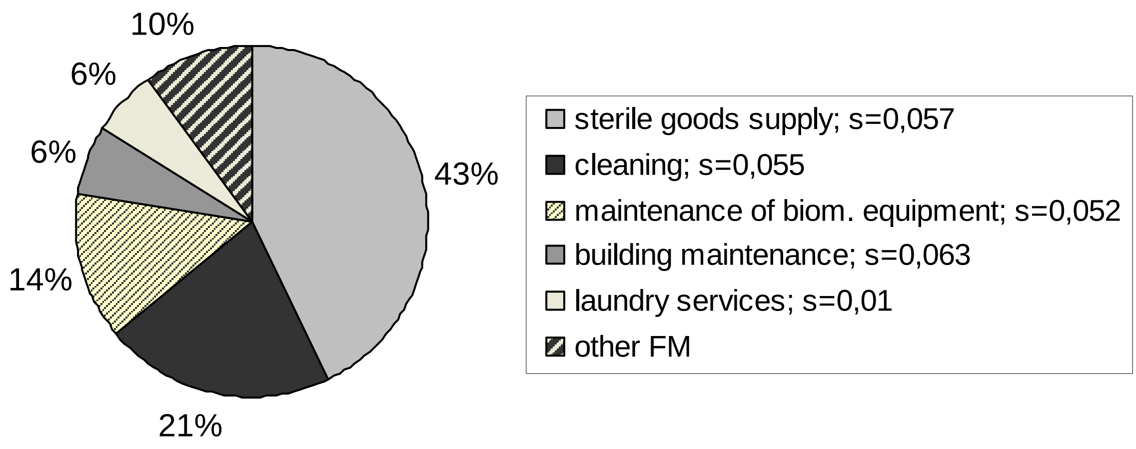
DEVELOPMENT OF THE MODEL FOR THE INFRASTRUCTURE CORE PROCESS PROVISION OF FUNCTIONAL UNIT OPERATION

Figure 3 shows the average cost shares of the relevant infrastructure processes for the operation units for a sample of four German hospitals and the standard deviations s.

43% of the cost is being related to the product "sterile goods supply". This process is dominant for the operation unit. 21% of the costs are related to "cleaning", followed up by "maintenance of medical equipment" with 14%, "building maintenance" with 6%, as well as "laundry services" with a cost share of 6%. The standard deviation for building maintenance is with 0,06 very high. These 5 products have in total a cost share of 90% of the total FM cost of the operation unit excluding base rent.

10% of the cost are related to other products which is "power supply", "cooling services", "heating supply", "water supply", "technical maintenance", "IT services", "technical services", "security", and with a minimum share "waste disposal", "outside facilities" and "office supplies".

Figure 3. Average facility management cost share for the functional unit operation of four hospitals



Power supply, cooling services, heating and water supply together have a share of 3% of the total cost. It has to be considered that in none of the hospitals the consumption is being documented by separate meters. The consumptions of heating energy and water are being allocated by space, combined with an allocation key based on number of persons, for the latter. Allocation base for power supply and cooling services is also space. For air-conditioned areas – as is the operation unit - an additional charge according to the engine performance during operation and stand by times is being made. The documentation of the actual consumption by meters would be preferable. Facing the small impact of these costs to the total cost in the operation unit, the influence of accurate consumption figures can be estimated as minor to the results of this research.

Analysis of fix and variable costs

The relevant FM products can be separated into fix and variable costs. The products “sterile goods supply”, “cleaning” and “laundry services” are direct costs and have a variable cost share of 72%. When changing operation time of the operation unit from one shift to two shifts per day and assuming to have similar workload, it may be assumed that these costs will double in a linear manner. The cost for “maintenance of medical equipment” would remain the same, because the maintenance cycles are set independent to the actual utilization times. Therefore the cost is defined as being indirect.

For the variable costs it is important to find the cost driver. If the cost of the product occurs once per operation with a fix amount, the number of operations is cost driver. If the cost is dependent from the length of the operation, the amount of operation time is cost driver.

Cost drivers

Allocation base and therefore abstract cost driver for the cost of the medical and non medical infrastructure in the operation unit is according to the standard by the German Institut für das Entgeltsystem im Krankenhaus (InEK) the time between first incision of the skin and last suture plus the setup time for each operation (DKG 2002, appendices S.20). This approach is simplifying in assuming that all infrastructure cost are in linear dependency to the length of the operation. Time is the only cost driver. For a transparent analysis of costs and for the purpose of benchmarking and optimization of FM products the relation between cost and cost driver has to be examined more into depth.

Does an operation of double the length really mean a doubled effort for sterilization and packing of the surgical kits? Cost driver for sterile goods supply is rather the number and the content of surgical kits, i.e. the kind of operation, than the procedure time. A problem is when large surgical kits are being opened just for the use of one or two pieces. The unused content has to be sterilized and repacked nevertheless. To avoid this senseless effort there has to be a good communication between surgeons, medical personal and the sterilisation department. For standardized operations standardized surgical kits should be not only available but also in use and the documentation should be made available for facility management purposes. In a simplifying approach the cost driver for sterile goods supply is set as number of operations.

Cleaning of the operation theatre is happening after the operation of the patient during the post processing phase. For most of the operations the effort of cleaning is the same, not depending on the operation time. On the other hand the availability of the cleaning personal is cost driver. Operational data of the four hospitals show that the personal is related to the operation theatres and possibly just waiting during operation procedure time. Thus time is cost driver.

The indirect cost for maintenance of medical equipment would fall down to half of the original cost per minute in case of a two shift capacity utilization of the operation unit instead of one. Similar to basic rent this cost is fixed. “In relation to the usage of the main processes” (Wöhe 2002, p.1159) – which is in this case the operation procedure time – these costs can be allocated to the patient.

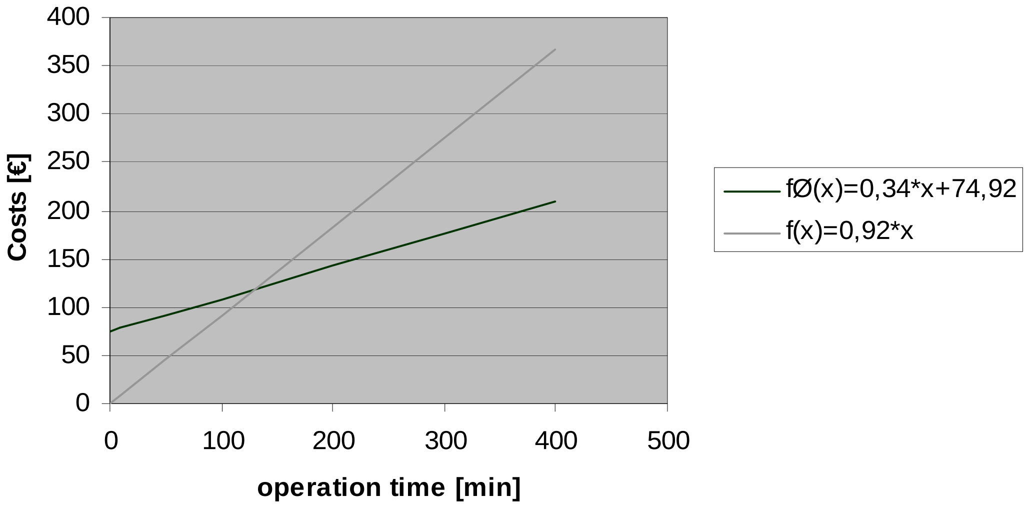
Building maintenance is dependant on the quality and the workmanship of the construction elements, as well as on the intensity of utilization (Naber 2002, p.157). The analysis of the construction elements of the operation units of the hospitals would exceed the framework of this research. Assuming that similar materials and qualities have been used in all four hospitals, and that the impact of utilization during operation time on abrasion is the same, the cost for building maintenance are deemed to be in linear dependency to the utilization time.

Laundry services in the operation unit – non sterile operation theatre linen - are direct cost. Surgeons, anesthetists, and supporting personal are changing into dresses, when (re-)entering the operation unit. In theory the daily scheduled operations could be performed in a row without major breaks. If there are breaks where personal is leaving the operation unit, or if personal is changing, additional need for theatre linen arises. In a simplifying approach the amount and therefore the cost of theatre linen is assumed to be fix cost arising once per operation. Cost driver for the product linen services is the number of operations.

7. Linkage to the primary process

According to the data of the primary performance of the hospitals for the reference year cost drivers for the relevant products have been assigned and a price per unit has been calculated. The definition of the length of the operation follows the standard by InEK, being the time between first incision of the skin and last suture and setup time. Setup time includes the pre- and post processing time of the patient in the operation unit (DKG 2002, p.135). This time interval is defined as “overall operation time“. Figure 4 shows the resulting cost functions. The approach by InEK results in a function that intersects the origin. But the approach of this paper assigns a fixed cost share of about 75,- Euro (middle value of sample, standard deviation: 17,5) to any operation. The slope of this function is less steep than the former. The functions intersect at an operation time of about 130 minutes.

Figure 4. Cost functions in relation to operation time (based on average figure of four hospitals)



CONCLUSIONS

According to the overall operation time, the two approaches assign different costs to a patient. The InEK approach is the German standard determining the hospital's proceeds. Facing real costs and dependencies, hospitals in Germany need to take into account what time wise is their spectrum of operations and the related cost risk. Taking the results of this paper into account, the optimization of certain facility management services becomes for the functional units operation of hospitals with average operation times under 130 minutes especially important.

The linkage of Facility Management processes and the primary process for the functional areas in the hospital is an important step towards strategic planning. The model described in this paper may be used as a starting point. Further research should include the other functional areas in the hospital. Also, the database of four German hospitals should be enlarged and documentation of costs, especially for cost dominant services as sterile goods supply should be improved.

REFERENCES

Wöhe, G. and Döring, U. (2002), Einführung in die Allgemeine Betriebswirtschaftslehre, 21., neubearbeitete Auflage, Verlag Franz Vahlen, München, 2002

Kristof, R. (2004), Ein hierarchisches Verfahren zur Terminplanung elektiver Operationen und Mehrressourcenbelegung in zentralen Operationsbereichen, IPA-IAO Forschung und Praxis, Band Nr. 395; Engelbert Westkämper, Hans-Jörg Bullinger (Hrsg.), Jost Jetter Verlag, Heimsheim

Hessel, M.(2004), Standardprozessmodell für Klinische Pfade in „Pfade durch das Klinische Prozessmanagement“, Methodik und aktuelle Diskussionen, Herausgeber: Michael Greiling, Verlag W. Kohlhammer, Stuttgart, S.27-41

Gaitanides, M., Scholz, R., Vrohlings, A., Raster, M.(1994), Prozessmanagement, Konzepte, Umsetzungen und Erfahrungen des Reeingineering, Hanser Verlag, München, 1994

DKG (2002), Kalkulation von Fallkosten, Handbuch zur Anwendung in Krankenhäusern, Version 2.0, 31.Januar 2002; Deutsche Krankenhausgesellschaft (DKG), Spitzenverbände der Krankenkassen (GKV), Verband der privaten Krankenversicherung (PKV)

Naber, S. (2002), Planung unter Berücksichtigung der Baunutzungskosten als Aufgabe des Architekten im Feld des Facility Management, Peter Lang GmbH, Europäischer Verlag der Wissenschaften, Frankfurt am Main, 2002

Abel, J., Lennerts, K. (2005), OPIK-Richtlinie, Facility Management, Kunden-Lieferanten-Verhältnis im Gesundheitswesen, Institut für Technologie und Management im Baubetrieb, Facility Management, Universität Karlsruhe, 2005

IMPLICATIONS OF THE ARCHITECTURE OF SERVICE PROVISION FOR HEALTHCARE FM: THE CASE OF ISRAEL

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ABSTRACT

Contemporary trends in healthcare service provision tend toward increased provision of healthcare services through community based healthcare centers. This concept of healthcare provision hypothesizes that the main source of healthcare services will be a network of community based clinics, where most primary and ordinary care will be delivered. It also implies that a network of community clinics equipped with state of the art means for telemedicine will be established with a wide geographical dispersion. This paper delineates the architecture of healthcare service provision in Israel, and examines its implications. The implications of healthcare facilities on the resources and performance of the built environment are comparatively investigated through the Israeli healthcare system, in clinics and hospitals. This paper also reflects the outcomes of research on healthcare facilities management over the past 7 years. Comparison of the performance and maintenance of hospital facilities with community clinics reveals that the economics and performance of clinic facilities reflect high potential for both improved healthcare performance of built facilities and lean facilities management.

KEYWORDS: Clinics, Hospitals, Maintenance, Performance.

INTRODUCTION

Countries all over the world are witnessing similar trends in healthcare services provision. Triggered by natural population growth and the ageing of the population, an increase in the demand for healthcare in public hospitals has been observed (Hosking and Jarvis, 2003). In order to cope effectively with the proliferation of in-patient admissions, which has consequently increased, and as a result of their limited resources, hospitals have tended to reduce patients' average length of stay (Federal Statistical Office Germany, 2003; Hensher and Edwards, 1999; AHA, 2006). These changes have led to a demand for investigating the structure of healthcare systems and Facility Management (FM) decision-making processes in the industry, e.g., Melin and Granath (2004), and Rees (1997, 1998).

When examining facility management in the healthcare sector, an underinvestment in the allocation of resources is noted. This might adversely affect non-core activities of healthcare providers, primarily facility management aspects, such as maintenance activities and operations. The American Hospital Association, in its Annual Report, states that "Hospitals have been under financial pressure in the last five years, both from public and private payers. Since 1999, up to one third of hospitals have had negative total margins" (AHA, 2006). A similar state of affairs is presented in the 2003 Annual Report of the British Ministry of Finance, which states that: "Over the past 30 years the UK has consistently invested a smaller share of its national income in healthcare than comparator countries. Historical underinvestment has resulted in poorer health outcomes than the EU average" (British Ministry of Finance, 2003). The 2004 health expenditure per capita in Israel was $1,534, where the total health expenditure as a percentage of GDP (Gross Domestic Product) was 8.6%. For comparison, the average health expenditures of the European Monetary Union countries and of the United States were 10.3% and 15.3%, respectively, of their GDP (World Bank, 2007). Obviously, there is a commitment on the part of Israeli policy-makers to provide quality healthcare to their people as realized by the high and increasing life expectancy due to the success in prevention of infectious and communicable diseases among older people (Brodsky, 2003). Studying that system's efficiency may offer insight into best facility management practices, leading to preferred health outcomes.

In response to a steady demand to provide healthcare in distant peripheral regions, the Israeli healthcare system developed a network of clinics organized in a vertical hierarchical scheme. This network is composed of three levels of clinics: community, regional and hospital-based. Community clinics are located in any town or village, and are approximately 500-2,500 sq-m in size (mean size of 1,200 sq-m). In the entire country, there exist 800 community clinics that provide primary care to an average of 8,000 insurees per clinic. Forty regional clinics support the community clinics, providing secondary care such as MRI, X-Ray, medical consultancy and regional laboratories that supply diagnostics services to both the community and the regional clinics. This network acts as a screening net that provides primary care to all participants in the Israeli system, prior to admission into a peripheral or regional hospital. Hospitals are classified into three categories of infrastructure and medical care: peripheral hospitals (less than 400 patient beds), regional hospitals (401-800 patient beds) and strategic hospitals that provide unique specified care and are equipped with built and human medical infrastructure (801-1,500 patient beds).

As one can tell from the service structure mentioned above, healthcare services provided through the community-based healthcare sector have expanded. Acute-care hospitals have witnessed an increased number of in-patient admissions, but at the same time, a decrease in the average length of stay. One possibility for sealing this gap is to develop a hierarchical network of community clinics aiming to provide most of the primary and part of the secondary care.

The present study investigates the FM characteristics of built facilities for healthcare: Key Performance Indicators (KPI's) are defined for hospital and clinic facilities; the KPI's are analyzed from samples of 12 acute-care hospitals and 42 community clinics. The paper discusses the implications of the performance, maintenance and benefit-to-cost ratio between investments in the development of built facilities for healthcare and the performance provided.

KEY PERFORMANCE INDICATORS

The research employed Key Performance Indicators for monitoring the performance and maintenance of healthcare facilities as follows:

1. Age coefficient (AC_y) – The age coefficient is defined as a coefficient for the adjustment of maintenance needs to actual service life of the facility. Simulation of this coefficient for a clinic facility with a Designed Life Cycle (DLC) of 50 years produced the age coefficient values for every year along the clinic's designed life cycle, where the average maintenance expenditure was found to be equal to 2.5% of the reinstatement value. Similar simulations were conducted for hospital facilities, with a DLC of 75 years, and they showed an average maintenance expenditure of 3.03% of the reinstatement value.
2. Clinics' patient Density Coefficient (DC) – The Density Coefficient quantifies the effect of density of patients in the clinic on the deterioration pattern of building components.

Standard density is defined as 175 patients-visits per sq-m per annum and is referenced as a normative 100% density of patients. The research hypothesis is that density conditions affect the deterioration pattern of building components and systems. The coefficient was developed through analysis of the life cycle of building components under intensive and under moderate service conditions. For hospital buildings, standard density was defined as 10 patient-beds per 1,000 sq-m of built floor area.

3. Building Performance Indicator (BPI) – This parameter enables the evaluation of the overall state of a building or of the facility portfolio, according to the performance of its components and systems. The indicator expresses the physical state, including the performance of its various systems. This is graded according to performance scales ranging from 0 to 100, where rating of 70 or less necessitates corrective maintenance measures. Values lower than 60 points indicate poor/dangerous performance conditions. The actual score for each system is composed of three components of facility maintenance: (1) actual condition of the system; (2) failures affecting the service provided by the system; and (3) actual preventive activities carried out on the system to maintain an acceptable service level (Israel Standards Institution, 2002). Preventive maintenance is evaluated on the basis of maintenance policy governing the component, and the frequency of pro-active inspections and periodical maintenance carried out with respect to standards for the particular facility. The combination of these three elements produces the performance score for the entire system. Weighting of each building system in the BPI is accomplished by weighting the contributions of the system's components to the life cycle costs. This parameter enables us: (1) to evaluate the overall state of a building; (2) to evaluate the state of the building's systems; (3) to benchmark the asset's performance in relation to other facilities (inter-organizational benchmarking); and (4) to benchmark the building's systems in order to compare the efficiency of the various maintenance crews (intra-organizational benchmarking).
4. Annual Maintenance Expenditure (AME) – This parameter monitors expenditure per sq-m built area (excluding cleaning, energy, and security expenditures), and determines the annual expenditure on maintenance of a building. It also provides an organizational measure of the overall expenditure on built assets in relation to the organization's turnover. From an analytical viewpoint, expenses must be analyzed in relation to the building's characteristics and with respect to the output (its physical performance). This examination is carried out in the framework of the Maintenance Efficiency Indicator (MEI), as described below. The Annual Maintenance Expenditure may be neutralized from the effects of service life and service conditions through using the Normalized Annual Maintenance Expenditure (NAME). NAME expresses the annual maintenance expenditure, neutralized for the effects of age, occupancy, and environment. This KPI provides a clear and transparent perspective of the Annual Maintenance Expenditure.
5. Maintenance Efficiency Indicator (MEI) – This indicator examines the investment in maintenance in relation to the building's performance. The latter is in fact the service provided to the healthcare organization by the FM department. This parameter expresses the expenditure on maintenance per building performance unit, normalized using the Age Coefficient (AC_y) and Density Coefficient (DC). For a clinic maintained at the desired level, we assume a BPI of 100. The average Annual Maintenance Expenditure (AME) per sq-m was analyzed to be 2.50% of the reinstatement value of a clinic facility ($1,180 per sq-m built). A facility with an Age Coefficient of 1.00 (the standard), and a Density Coefficient of 1.00 would yield an MEI value of 0.30. The upper and lower bounds of the desirable range were deduced from the Standard Deviation of the MEI for the clinic sample population. The MEI values are thus interpreted according to the following categories: (1) MEI lower than 0.20 indicates high efficiency with which the resources are

utilized, or scarcity of resources for maintenance, or both; (2) MEI between 0.20 and 0.40 reflects a normative range of maintenance efficiency, in which the lower bound indicates good efficiency while the upper bound indicates low efficiency and/or slack of resources; and (3) MEI higher than 0.40 indicates a high level of resources relative to the actual performance – such levels may express high maintenance expenditures, low physical performance, or a combination of these two extreme situations.

In a similar manner, three ranges for MEI were established for hospital facilities in Israel: (1) lower than 0.37 expresses high maintenance resource utilization efficiency, and/or lack of resources; (2) between 0.37 and 0.52 indicates normative use of maintenance resources; and (3) higher than 0.52 indicates high inputs in comparison with the actual performance, and/or surplus of resources.

6. Maintenance Sources Diagram (MSD) – The mixture between in-house and outsourcing is expressed by this parameter, as outsourcing constitutes an alternative to the implementation of maintenance activities by in-house employees who require ongoing management. Outsourcing can serve as a source for the execution of seasonal preventive maintenance work, as well as rehabilitation, renovation and replacement work. This parameter may be used in the planning of corrective policy.
7. Managerial Span of Control (MSC) – Geographical dispersion and the size of clinic facilities imply that the management of the facilities is conducted in a hierarchical manner as follows: several small facilities (e.g. clinics) located in a close regional area are managed by a regional facility manager. The number of facilities subordinated to the supervision of a regional FM is defined as the Managerial Span of Control (MSC). At small spans of MSC (MSC<6), the managerial overhead costs per clinic rise as some of the managerial resources may be redundant. On the contrary larger spans of MSC (i.e. MSC>8) reduce the costs of managerial overhead, though the effectiveness of supervision may be diminished. In regions with wide geographical dispersion, the effective MSC may be reduced due to effort and time required for control of distant sites.

PROFILE OF HEALTHCARE FACILITIES

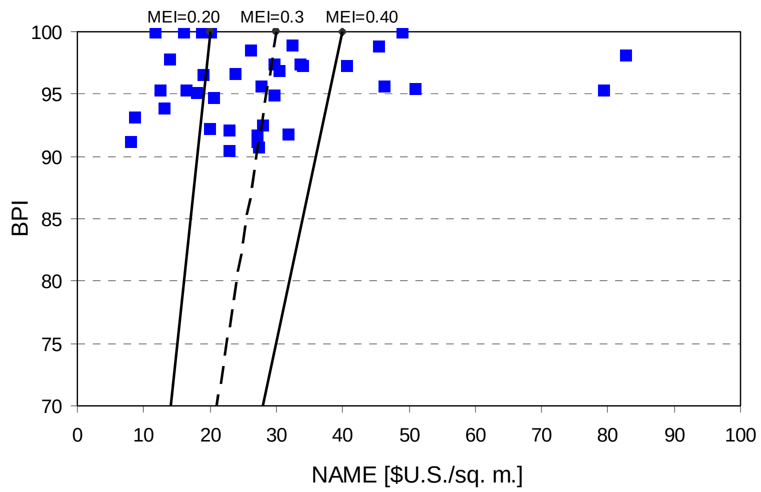
Clinics

The sample of clinics encompasses 42 data-points. The mean floor area of the clinics is 1,154 sq-m with an average age of 7.9 years. The respective mean Age Coefficient for the population is 0.88. The annual number of visitors per sq-m, representing the density of the clinics, is 263.8, where an annual number of 175 is defined as standard density. In light of the latter finding, we can deduce that the clinic facilities sample represents a facilities population under intensive service conditions. The mean Annual Maintenance Expenditure for the maintenance of the clinic sample population is $26.9 per sq-m constituting an annual expenditure of 2.27% of the re-instatement value of the clinics. In light of the young age of the clinic sample, this level of expenditure is high and may be explained by the intensive service condition of the clinic facilities as discussed above. The Maintenance Sources Diagram (MSD) expresses the mixture of outsourcing as opposed to in-house maintenance service provision. The MSD shows that 60% of the services are contracted out. This delegation of resources is rationalized by the intensive service conditions that require high availability of maintenance crews for urgent services that are supplied by in-house maintenance crews. Managerial Span of Control of the clinics' regional facility manager is 7.2 compared with a standard value of 6. This span is explained by the relatively small sizes of the facilities. The Building Performance Indicator's mean value is 95.5 points, with a standard deviation of 1.9 points. This high parameter indicates high performance of the clinic facilities sample. The Maintenance

Efficiency Indicator (MEI), which expresses the efficiency with which the maintenance resources are utilized, was found to be 0.30, with a variance of 0.16. This level falls within the predicted analytical value (0.30), and the variance in this parameter expresses significant variability in this efficiency. This level of efficiency was accomplished following a two year corrective and preventive maintenance policy.

Figure 1 depicts the distribution of the clinic facilities sample in a two dimensional setup where the independent variable is the Normalized Annual Maintenance Expenditure (NAME) and the dependent variable is BPI. The three lines represent equivalent levels of efficiency where 0.30 is the normative, and the other two express the margins of the normative range of efficiency: 0.40 represents marginally high expenditure and 0.20 is the lower margin of costs. The distribution shows that 2/3 of the sample population falls between the upper and lower limits of the standard region. The distribution validates the predicted values deduced from the analytical development of this parameter. Facilities that are found close to the left margin (MEI=0.20) exemplify high efficiency with which the maintenance resources are used, where facilities found close to or beyond the right margin (MEI=0.40) require further analysis to uncover the sources of inefficiency and to set up the outlines for an improvement program.

Figure 1. Building Performance Indicator (BPI) as against Normalized Annual Maintenance Expenditure (NAME) of the clinic sample



Hospitals

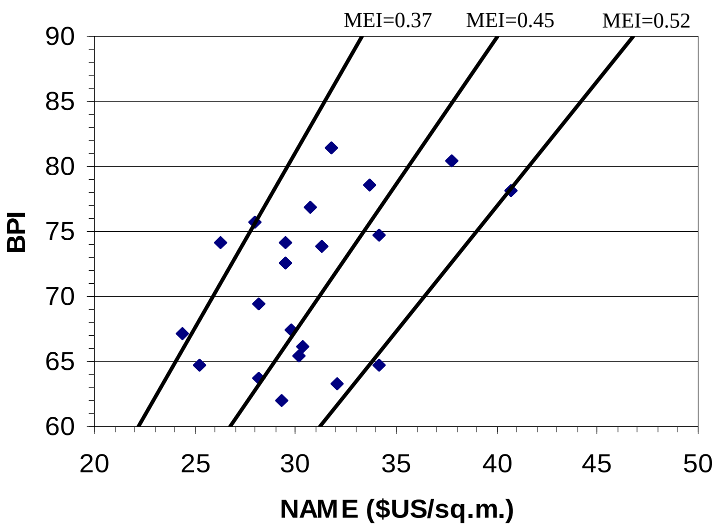
The Israeli healthcare sector encompasses a total number of 41,140 patient beds (CBS, 2004); 70% of the total patient beds in Israel are publicly owned, whereas only 30% are private. In the acute-care sector, the share of publicly-owned beds is even higher and accounts for more than 96% of the total patient beds. Based on a survey of 12 large acute-care facilities, which total a floor area of more than 1,000,000 sq-m, it was found that the average size of a hospital is 76,410 sq-m of floor area per campus, distributed among almost 50 buildings. In addition, these facilities were found to offer healthcare services through more than 8,000 patient beds, which means an average of about 670 patient beds per facility; and an average of 8.9 patient beds per 1,000 sq-m of floor area (Shohet and Lavy, 2004).

The capital reinstatement value of a hospital in Israel is $1,800-3,300 per sq-m, and the annual maintenance expenditure required to maintain a hospital facility is $35-54 per sq-m depending on the level of performance provided (Shohet et al. 2003). Roughly 60% of the resources for maintenance are labor, therefore the maintenance departments in hospitals are labor-intensive. Furthermore, these facilities are heavily sensitive to failures in critical systems such as medical gases, power supply, and fire suppression.

The mean performance score was found to be 76.6 points, with a standard deviation of 5.9 points. The average BPI means that the level of performance of acute-care hospital facilities is Satisfactory; nevertheless, four facilities were found to be performing at a Good level of performance (80 points or more).

Concerning maintenance staff, it was found that there are 47.6 maintenance employees, on average, per hospital, excluding gardening, cleaning, kitchen, security, and energy-related employees. On average, there were found to be 0.63 employees per 1,000 sq-m of floor area, with a standard deviation of 0.18. The average Annual Maintenance Expenditure (AME) in hospital buildings was $37.2 per sq-m (in 1999 values), with a standard deviation of $5.3 per sq-m. These funds were distributed as follows: 51.6%, on average, were spent on in-house maintenance labor, 36.7% on outsourcing contractors and service contracts, and 11.7% on materials and supplies. This distribution emphasizes that hospital facilities depend to a significant extent on in-house labor, with its main advantages of familiarity with local conditions, and availability and accountability at the job site. On the other hand, it is more than reasonable to assume that some of these expenses could have been saved if a larger portion of the work had been given to external service providers. However, availability and accountability of the labor force are two major concerns that facility managers, particularly in large strategic infrastructures such as hospital buildings, must take into consideration, and it may explain their preferences in depending on in-house labor. As a result, the average Maintenance Efficiency Indicator (MEI) in hospitals was found to be 0.43, which represents a normative use of maintenance resources since it is in the normative range between 0.37 and 0.52. A distribution of the observed MEI values may be found in Figure 2, as represented on a NAME vs. BPI graph.

Figure 2. Building Performance Indicator (BPI) vs. Normalized Annual Maintenance Expenditure (NAME) in hospital buildings



The Managerial Span of Control (MSC) is another Key Performance Indicator to indicate the effectiveness of the organizational structure of the FM department. It was observed that the principal engineer managed, on average, 3.5 direct subordinates. Second level managers, mainly engineers or experts in the different maintenance disciplines (e.g., electrical, mechanical, HVAC, etc.), supervised, on average, 7.1 subordinates. Based on the literature, these numbers seem to be appropriate, allowing the principal engineer to dedicate an appropriate amount of time to planning issues, while the second level managers are usually kept busy with the operation of the facility, mainly with daily problem solving (Laufer and Shohet, 1991).

DISCUSSION

A comparison of hospital facilities with clinics reveals considerable differences between the facilities in terms of FM parameters: while hospital facilities necessitate the allocation of double resources for maintenance, accomplishing high performance for hospital built-facilities is highly resource demanding. The BPI for clinics (95.5) indicates high performance, compared with mediocre conditions in hospitals (76.6). Furthermore, examining the built-floor area per insuree explores that the floor area in clinic facilities (0.15 sq-m) falls far below the respective floor area for acute-care hospitals (0.30 sq-m); thus, the actual expenditure per patient in a hospital facility is four times higher than in clinic facilities.

Community clinics are much more accessible than peripheral or regional hospitals in terms of geographical dispersion. Close care is accomplished, at a facility costs per patient approximately 75% lower than in regional hospitals. Furthermore, from a life cycle perspective, the maintenance of hospital facilities implies two critical life-supporting systems (electricity and medical gas), and two more electro-mechanical systems that support healthcare and hygiene (communication and low voltage, and water supply and sanitary system); in clinic facilities, for comparison, only two systems are critical for the performance of the facility: electricity and low voltage, and communication.

The above comparative view of Key Performance Indicators reveals that delivery of primary and ordinary healthcare through clinics entails multiple advantages from the FM point of view:

(1) capital cost invested per insuree is considerably shorter;

(2) the provision of high performance facilities for medical staff and for patients is realized with considerably fewer maintenance resources.

(3) accessibility of healthcare for high-demand populations is considerably high;

(4) susceptibility of the built facilities to extreme events such as accidents or major mechanical failures is significantly low.

The employment of clinic facilities, instead of peripheral and regional hospital facilities, for primary care offers the potential for flexible infrastructure for close healthcare that can be maintained with a lower capital investment and life cycle costs. This comparison suggests that the core of the future hospital should be reduced to the core of hospitalization care; whereas the primary and secondary care will be delivered through a network of less complex and more flexible clinic facilities geographically dispersed around the core hospital.

REFERENCES

American Hospital Association (AHA) (2006), “Trend Watch Chartbook 2004: Trends affecting hospitals and health systems – September 2004”, available at: http://www.hospitalconnect.com/ahapolicyforum/trendwatch/chartbook2006.html.

British Ministry of Finance (2003), “Budget 2003: Report – Chapter 6: Delivering high quality public services”, available at: http://www.hm-treasury.gov.uk/budget/bud_bud03/budget_report/bud_bud03_repchap6.cfm.

Brodsky, J. (2003), “The challenges of a success: The ageing of Israeli society”, Israel Medical association Journal, 5(5), 375-378.

Central Bureau of Statistics in Israel (CBS) (2003), “Beds in hospitals, by ownership and type of bed”, available at: http://www1.cbs.gov.il/shnaton55/st06_06.pdf.

Federal Statistical Office Germany (2003), “Facilities, beds and patient turnout: Hospitals, 1991-2003”, available at: http://www.destatis.de/basis/e/gesu/gesutab29.htm.

Hensher M. and Edwards N. (1999), “The hospital of the future: hospital provision, activity, and productivity in England since 1980”, British Medical Journal, 319(7214), 911-914.

Hosking, J. E. and Jarvis, R. J. (2003), “Developing a replacement facility strategy: Lessons from the healthcare sector”, Journal of Facilities Management, 2(3), 214-228.

Israel Standards Institute (2002), IS-1525 (part 2) "Building maintenance management: elements and finish", Tel-Aviv, Israel.

Laufer, A. and Shohet, I. M. (1991), “Span of control of the construction foreman: a situational analysis”, Journal of Construction Engineering and Management, 117(1), 90-105.

Melin, A. and Granath, J. A. (2004), “Patient focused healthcare: an important concept for provision and management of space and services to the healthcare sector”, Facilities, 22(11/12), 284-289.

Rees, D. (1997), “The current state of facilities management in the UK National Health Service: an overview of management structures”, Facilities, 15(3/4), 62-65.

Rees, D. (1998), “Management structures of facilities management in the National Health Service in England: a review of trends 1995-1997”, Facilities, 16(9/10), 254-261.

Shohet, I. M., Lavy-Leibovich, S., and Bar-On, D. (2003), “Integrated Maintenance Management of Hospital Buildings”, Construction Management of Economics, 21(2), 219-228.

Shohet, I. M. and Lavy, S. (2004), “Healthcare facilities management – state of the art review”, Facilities, 22(7/8), 210-220.

World Bank (2007), “World Bank series”, available at: http://devdata.worldbank.org/query.

CLINIC FACILITY MAINTENANCE USING LIFE CYCLE COSTS PRINCIPLES

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ABSTRACT

Longer life expectancy, as well as a continuous increase in in- and out-patient admissions in acute care hospitals drove healthcare institutions in developed countries including Israel to minimize the duration of medical services provided by acute care facilities. This trend raised the need to provide primary and secondary healthcare in community health centers. The objective of the research was to develop Key Performance Indicators for clinic facilities performance and maintenance management. The research method included a LCC analysis of clinics and the development of Key Performance Indicators for clinics as the method's basic tools. This was followed by a comprehensive field survey to implement and validate the method. The field survey encompassed 89 clinics and comprised two phases: Phase I - Benchmarking of clinics' performance and maintenance, analysis and diagnosis of performance and maintenance as a basis for remedial policy; Phase II – implementation of the remedial maintenance policy, monitoring of performance and maintenance, and validation of the effectiveness of the KPIs. The research findings depict a 30% improvement in clinic maintenance efficiency between Phase I and Phase II. This uplift was accomplished along with an improvement in the performance of the clinics' built facilities.

Keywords: Clinics, Healthcare, Maintenance, Performance.

INTRODUCTION

In response to a steady demand to provide healthcare in more remote regions, the Israeli healthcare system developed a network of clinics organized in a vertical hierarchical scheme. This network is composed of three levels beginning with community clinics in every city, town, or village, which range in size from 500 sq.m. to 2,500 sq.m. (with a mean floor area of 1,200 sq.m.). Eight hundred community clinics operate throughout the entire country, each providing primary care to an average of 8,000 insurees. The community clinics are supported by a network of 40 regional clinics that provide secondary care services such as MRI, X-ray and medical consultancy, together with regional laboratories that supply diagnostic services to both community and regional clinics. This network acts as a screening mechanism that provides primary care to insurees of the Israeli healthcare system prior to their admission into peripheral or regional hospitals.

Healthcare Facilities Management encompasses five core domains (Akintoye, 2005; Gallagher, 1998; Gelnay, 2002; Payne and Rees, 1999; Shohet and Lavy, 2004): Maintenance management, Performance management, Development, Supply Services Management, and Risk Management. The five core domains are integrated in to an Enterprise Resources

Planning (ERP) system through an IT integrating module. Integration of the core domains through an IT module implies that analytical quantitative methods be developed for facilities management. Quantitative methods for healthcare facilities management were developed for hospital facilities: e.g. Shohet (2006) developed a strategic integrated performance and maintenance management tool of KPIs for hospital facilities, this model is composed of four modules: (a) Maintenance; (b) performance; (c) development; and (d) organizational management. Macsporran and Tucker (1996) developed Operating Budget Levels for facility operation to monitor various levels of activity (for instance, Energy Costs in $/sq. m.). Operating Budget Levels should have the following attributes:

- Easily produced from available data;
- Non-dependant on year of calculation;
- Non-dependant on building's size, location, quality, etc.;
- Obtained by practical sense.

RESEARCH OBJECTIVES

The objective of the research was to develop a quantitative analytical model for practical performance and maintenance management of clinic facilities based on Life Cycle Costs guidelines. This objective was divided into the following three goals: (a) to develop integrated and practical analytical model for clinics maintenance and performance management; (b) to implement the KPIs in a comprehensive field survey; (c) to validate the analytical model through a remedial phase that will be based on conclusion drawn on the basis of the KPIs.

RESEARCH HYPOTHESES

The hypotheses of the research were defined as follows: (a) Using Key Performance Indicators (KPIs) based on performance and Life Cycle Costs (LCC) principles, the maintenance and performance of clinics can be systematically monitored with a high degree of accuracy and reliability; (b) Implementation, by clinics, of the above-mentioned principles can contribute to effective and efficient maintenance and to improved performance.

METHOD OF RESEARCH

The research method used LCC analysis, and development of KPIs for clinics as the basic tools for performance and maintenance management. This was followed by a comprehensive field survey to examine the method's implementation and validate it. The field survey encompassed 89 clinics in a two-phase survey: Phase I - benchmarking of clinics performance and maintenance, analysis of findings, and setting of remedial maintenance policy. Phase II - monitoring of performance and maintenance of clinics following remedial policy implemented at the end of Phase I and validation of the effectiveness of the method. A Decision Support System (DSS) was developed so as to enable implementation of the method in sick fund clinics in Israel.

KEY PERFORMANCE INDICATORS

The principal KPIs developed in this research include: Annual Maintenance Expenditure (AME), Normalized Annual Maintenance Expenditure (NAME), Building Performance Indicator (BPI) (adapted for clinics), Density Coefficient (DC), Age Coefficient (AC_y), Maintenance Efficiency Indicator (MEI), Managerial Span of Control (MSC), and Maintenance Sources Diagram (MSD).The following paragraphs describe the basic hypotheses and theory behind the core parameters that lay the ground for the analytical KPIs that follow.

Age Coefficient

The age coefficient is defined as a coefficient used to adjust the facility's maintenance needs to its actual service life. It is computed using the following equations:

$$AME_Y = \sum_{n=1}^{10}\left[\sum_{j=1}^{m}\left(M_{nj} + R_{nj}\right)\right] \qquad [1]$$

$$\forall y = 1,2,3,...,50$$

where,
AMEy – Annual Maintenance Expenditure for year y
n – counter of building systems;
j – index of component in system n;
m – Total number of components j in system n;
M_{nj} – Annual maintenance costs of component j in system n [$/sq. m.];
R_{nj} – Costs of component j in system n [$/sq m.];
y – Counter of years throughout the building's service life.

$$AME_{ave.} = \frac{\sum_{y=1}^{50} AME_y}{50} \qquad [2]$$

where,
$AME_{ave.}$ – Average Annual Maintenance Expenditure throughout the clinic's service life (50 years) in $/sq.m.;
AME_y – Total annual maintenance expenditure for year y;
y – Counter of years thorughout the building's service life;

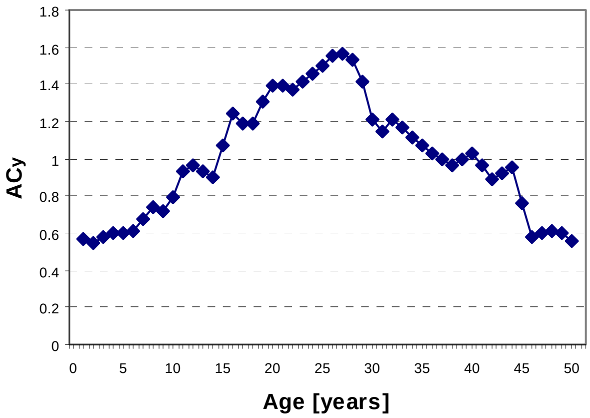
$$AC_y = \frac{\sum_{y-4}^{y+4} AME_Y + \frac{1}{2}\left(AME_{y-5} + AME_{y+5}\right)}{10 * AME_{ave.}} \qquad [3]$$

$$\forall y = 6,7,8,...,50$$

Where,
AC_y – Age Coefficient for year y;
AME_y – Total annual maintenance expenditure for year y [$/sq.];
$AME_{ave.}$ – Average Annual Maintenance Expenditure throughout the clinic service life [$/sq.m.];

Simulation of the above coefficient for a clinic facility with a Designed Life Cycle (DLC) of 50 years produced the following results: A value of 1 represents the average maintenance expenditure (2.5% of reinstatement value) throughout the clinic's designed life cycle. The total area below the graph equals 50. The graph depicts a maximum point at the middle of the facility's Designed Life Cycle, and multiple local maxima points indicating minor clinic renovation works.

Figure 1. Age coefficient (AC_y) vs. actual age of the clinic for a DLC of 50 years



Density Coefficient (DC)

The Density Coefficient quantifies the affect of patient density in the clinic on the deterioration of building components. Standard density was empirically defined as 175 patients per sq.m. per annum and is referenced as 100% patient density. According to the research hypothesis, density affects the deterioration pattern of building components and systems (Shohet et al. 2003). The Density Coefficient was developed on the strength of the analysis of the life cycle of building components under intensive, standard, and moderate service conditions. The results revealed the following:

a. Under moderate density conditions (less or equal to 80% of standard density), the density coefficient equals 0.97, expressing only minor savings in the maintenance activities due to compulsory preventive policy.
b. Between 80% and 100% relative density, the increase in maintenance activities is moderately linear, with a slope of 0.001625;
c. Between 100% and 154% relative density, patient density has a greater impact on the maintenance expenditure, the slope of the graph increases to 0.00578, and the Density Coefficient under high-density conditions remains constant at 1.31.

Building Performance Indicator (BPI)

This parameter enables to evaluate the overall state of the clinic or of the clinic portfolio, according to the performance of its components and systems. The indicator is defined by a value, between 0 and 100, that expresses the clinic's state, including the performance of its various systems (P_n). Each system, P_n, is graded using performance scales between 0 and 100 of its components, where $P_n<60$ indicates poor/dangerous performance condition, $60<Pn\leq70$ indicates deteriorating performance condition, $70<Pn\leq80$ indicates marginal (70) or satisfactory (80) condition, and $P_n>80$ indicates good condition. The actual score for each system (p_n) is expressed by Equation [4] and is composed of three aspects of facility maintenance: (1) actual condition of the component (C_n); (2) failures affecting the service provided by the component (F_n); and (3) actual preventive activities carried out on the component to maintain acceptable service level (PM_n).

$$P_n = C_n * W(C)_n + F_n * W(F)_n + PM_n * W(pm)_n \qquad [4]$$

where,

$W(C)_n$ – weight of component condition of system *n*
$W(F)_n$ – weight of failures in system *n*
$W(pm)_n$ – weight of preventive maintenance for system *n*

For every component in system *n*, the sum $W(C)_n$,+$W(F)_n$+ $W(pm)_n$ equals 1.
The score C_n is evaluated based on a 100-point rating scale, where 100 expresses complete performance score, 60 deteriorating, and 40 and 20 reflect failure and poor performance respectively. Preventive maintenance is evaluated on the basis of the maintenance policy governing the component, and the frequency of pro-active inspections carried out with respect to standards of maintenance per system. Frequency of failures is evaluated on a scale between 100 - no failure in 12 months, and 20 – frequent occurrence (e.g. 12 times in the last 12 months in a roofing system). The combination of these three elements produces the performance score of the entire system (P_n). Weighting of each building component in a system (W_n) in the BPI is accomplished by weighing the contributions of the system's components to the Life Cycle Costs.

Once the systems' components functional states have been diagnosed, the BPI is calculated. The BPI is obtained for each system by multiplying its weight by its score (Equation 5).

$$BPI = \sum_{n=1}^{10} P_n \cdot W_n \qquad [5]$$

The desired BPI range is BPI>80, although at such performance scores, any component or system with a performance score lower than 70 is considered in deteriorating/failure condition and requires remedial maintenance measures. This parameter enables (1) to evaluate the overall state of a clinic; (2) to evaluate the state of the clinic's systems; (3) to benchmark the asset's performance in relation to other clinics or facilities (inter-organizational benchmarking); and (4) to benchmark the clinic's systems in order to compare the efficiency of the various maintenance crews (intra-organizational benchmarking).

Annual Maintenance Expenditure (AME)

This KPI reflects the scope of expenditure per sq. m. built (excluding cleaning, energy, and security expenditures). From an organizational viewpoint, this parameter determines the annual expenditure on maintenance of the clinics, and it can further provide a measure of the overall expenditure on built assets in relation to the organization's turnover. From a managerial-professional viewpoint, however, the expenses must be analyzed in relation to the clinic's characteristics and with respect to the output (the clinic's performance). This examination is carried out in the framework of the Maintenance Efficiency Indicator (MEI), as described below.

Maintenance Efficiency Indicator (MEI)

This indicator enables to examine the investment in maintenance in relation to the clinic's performance (which is in fact the service provided to the healthcare organization by the FM department). The MEI is calculated using Equation [6]:

$$MEI = \frac{AME}{ACy} * \frac{1}{BPI} * \frac{1}{DC} * i_c \quad [6]$$

where, AME is the actual Annual Maintenance Expenditure, AC_y is the Age Coefficient for year y, BPI is the monitored Building Performance Indicator, DC is the Density Coefficient for the clinic in question, and i_c is the construction prices index. This indicator expresses the expenditure on maintenance per clinic performance unit and is normalized using the Age Coefficient (AC_y) and Density Coefficient (DC). MEI can be analyzed in the two-dimensional setting of BPI and the Normalized annual Maintenance Expenditure (NAME), as expressed in Equation [7]:

$$NAME = \frac{AME}{AC_y * DC} \quad [7]$$

NAME expresses the Annual Maintenance Expenditure after it is neutralized from the effect of age (AC_y) and the clinic's patients' density (DC). For a clinic maintained at a desired level, we assume a BPI of 100. The average Annual Maintenance Expenditure (AME) per sq.m. was found to be 2.50% of the reinstatement value of a clinic facility, which was calculated to be $1,180 per sq.m. built. Assuming a facility with an Age Coefficient of 1.00 (the standard), and a standard Density Coefficient of 1.00, MEI would yield a value of 0.30. The upper and lower limits of the desirable range were deduced from the Standard Deviation of the MEI for the clinic sample population. The MEI values are thus interpreted according to the following categories:

- MEI<0.20 indicates either a high efficiency situation in which resources are allocated and utilized, or a scarcity of resources for maintenance, or both;
- 0.40≥MEI≥0.20 reflects normative maintenance efficiency, in which the lower limit indicates high efficiency while the upper limit indicates low efficiency and/or a slack of resources; and
- MEI>0.40 indicates a high level of resources relative to the actual performance. Such high indicator values may express high maintenance expenditures, low physical performance, or a combination of these two extreme situations.

Maintenance Sources Diagram (MSD)

This KPI reflects the mix of internal and external maintenance resources, and expresses the extent of outsourcing (in %) out of the total labor resources allocated for maintenance of the facility. Previous studies revealed that outsourcing may contribute to savings of about 10% compared with in-house provision (Domberger and Jensen, 1997). A mix that includes 60% outsourcing may provide a solid balance in healthcare facilities under standard service conditions.

Managerial Span of Control (MSC)

This indicator is defined as the number of subordinates reporting to a given supervisor. It reflects the scope of managerial resources invested in the FM department. In a large FM organization, there will usually be at least two organizational managerial levels: the Head of the organization (a maintenance engineer, who in fact functions as the Facility Manager), and the Maintenance Manager, who supervises on-going maintenance activities and inspects in-house maintenance crews. A previous study of MSC in the construction industry (Laufer and Shohet, 1991) found that the span of control affects the way managers allocate their time and consequently the performance of the organization. The MSC, therefore, must be adapted to prevailing conditions. The desired span of control at the head of organization level is no greater than six, while at the Maintenance Manager's level the desired span of control is eight subordinates.

PHASE I – BENCHMARKING

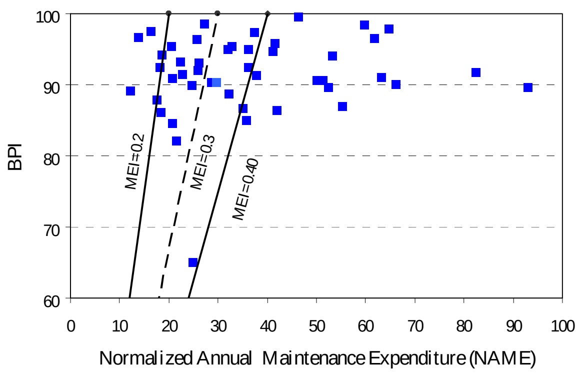
Phase I of the implementation of the KPIs was carried out using a field survey conducted on a sample of 47 clinics. Table 1 and Figure 2 present the sample parameters. The mean floor area of clinics was 1,139 sq.m., the clinics' average portfolio age was relatively young - 10.9 years and, therefore, the respective Age Coefficient is 0.83. Service conditions, as derived by the number of visitors, were found to be high: 269 visitors per sq.m. per annum. Thus, the respective Density Coefficient is 1.16, reflecting the intensive service regime. Annual Maintenance Expenditure per sq.m. was found to be 33.2 and the level of outsourcing was 60%, as depicted by the MSD. The MSC at the regional facility managers was found to be 7.3 clinics per facility manager. This value is relatively high considering the wide geographic dispersion of the clinics. The performance of the clinics was high, as depicted by the BPI; however the efficiency with which the allocated resources were used was found to be marginal, as the average MEI of the clinics was 0.40, compared with the normative level of 0.30. This conclusion led us to establish a remedial maintenance policy, the main objective of which was to reduce the Normalized Annual Maintenance Expenditure, and to improve effectiveness of the maintenance and management activities.

Table 1. Profile of clinic facilities – Phase I.

Parameter	N	Mean	Standard Deviation
Floor Area [sq. m.]	47	1,139	894
Age [years]	47	10.8	7.1
Acy	47	0.83	0.23
Annual number of visitors/sq. m.	47	269.1	152.4
DC	47	1.16	0.15
Annual Maintenance Expenditure [$/sq. m.]	47	33.2	15.4
Maintenance Sources Diagram (MSD)	47	60.6%	8.8%
Managerial Span of Control (MSC)	47	7.3	3.2
BPI	47	91.6	5.6
MEI	47	0.40	0.19

Figure 2 depicts that the variance in the population of the clinics during Phase I is wide, reflecting diversity and lack of control as well as a high level of annual maintenance expenditures. The objective of Phase II was thus to reduce the variance of the population as well as the NAME.

Figure 2. Building Performance indicator vs. Normalized Annual Maintenance Expenditure – Phase I.



PHASE II – REMEDIAL MAINTENANCE AND PERFORMANCE MANAGEMENT POLICY

The remedial maintenance policy was established based on five core principle guidelines:

a. The preventive maintenance policy was established for the core disciplines of maintenance, i.e. power supply and HVAC;
b. Performance Based Maintenance (PBM) was applied for the rest of the systems;
c. The Managerial Span of Control (MSC) was adapted to prevailing conditions and effective inspections and supervision of maintenance was performed at the community and regional clinics level.
d. Improved in-situ and superior inspection using performance scales (BPI) and maintenance performance specifications was implemented.
e. Outsourcing was reduced to achieve the NAME goals since reduction of in-house sources was actually not possible due to labor agreements.

The second phase of the research lasted for a period of two years, during which the remedial maintenance measures were carried out. Remedial measures according to the above listed guidelines were materialized by the following steps:

- Performance of components was rigorously monitored according to BPI performance scales, this helped insure the performance of building components and insured that corrective measures be implemented at an appropriate order.
- Managerial Span of Control was adapted to prevailing conditions, regional facility mangers with a wide span were entitled to a shorter body of facilities (e.g. span was reduced from 8-9 facilities to 6-7), and opposite cases with a span of 5-6 facilities under moderate service conditions were expanded to a span of 7-8 facilities. This policy improved the quality of facility management decision making.

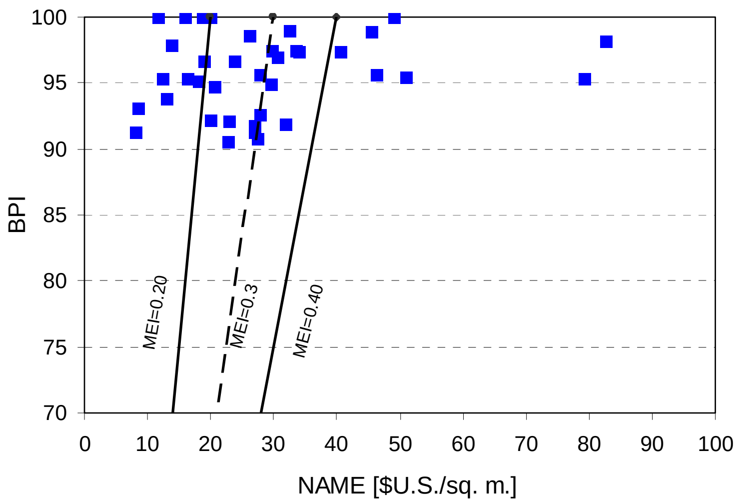
Validation of the method's effectiveness was performed using a performance and maintenance survey of a sample of 42 clinics with a similar profile to the sample used in Phase I. The performance, effectiveness and efficiency of the remedial policy were studied by comparison of the KPIs of the model between the two phases. The KPIs that provide most of the outcomes are the BPI – reflecting performance of the clinics, AME expressing the annual expenditure on maintenance, and MEI – reflecting the efficiency with which resources are used.

Table 3 depicts the profile of the Phase II clinic population: the mean floor area of the clinics was 1,154 sq.m. and their mean age was 7.9 years – 3 years less than the Phase I sample. The respective Age Coefficient for this phase was 0.75, reflecting a younger clinic portfolio, this parameter implies that fewer resources be allocated for a given performance. The service conditions were intensive, as revealed by the high level of visitors – 258 visitors per sq.m. per annum compared with a standard of 175 visitors per sq.m. This phase revealed a 30% improvement in the efficiency of maintenance, as the MEI level dropped from 0.40 to 0.30, which is the normative range deduced from the analysis of the MEI. This improvement was complemented with a slight amelioration in the performance rating of clinics manifested by BPI values of 91.6 in the first phase rising to 95.5 in the second phase.

Table 2. Profile of clinic facilities – Phase II.

Parameter	N	Mean	Standard Deviation
Floor Area [sq. m.]	42	1,154	1,148
Age [years]	42	7.9	6.1
Acy	42	0.75	0.23
Annual number of visitors/sq. m.	42	258.0	124.0
DC	42	1.17	0.15
Annual Maintenance Expenditure [$/sq. m.]	42	24.2	13.7
Maintenance Sources Diagram (MSD)	42	45.3%	3.2%
Managerial Span of Control (MSC)	42	6.1	1.9
BPI	42	95.5	2.9
MEI	42	0.30	0.16

Figure 3. Building Performance Indicator vs. Normalized Annual Maintenance Expenditure – Phase II.



CONCLUDING REMARKS

Eight Key Performance Indicators were developed for clinic facility maintenance. The KPIs were employed in a two-phase procedure: Phase I – Benchmarking, Phase II – Analysis, remedial maintenance policy and validation. Remedial maintenance policy was established on the strength of five guidelines: (a) Preventive maintenance policy for the maintenance of core disciplines; (b) performance-based maintenance for the rest of the disciplines – this was implemented with the aid of the performance scales and the maintenance-performance specifications that serve as a guide for pro-active corrective maintenance; (c) effective managerial span of control – this parameter serve as a key factor in moderating the quality of FM decision-making, (d) in-situ and superior supervision of maintenance, and (e) reduced outsourcing of maintenance – this guideline was established in light of the existing body of in-house staff. The procedure, implemented for two years in clinics run by the sick funds in Israel, yielded a 30% improvement in the efficiency with which maintenance activities were implemented. This was evidenced by the MEI value in the second phase of the research. This accomplishment was accompanied by an improvement in the performance of the clinics as well as realized by the level of the BPI.

REFERENCES

Akintoye, A. (2005), "Private finance initiative in the healthcare sector: trends and risk assessment", Engineering, Construction and architectural Management, 12(6) 601-616.

Domberger, S. and Jensen, P. (1997), "*Contracting out by the public sector: theory, evidence, prospects*", Oxford Review of Economic Policy, 13(4), 67-78.

Gallagher, M. (1998), "Evolution of facilities management in the health care sector", Construction Papers, No. 86, pp. 1-8, The Chartered Institute of Building, Editor: P. Harlow.

Gelnay, B. (2002), "Facility management and the design of Victoria Public Hospitals", Proceedings of the CIB Working Commission 70 – Facilities Management and Maintenance Global Symposium 2002, Glasgow, Scotland, pp. 525-545.

Laufer, A. and Shohet, I.M. (1991), "Span of control of the construction foreman: situational analysis.", *ASCE J. of Const. Eng. and Mgmt.*, 117(1), 90-105.

Macsporran, C. and Tucker, N. (1996), "Target Budget Levels for Building Operating Costs" *Construction Management and Economics*, 14(2), 103-119.

Payne, T. and Rees, D. (1999), "NHS facilities management: a prescription for change", Facilities, 17(7/8), 217-221.

Pullen, S., Atkinson, D., and Tucker, S. (2000), "Improvements in Benchmarking the Asset Management of Medical Facilities", Proc. of the International Symposium on Facilities Management and Maintenance, Brisbane, Australia, pp.265-271.

Ridgway, M. (2001), "Classifying medical devices according to their maintenance sensitivity: a practical, risk-based approach to PM program management", Biomedical Instrumentation and technology, 35(3) 167-176.

Shohet, I.M. (2006), "Strategic healthcare facilities maintenance – key performance indicators", *ASCE J. of Construction Engineering and Management* 132(4), 345-352.

Shohet, I.M. and Lavy, S. (2004), "Healthcare facilities management – state of the art review", *Facilities*, 22(7/8), 210-220.

EFFICIENT AND HEALTHY ENVIRONMENTS IN PUBLIC BUILDINGS: A STRATEGIC QUESTION IN THE FM ORGANIZATION?

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ABSTRACT

Studies show that more than 40% of the public buildings in Norway have severe problems with their condition due to deficient maintenance. Most of these studies also report problems with the indoor climate/environment. Furthermore approximately 40% of the buildings are considered to have a low degree of suitability that does not support the efficiency and quality of the core activity/occupants in an optimal manner. The situation is alarming considering the long-term effects on the occupants and the occupying business, with regard to health, efficiency and economy. The reality today is in many cases a Facility Management (FM) regime which is focusing its effort and financial resources on “fire-fighting”, instead of planning and working on a more sustainable long-term perspective. There is a demand for knowledge and better methods to communicate and address these challenges.

Based on studies and cases performed during recent years, this paper will present and discuss findings and central challenges for the public buildings and for FM. Also some temporary results from a national Research and Development project (”FM as a strategic tool for achieving efficient health services”) supported by the Research Council of Norway will be presented. The objective of this paper is to shed light on the demand for knowledge and the need for development of competence and methods in order to strengthen the asset management and strategic planning, including looking at the role of FM at the strategic level. The purpose is also to establish a foundation for further studies.

KEYWORDS: asset management, strategic planning, facilities management, suitability, efficient and healthy environments

INTRODUCTION

Poor technical condition, inferior interior environment and unsuitable buildings are symptoms of inappropriate and uneconomical FM, which can lead to considerable negative consequences for users of the buildings. Examples of the results include reduced productivity and poor quality of public services. In Norway the situation for many public buildings is alarming, and the cause comprises both political and organizational structures and conditions, lack of competence on several levels and insufficient systems, methods etc. It is also indicates that the FM philosophy lacks status as an indirect cause as well, since FM is not a core activity for neither politicians nor the administration in the public sector. This affects the attitude and culture in the organizations and makes it harder for the facility manager to secure funding for FM.

The intention of this paper is to look at how the public sector, and especially the FM, can be strengthened to meet these challenges. What does this mean for asset management (AM) and the strategic planning within FM, and for the role of FM in the public sector in general and the hospital sector in particular? The purpose is to shed light on the demand for knowledge and development of competence in order to strengthen the FM, and establish a foundation for further studies. The paper starts with a presentation of the status and challenges for parts of the public buildings and public FM in Norway. A theoretical framework related to the central challenges that the paper explores further is presented. Two case studies and results from interviews with representatives from the national, regional and local levels in the specialized health care sector are presented. Finally conclusions and recommendations for further work are given.

STATUS FOR THE PUBLIC BUILDING PORTFOLIO AND FM IN NORWAY

The data referred to here are based on several assessments and studies mainly performed during the last 5-6 years. The data are partly from available reports and publications, and partly from projects and studies the authors have been or are involved in at the time of writing. The different methods used for mapping/data collection and analyses are not presented or discussed here. However, the methodology and level of detailing used in the different projects varies somewhat, and the results must be considered as an approximate indication of the situation.

Condition and suitability

A summary of results from different studies on condition and suitability is presented in Table 1 showing that approximately 40% of all buildings examined are found to have a too low degree of suitability in order to support the efficiency and quality of the core activity/occupants in an optimal manner (Larsen, 2007).

Rebuilding and adaptation of buildings is also often necessary in addition to a technical upgrading in order to meet the need of the core business activities. Studies show that one of the major challenges in hospitals is to adapt the buildings and the technical infrastructure to new demands and needs (Valen & Larssen, 2006). It is well known that the physical adaptability of the buildings varies and a large amount of the existing buildings will be difficult and costly to adapt.

Table 1 Approximate amount of examined buildings within different public sectors with condition below an acceptable level (Source: Larsen, 2007*)*

Category	Schools	Health	Adm. and Culture	Sports
Condition	55%	45%		
Suitability	40%	45%	35%	30%

Vision, strategies and objectives

The formulation of visions, strategies and objectives for FM within the public sector is often insufficient, and in many cases absent. A survey performed within the specialized health care sector (Kampesæter, 2007), shows that 23% of the health trusts answer yes when asked if they have a strategy for the building portfolio and the FM services in general, 58% answer that they partly have such a strategy, and 18% answer that they do not have a strategy. 57% of those who have a strategy say it is developed in accordance with the strategy for the core activity, and only 35% of those who have/partly have a strategy consider the strategy to be useful in the daily work. Status reports regarding the condition, operational economy or key indicators of the building portfolio from the FM are rarely asked for by the management or the political level.

Organizing of property and asset management; FM regime

During the last 5-10 years there has been an extensive centralization of the FM activities within most of the public sector. The intention has been to professionalize and make the FM more efficient. In the specialized health care sector (here: mainly hospitals) a hospital reform in 2002 in many ways has led to a decentralization of FM. From being owned by 19 counties, the sector is now organized in 27 hospital trusts, where each of these trusts is the formal owner of the properties and buildings. The trusts are owned by 5 Regional Authorities, which again are owned by the state.

THEORETICAL FRAMEWORK

The combination of the suitability and adaptability of a building is important for the choice of strategy for further development of the building(s) as shown in Figure 1 (Larssen and Bjørberg, 2004).

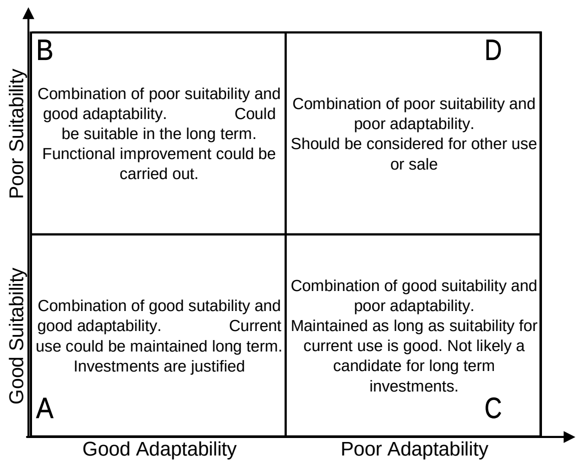

Figure 1. The suitability and adaptability matrix (Larssen and Bjørberg, 2004)

If there is both a considerable need for maintenance and as well poor suitability for the user, the physical adaptability of the building(s) can be decisive for what strategy one should choose; whether to upgrade/adapt or relocate etc. This emphasizes the demand for a coordinated development of the user organization and the building(s) in a long-term perspective.

CASE STUDIES

Two case studies are presented, where the role of the FM has been changed on the strategic level leading to a better cooperation with the owner and users and resulted in more funding to maintenance and other investments.

University Hospital of North Norway Trust (UNN)

This case description is based on a presentation by and interview with the head of the Property and FM department. He started at UNN in January 2007, and has since then introduced several changes and improvements. In the following some of these are presented as good examples for steps towards a more professional FM on the local level (within a single trust).

Before 2007 responsibility for different FM tasks were spread between many different organizational units, with varying local FM competence and capacity. Hence, reorganizing became an important tool for a more professional and rational FM. During 2007 FM was reassembled in a unit with 3 departments, and in 2008 it will be one of 12 departments in direct line reporting to the CEO. The FM unit will consist of 620 employees. The head of the FM unit is now part of the trust's management team and participates in board meetings and other arenas where the board and the hospital management meet. This is pointed to as a key for success, both the informal and formal position for influence.

In order to reach the goal of space efficiency, a booking system for meeting rooms was introduced. The intention was to create a history of success before one starts to look at efficiency of office facilities. Internal rent is also considered, and might be implemented unless other methods can lead to satisfying effects on space efficiency

The technical condition of the buildings is documented estimating a maintenance backlog of more than NOK 1 billion (EUR ~127 million), where approximately NOK 300 million (EUR ~38 million) has developed over the last 5 years. This documents an accelerating decline. However, this information is now available for the management and the Board as the FM unit has presented the condition status, risk analysis and impact assessments of the building stock. Hopefully this will affect the Trust’s priorities and strategies in the near future. Systematic collection of data such as area, condition, FM costs, key indicators and systems to process the information is under development. Some operative functions will also be considered outsourced.

Västfastigheter

The case description is based on a presentation during a meeting with a special adviser for the management of Västfastigheter (VF) in Sweden. This is part of Västra Götaland, a politically governed region, and VF provides premises for the region’s activities, such as hospitals, health care institutions, and schools. This case is chosen because it is a good example of a proactive FM. In the context of this paper their approach to strategic planning is briefly presented as they proactively plan for their clients' ever-changing activities

A building plan was prepared for each hospital, illustrating the capacity, possibilities and limitations. In close cooperation with the hospital an activity plan was also developed, which described possible scenarios and prognosis for the development of the core business, and hence the future demands for premises. Based on these documents a plan for the supply of premises was compiled. It included necessary measures to satisfy the activity plan, including costs. The plans were subject to regular updating. This approach makes VF able to provide facilities and plan the use of the buildings with an efficient operation economy in the long run in order to keep up with the development and changes in the core business activities.

RESULTS FROM WORKSHOP AND INTERVIEWS

The results from a workshop with 10 FM managers (from local Health Trusts and Regional Health Authority's) and a series of 9 interviews with people representing four local Health Trusts, one Regional Health Authority and the Ministry of Health and Care Services is presented. The purpose of the workshop was to point out some central challenges for the FM in the health care sector. The interviews confirm results from earlier studies (Kampesæter, 2007) and from the workshop, and gives more in depth understanding of the conditions under which FM operates and the causal relationships that has lead to today's situation. The results are systematized and related to a set of criteria for good asset management and good FM as suggested in NOU 2004:22 (2004) and the main results are shown in Table 2. The task is to identify the gap in performance between today's practice and a more optimal FM, and hence identify central areas for improvement.

Table 2 A brief summary of the status and some main challenges for asset management and FM within the specialized health care sector in Norway.

Criterias for good asset management and good FM	Status in the Spesialised Health Care Sector
1 Visions, strategies and objectives is defined for the asset management and FM	Insufficient, but good examples on regional and local levels exist
2 Rational systems for planning and control is implemented	Insufficient most places, need for more standardisation on regional and national level
3 Satisfy user needs	High focus among FM units on local and regional level, but insufficient methodology and evaluation.
4 Space efficiency	Insufficient, users not responsible for costs (internal rent will be implemented in near future several places however), relatively high amount of unsuitable premises, hard to measure, methodology missing.
5 Maintaining asset value	No, insufficient, hard to get funding, has not had much focus until lately. Status reports rarely asked for.
6 cost efficient FM	Insufficient, data and KPI's rarely available, with some good exeptions. Need for systems and methodology. Maintenance situation is very costly in the long term.
7 Strategic development of the properties	Insufficient, master plans some places, need for better methods and processes on regional and local levels.
8 Appropriate organizing of the FM-organisation	Great variations, distribution of responsibility vague some places, roles not clearly defined many places, partly mismatch between responsibility and formal authority. Processes on redevelopment of organization is ongoing several places.
9 Adequate economic resources adapted to the longterm perspective of the property portfolio	No, short term priorities and lack of resources.

The table shows that there is a call for improvements in all areas. However, it is important to note that there are several excellent examples of good practice within many of these areas today, but this picture is an indication of the overall situation. Most FM units will recognize the description in several of these areas. There is clearly increasing focus on FM in the sector, and much successful improvement work is being started.

DISCUSSION

The public sector faces considerable challenges, with a combination of extensive demands for changes in functionality and use, a building portfolio that is partly out of date, i.e. that they does not match future demands and with enormous maintenance backlogs. The interviews

shows that for most trusts the burden of debt is so heavy that the long term economic viability represents a challenge. Access to investment funding is and will probably stay limited. As a result, financially attractive projects are not implemented or must wait at the end of a long list of prioritized pending projects. If no means are found to clear the backlog of maintenance the result will be an even greater tightening of the financial framework for activities.
Hence, rationalizing of funding in order to secure optimal cost benefit is crucial. Furthermore, optimizing and efficient use of existing space is necessary, not only in terms of square metres, but in terms of suitable, comfortable and health promoting design solutions.

The central question this paper explores is: How can FM be strengthened to meet these challenges? The results presented here points towards several actions that are required.

First and foremost the ownership needs to be strengthened. The maintenance backlog is a clear symptom that the ownership has been ineffective for decades, and there are many indications that the decline continues also today.

In general the results confirm that the distribution of responsibility and tasks between the owner, the user and the FM units on all levels (strategic, tactical and operational) is diffuse in several trusts, and hence the understanding of the different roles within FM is not clear. Results show that the development of the FM role and competence on the strategic and tactical levels are required. Central topics are portfolio management, economic management, professional leadership and communication. Knowledge and understanding of the primary business and its drivers for change are emphasised by the respondents as important parts of this competence.

As the UNN case from Tromsø shows it is essential to get access to relevant communication arenas where decisions are made, such as management and board meetings. The right competence and skills are of decisive importance. One has to be tough and professionally confident in order to fight for "unpopular" cases. Argumentation by using the executives own "currency", i.e. consequences for patient treatment, work environment and economy, is essential. Furthermore organizational placing and ability to create and communicate results has been a prerequisite for access to the right arenas for communication and decision-making in this case. In an expanded definition taking care of facilities is also a part of the health services. Increased consciousness and knowledge of asset management and FM among executives and board members is also a result of the head of FM's initiative to inform them.

The Vastfastigheter case illustrates how the FM can proactively take the initiative to coordinate the future needs for change in the health services with the strategic planning of the building portfolio. This leads to a much better and consistent planning of resources in a long-term perspective.

According to the respondents, one of the challenges for the FM units is to recruit and keep qualified staff. The smallest units are also too small to have complete FM competence. This becomes an argument for more coordinated training and competence building on the regional or national levels, and for networking between trusts and regions. The internal organization of the FM units and services varies, and most respondents express a desire for more equal structures between different FM units and trusts. Considering the demand for a strengthened and proactive portfolio management, the challenging competence situation, a need to strengthen the ownership and to increase the economic "space for action" combined with limited access to funding, it will be necessary to consider the organizing of AM and FM within the health sector, on all levels, including the formal ownership. Within some of the Regional Authorities and also in single trusts there are processes going on where different models for organization are considered.

Also development of more standardized systems, methods and tools on regional or national levels is desired by respondents. A critical selection of which buildings it will be worthwhile to upgrade and develop, and which ones to replace by new facilities is required. From the FM perspective a main challenge will be to provide the necessary information about the properties, their suitability and cost efficiency today, and their possible potential for future use with related cost consequences, and to present this in a way that is easily understood by decision makers.

During the last few years a methodology that attempts to provide this information has been developed, and has shown valuable as a basis for strategic analysis on a portfolio level (Larssen and Bjørberg, 2004). However there is still a need to develop the methodology further, especially regarding to suitability, ref. Figure 1. Key issues are: what characterizes suitability for different hospital functions, and for the hospital as a whole? How can this be described and evaluated for use on a strategic level and in an effective manner in terms of resources? Furthermore there is a demand for simulation models that combine activity (i.e. care pathways and number of patients) and the consequences of requirements for premises (space, technical requirements etc.). Such methodology is under development as part of a Norwegian Research and Development project called ”FM as a strategic tool for achieving efficient health services”. Hopefully this will be a valuable tool in strategic planning.

SUMMARY AND CONCLUSION

The paper has described the status and challenges for the public asset management and FM in Norway, with special focus on the specialized health sector (mainly hospitals). The situation is alarming and the asset management and FM performance in today’s regime is far from optimal. That being said, there are also many examples of good practice in several areas, but the overall situation is challenging and improvements are required. We conclude with several actions, which comprise all hierarchical levels that are necessary in order to strengthen asset and facilities management.

1) First and foremost there is a need for a national strategy for how the enormous challenges related to the upgrading, development and renewal of the building stock in accordance with the future development of health services is to be managed in hospitals. A central part of this strategy must include a strengthening of the ownership. The Norwegian Government has stated in their political platform, the Soria Moria Declaration, that “hospitals will be given adequate economic conditions to secure the necessary renewal of buildings and equipment and counteract the development of an increasing backlog in maintenance” (The Norwegian Government, 2005). A follow up of this declaration is called for.

2) Development of competence and skills. This is especially competence in strategic planning and portfolio management. The role of FM as a proactive and strategic function must be further developed. Knowledge and understanding of the primary business and its drivers for change is an important part of this competence. FM also needs to improve the communicative skills. Increased consciousness and knowledge of asset management and FM among executives and board members is also necessary.

3) Organizing AM and FM and formal ownership of the properties within the health sector needs to be reconsidered

4) Framework conditions. With today's formal economic conditions and regime for investments the probability is high that trusts will steer towards an even greater tightening of the financial framework for activities. Action to avoid an escalating maintenance backlog is demanded, and must be considered in combination with the overall need for development and renewal of the building stock on regional and national levels.

5) Tools and methods. There is a necessity to redistribute functions and long-term transformation of the building stock in order to provide facilities according to the users need. This requires better methods and tools for planning and control. Many of these should be developed on a national and/or regional level and be made available to all.

In 2008, for the first time the Ministry of Health and Care Services has asked for reports on the maintenance situation in the hospital trusts. Hopefully this is a signal of increased consciousness that will contribute to an improvement of the situation. Further studies will focus on developing better models that examine and evaluate the suitability of buildings as well as models that examine activity and functions in relation to demands for premises.

REFERENCES

Kampesæter, Anette (2007), "Status survey of the property and asset management of Norwegian hospitals and the effect of the reform of 2002 within the specialised health care services", Master's thesis (in Norwegian), Norwegian University of Science and Technology (NTNU), Trondheim, June 2007.

Larsen, Anders, Multiconsult (2007), "Vedlikeholdsetterslep i offentlig bygningsmasse" (Maintenance backlog in public buildings), presentation at the FSTL conference in Trondheim, October 2007. In Norwegian.

Larssen, A.-K. and Bjørberg, S. (2004) "User needs/Demands (functionality) and adaptability of buildings – a model and a tool for evaluation of buildings" – the 12th CIB W70 Conference Proceedings on "Human Elements in Facilities Management and Maintenance, Danny Then (editor), Hong Kong, Dec. 7-8., 2004, ISBN 1 962-367-435-x

NOU 2004:22, "Velholdte bygninger gir mer til alle, Om eiendomsforvaltningen i kommunesektoren" (About the property and Asset management in the Local Government sector), Report for the Ministry of Local Government and Regional Development (in Norwegian). Statens forvaltningstjeneste Informasjonsavdelingen, Oslo 2004.

Valen, M. S., Larssen, A.-K. (2006) "Adaptability of hospitals–Capability of handling physical changes", the 13th CIB W70 Conference Proceedings on "Changing user demands on building", in Trondheim, Norway, June 2006, ISBN 82-7551-031-7, p. 623-633.

HEALTHCARE IN HOUSING – SPACE AND ORGANISATION

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ABSTRACT

The background is the great challenge in a rapidly increasing aging population. In many European countries, elderly persons will stay in their own homes as long as possible. This fact puts housing-areas under special constrains. Collaboration between different community sectors is needed. The area is of huge importance for local communities, responsible for the well-fare of elderly persons.

The aim of this project is to find, design and discuss solutions within built areas of housing, when homes also are workplaces. This project is in an early phase of deepening the research questions and establishing collaboration between disciplines, why main results not yet exist.

Method in this qualitative research is use of multiple tactics: Interviews, Questionnaire survey, Observations and evaluations of authentic processes of changes as well as Briefs and Design-projects made by master-students. The project is also part of the recently formed Research-centre Ageing-Wellfare in Sweden.

KEYWORDS: elderly, housing, space-management, usability.

INTRODUCTION

The purpose of this paper is to introduce a research-area where private homes of elderly persons will more and more at the same time become a workplace for personnel in care and healthcare. Initially the paper gives a background, presenting the challenge of the new demographic situation. Its consequences on space and organisation will follow and after that a description of the research method that will be applied. Finally there is a short presentation of ongoing work so far.

The population of elderly persons is increasing rapidly in Sweden as in most European countries. In the last hundred years the mean-age of the whole population of Sweden has increased by 25 years, and in the last 20 years the number of persons with an age over 90 years has become three times larger (Göteborgs stad, 2006). The normal age for retirement in Sweden is 65 years. In the next 10 years the number of retired persons will be highly increased, as unusually many Swedes were born after the second world-ware; the generation born 1945 – 1954 is sometimes called the "record-generation".

New situation - Staying at home

Housing for elderly has also been a subject of research for many years and is fairly well examined and documented by researchers both internationally (Regnier, 2002) and considering a national Swedish context (Paulsson, 2002).

What is new today is the situation that even though the amount of elderly in Sweden, as well as in most European countries is increasing, building of specific housing for elderly is no longer enough. The society does not have the possibility to build or to run such facilities to meet the needs of care from the elderly. In many European countries, elderly persons will stay in their own homes as long as possible. In Sweden there is a governmental strategy saying that staying in your own home always shall be the first alternative for elderly persons (SOU 2003:91).

In healthcare there is a trend towards only highly qualified treatments and short stays in a few, large hospitals and more of the low-qualified healthcare delivered near the patients, in their own homes or in smaller hospitals near housing-areas. (Vårdbyggnadsforum, 2005)

Higher demands

The elderly in the coming decades will also have higher demands on the spaces where they are going to live their every-day life, than the elderly of today. Many of them have had or still have high positions in their working-life, and have got good recourses to arrange for a good life of retirement, on which they will have high demands of quality. But there will of course also be a lot of elderly persons with none or poor recourses, who will need housing and service. Both persons with good recourses and persons with small financial recourses, will contribute to put housing-areas as well as the buildings of housing under special constrains.

Important aspects for elderly persons in the built environment are regarded to be Accessibility, and possibility to Orientate. Aspects of accessibility of different kinds have been identified and are important parts in the education of architects in many European countries (Paulsson, 2006). Still many problems remains concerning accessibility and possibilities to orientate in society and in housing. Dysfunctions related to a normal aging are quite well known and described (Wijk, 2004). Concerning persons with dementia, results from research on the physical environments, show that they need housing with specific characteristics such as distinct markings for functions (Andersson, 2005).

Home modification

In Sweden you can as an elderly person apply for not only aids but also adjustments or modification of your home to improve your mobility and accessibility. A recent report (Lindahl & Arman, 2006) shows that the value of home modifications for elderly made in Gothenburg are improved movements both within the private home and in and out of the home. Improvements were also showed in personal care in bathrooms.

The process of home modifications is increasingly expensive and costs has to be taken into consideration not only for the adjustment but also for the removal of adjustment so the next tenant can be able to live without modifications in their home. A study of home modification made by two master-students, points out that a changing of strategy towards better housing standard instead of home modification will improve the possibilities for the principle of elderly staying in their homes to succeed (Jansson & Taheri, 2005). In 2006 architectural students got the possibility to make observation of the visual results of home modifications, and they reported lack of aesthetical considerations in the way that the adjustments were done. Many adjustments made the private homes look like an institutional living.

Gothenburg Municipality now starts a survey of the planning-process of new housing-areas regarding the needs for elderly to be able to stay in their own homes in general housing areas. Not only indoor aspects are regarded, but also the location of communications and service. Pilot-studies has started in three districts with structure of income, social factors etc (www.vartgoteborg.se)

Quality in housing

Most aspects of quality in housing are general for persons of all ages, such as conditions of light, indoor-climate, possibilities of outlooks and overview, bathroom near bedrooms, a social context and space to interact with your neighbours; to meet others and to be seen by others. Some aspects, though, are more connected to the specific situation of being elderly and in need for assistance from other persons.

The storage of both aids and materials is a huge problem. Space is needed to put wheelchairs, mobility scooters etc when they are not used, and many elderly needs diapers and other disposable articles that need to be stored. When care and healthcare has to be delivered within persons private homes, the need for storage will increase.

A lot of compromises have to be done in the combination of needs from the living, elderly persons and the needs from personnel working in the sectors of care – homecare and healthcare. Some of the living persons needs are practical, such as accessibility and the possibilities to orientate, to be able to come outside and to have space enough. Even if such needs are not always fully satisfied, they are easy to formulate. But needs related to your personal integrity is not always easy to even formulate.

We already have the situation today where the same space shall be usable for different purposes; a home is at the same time someone else's workplace. But this situation will increase with the elderly population in the years coming. If the single housing apartment shall continue to be a good home, we have to consider the questions of personal integrity. An elderly man, who has been having home care for ten years formulates the problem in a magazine: "To have persons you do not know in your own home all the time – you will never get used to it!" (Samspel, p. 12) Can changes in the use of different rooms in the apartment make that more respect is taken to privacy and personal integrity? Can new kind of mobile screens be used to create easily removable borders between a private sphere and the working space? Probably a whole range of interior artefacts and arrangements have to be created to suit different personal needs.

Housing as Work-space

This area involves several different occupations such as nurses, physicians, as well as care- and homecare-personnel and caretakers in Housing companies. Jobs in the sectors of care are, at least in Sweden, regarded as low-status jobs. Technical innovations in IT, new, intelligent materials etc may lower the need for care, but still there will be an important need for meetings with a real person. The visit of the care personnel is in many cases the only human contact the elderly will get. If we want qualified personnel in the future, the status has to be raised principally by better salary. But better working-conditions can contribute and architects can by a careful design arrange better physical working-conditions for those employed.

Many needs of the personnel are also practical, such as for avoiding heavy lifts for example. Aids for these purposes already exist. There also have to be enough space in for example corridors and bathrooms so they can give the elderly the required assistance all over the apartment.

But an important aspect in establishing well-functioning working-space for the personnel in homecare and healthcare is to arrange workspace outside the private homes; in the housing-areas. Then I mean such work-space that in general is regarded as most basic, for example changing-rooms, showers and space for meetings and for lunch. So it is not only from the perspective of housing, but also from the perspective of workspace, that aspects of functionality and usability have to be applied.

PURPOSE

This study concerns living-conditions for elderly persons within the ordinary stock of housing and housing-areas that also are offering good working-facilities and include aesthetical aspects. The purpose of this study is to explore, design, discuss and analyze such units, both in existing areas of the city Gothenburg and new suggestions for design of housing and housing-areas.

Some related research-questions are: How do new and different degrees of services influence the building and the building-process? What kind of spaces for other facilities than housing will be needed? What are the possibilities for combinations of different activities in the same facilities?

METHOD

The research-problem is complex and a combination of methods will be needed. A Qualitative method will be applied, as it will correspond to the material, which is of mostly qualitative character and will allow broad understanding of situations (Alvesson & Deetz, 2000). In architectural research the qualitative method has the characteristics of Emphasis on natural settings, Focus on interpretation and meaning and the Use of multiple tactics (Groat & Wang, 2002).

The participation of – and dialogue with - many related parts into the process of knowledge and research is essential. Examples of these related parts are Governmental departments such as planning offices, Real-estate companies, housing companies, traffic-planners and of course the elderly persons themselves – the part that are most dependent of the effects from both lack of improvements and upcoming innovative solutions.

This will be done by some of the following tactics: Meetings – to introduce the question, a Questionnaire survey, Interviews – semi-structured interviews with stakeholders and Workshops where persons with different competences take part.

Other working-methods that can be used in the project are: Part-taking observations – in housing-areas and in private homes and Full-scale experiment – a new Laboratory for Care offers the possibilities for testing measures and innovations in the interior of housing.

Evaluation will be made of authentic, ongoing processes of changes in built environment and/or organisation. A pilot-project has recently been formed in the Municipality of Göteborg for improving efforts for the elderly by cooperation between different kinds of care and services. One method will be to follow this project will be observed and its results will be evaluated on usability of the architecture and built environment.

Also processes of authentic programming/construction briefing may be evaluated. This method will be used if any situation will occur, as actual research tells that the opportunities to influence the outcome and to introduce alternatives in design are higher in the earliest stages of a construction process (Ryd, 2003).

Delimitation

The problems of elderly persons staying in their ordinary homes are widely regarded most complex research-areas, containing questions concerning several different competences. The aspects of the built environment, the architecture, including organisation of space, are in focus and therefore some exclusions have to be done. Questions of public transports and traffic-systems as well as management and organisation of services will not be in the centre of this architectural study, even though aspects of these questions will be parts of the background and regarded as such in the study.

Empirical materials

Empirical materials of this study will be the results of interviews and questionnaire, the documentation of part-taking-observations, in written material and photos, results from full-scale experiments and from design-exercises. Answers from participants will be expressed as experienced effects or estimated values of realized efforts and changes, and suggestions of new solutions.

One way of structuring the empirical material and results, is to use typology of buildings for housing. Types of layout for housing areas can be used, such as yards surrounded by buildings, or buildings lying free in a park or landscape. Another typology is emanating from layout of different spaces/rooms within the single unit (Nylander, 2007). The following five plans are often used in housing design of today in Sweden: One big room in the centre, all installation and technique located together, organized around a neutral hall, divided in three parts with secondary space in the middle and the zone-plan with division between public and private zones.

The type of building that was most common in European cities before 1960 is Multi-purpose building (Malmqvist, 1992). In this type of building the ground-floor contains space for other purposes such as shops, while the floors above, contains housing apartments. Many housing blocks and housing areas still have Multi-purpose buildings. These ground-floors offer specific possibilities to include services, care-units, day-centres and almost whatever may be of interest for the elderly living in the actual building or in the neighbourhood. Outgoing the most frequent types of buildings for multifamily housing existing in Sweden, an investigation will be done of the possibilities to secure or to increase qualities for elderly persons.

International and multidisciplinary cooperation

An International network is offered in the research-network FM in healthcare in Europe, which will give opportunities to discuss results and actions of care and services between many European countries. The project is also part of the recently formed National Research-centre Aging-Wellfare in Sweden, which offers possibilities for multidisciplinary collaboration.

Ways to spread results

Questions that are raised in this project is of huge importance for local communities, responsible for the well-fare of elderly persons in for example Sweden. There is a need for not only knowledge but also new ideas and suggestions for solutions among the municipal and also governmental institutions in Sweden. The cooperation with departments of municipality of Göteborg will help to spread the results of the study. The national research-network Aging -Wellfare will also contribute with all its connections in the society.

A specific task will be to make younger professionals such as planners and architects aware of constrains and possibilities of the increasing elderly concerning urban planning and architecture. This was started last study-year in the international Master-program Space for Healthcare, Housing & Work at the School of Architecture, Chalmers University of Technology.

ONGOING RESEARCH ACTIVITIES

The project is still in its early phase of refining the research questions and establishing collaboration between disciplines. Results expected from this study will be new knowledge of how to manage constrains in built environment of the increasing elderly population. It is the intention that it will be realised in:

- A detailed picture of the situation and of constrains concerning living-conditions for elderly in the normal housing areas in Sweden in general and in Gothenburg in specific.

- Good examples of solutions to problems in existing buildings and in housing areas.

- New design of buildings for housing and housing areas with high aesthetical qualities, where elderly can live a safe and comfortable life until the end and the functionality and usability also as workplaces has been taken into consideration.

Evaluation of design-projects

The fact that architecture is a making profession makes it possible to among other empirical material use design-projects. Processes of knowledge-creation and research have similarities with processes of design (Groat & Wang, 2002). Analysis of the process of design and evaluation of results in innovations and suggestions in design-projects, gives a concretion to other kinds of empirical material. The results on a hands-on-level from design-exercises made by students in the international Master-program Space for Healthcare, Housing & Work at Chalmers University of Technology, will be explored. Analysis of design-projects from two study-years has now started, where one of the important aspects is the double-perspective of space for living and for working.

Workshops with senior persons

The aim of this smaller project is to investigate the needs for new or further developed products and services concerning physical environments, transports and information- and communication-technology, which are needed for elderly persons to be able to stay in their own homes and have an active life. The method used is to collaborate with Chalmers Senior Association. These persons have both their competence as former professors, teachers etc and the competence of being old. We use several tactics such as a questionnaire, studies of literature and workshops.

The result of the project is still in work: A mapping of needs for new or developed products and services needed for elderly possibilities to live a qualitative and active life. But some general results are already obvious: There is more need for services of different kind than for products. Large needs were found for improvement of the organisation of social services and healthcare. Elderly persons still want to take part in some kind of social context, and therefore spaces for common use are needed.

REFERENCES

Books

Alvesson, M. & Deetz, S. (2000), Kritisk samhällsvetenskaplig metod. Lund. Studentlitteratur.

Andersson, J. (2005), Rum för äldre – om arkitektur för äldre med demens eller somatisk sjukdom. KTH Royal University of Technology, Dept. of Architecture. 2005

Groat, L. & Wang, D. (2002) Architectural Research Methods, … US

Jansson, K. & Taheri, M. (2005), Rätt bostadsstandard istället för bostadsanpassning. (Universal design for a better housing standard instead of home modification). Chalmers University of Technology, Master-thesis in Facilities Management.

Lindahl, L. & Arman, R. (2006,) Att ta bort trösklarna till ett självständigt liv. Slutrapport från studien om nyttan och värdet av bostadsanpassningar. FoU iVäst Rapport 1:2006

Malmqvist, I. (1992), Vardagshus i staden (Multipurpose-buildings for everyday life). ByACTH 1992:3, Chalmers University of Technology, ISBN 91-7032-696-7, diss

Nylander, O. (2007), Bostadens rum (Space of housing). Chalmers. ISBN 978-91-976644-7-9.

Paulsson, J. (2002), Det nya äldreboendet. Ideer och begrepp, byggnader och rum. Svensk byggtjänst. ISBN 91-7332-002-7

Paulsson, J. (2006), Design för alla utbildning. Universal Design Education. EIDD - European Institute for Design and Disability Sweden & NHR

Reginer, V. (2002), Assisted living housing for elderly. Design innovations from the Unites States and Europe. John Wiley & Sons. ISBN 0-471-35182-2

Ryd, N. (2003), Exploring Construction Briefing. From Document to Process. Chalmers. ISSN 1650-6340 2003:12, diss

SOU 2003:91. (2003), Äldrepolitik för framtiden. 100 steg till trygghet och utveckling med en äldre befolkning. Fritzes förlag.

Wijk, H. editor (2004), Goda miljöer och aktiviteter för äldre. Studentlitteratur. ISBN 91-7332-002-7

Others

Conference:

Vårdbyggnadsforum. (2005), Höstkonferens oktober 2005, Stockholm: Tema Framtiden (Conference at Forum for research on Space for healthcare; Several speakers presented trends in space for healthcare in the future)

Magazine:

Samspel. (2007) Tidningen för dig som arbetar inom äldreomsorgen i Göteborgs stad. (Magazine for personnel in elderly-care). Article Hemma hos … 1:2007

Web site:

Göteborgs Stad, (2007) Pilotstudier ska ge svar om äldres boende inför väntad boom. Available at: http://www.vartgoteborg.se

REAL ESTATE STEREOTYPES AND THE WORKING ENVIRONMENT

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ABSTRACT

The working environment is usually inherited by users who are unable to change their nature. Invariably, such workplaces conform to a neutral, impersonal and grey stereotype. Peters and Waterman (1982) said that one of the criteria of success in organizations is the availability of an open and creative working atmosphere. Leif Edvinsson (2006) affirmed, through the concept of 'intellectual city', that talent would flow to the port and harbour that would make them facilitate success as well as offering employees a quality of life.

Each environment possesses particular qualities that are significant for human beings in terms of their lifestyle, survival, residence, free time and work. The response of users to such environments can be valuated in terms of satisfaction, functionality or economic return. The question remains 'which elements of the working environment enable better employee satisfaction and efficiency? In particular, does the possibility for individual control of the working environment bring positive changes in relation to working efficiency?

The results of research in this paper in terms of individual real estate elements are considered in relation to working comfort and efficiency. The synergy between the individual or group and real estate elements is analyzed in terms of technical, social, psychosocial or economic influences. In principal, all the working environments were analyzed through the viewpoint in relation to the sustainability: a renovation of the buildings, an improvement of their economic, social, dwelling and ecological characteristics and their influence on the working efficiency.

KEYWORDS: real estate stereotypes, working environment.

RELATION TO THE WORKING ENVIRONMENT

The relationship of people with its physical surroundings is studied according to the different point of views. Much research has already been carried out on the theme of architecture, urban planning, sociology, political sciences, ethnology, anthropology, geography, environmental management, psychology and social psychology (Rus, 1997). The main questions in environmental research are connected with the interaction between the environment and social behaviour, and their assimilation to the changes that are caused. The interaction models between the individual and the environment are gathering on analyses of social variables considering the influence of physical facts and variable's analyses of nature and shaped environment. The results of these researches show that the characteristics of physical microenvironment can significantly influence the quality of our life.

Each space is shaped by the proportion of the shell that surrounds it (Pirih, 2007). That means the proportion of length, breadth and height of the space. We can talk about the character of the space which is influenced by the: largeness; natural light; orientation of the place; organization and largeness of the windows; views from the windows; the finalization of the walls, ceiling, floor with their texture, structure, materials, colours; shape, materials, colours of the furniture and equipment – when combined they create a specific ambient. In most of the cases the working places are ‘neutral’, ‘impersonal’ and ‘grey’. The modern office should be functional and desirable; the stress should be on colours, natural light and creativity.

Most employees are used to the office furniture being designed without imagination, basic white offices, computers, impersonal spaces; the only sign of personal objects being family photos and plants. Sitting behind the same desk in the same place every day for twenty years the working place can become a nightmare, where the working efficiency is on minimum. The characters and demands of people are all different, including colours frequencies, especially because of the different life periods and experiences that we have and which change us. The changing of colours, even if it includes only colours of walls, is the cheapest and easiest way of establishing the resonance between the ‘giving’ place and personal frequency. This is a precondition for the harmonic effect and it coincides with regular maintenance works. Employees will spend more time in a more pleasurable office. They will be more effective, healthy and happy.

The synergic relation between human and environment was the theme of the research, where the relation of an individual with real estate was studied according to the technical, social, psychosocial, historical, cultural and economical influences (Temeljotov, Zupančič 2005). It concerned the analysis of the relation between the real estate status of family and the social climate and self-evaluation of the family members, values, different orientations, life style, identity and efficiency of the individual. In this paper the results connected with the perception of the working environment and sustainable renovation of the buildings are given.

THE TOTAL RENOVATION OF A WORKING ENVIRONMENT BY MEANS OF EFFICIENT ENERGY UTILIZATION AND RENEWABLE ENERGY SOURCES

Historically viewed the widely extended residential build started at the end of twenties, which was financed by the state and where the municipalities took the responsibility for the urban and residential planning and building. It was natural that society had the residential quality required because of their financial contributions. Until then, the European philanthropic movement were active in improving the housing conditions of workers’ families (Holm, 1988). At the end of the fifties the planners of residential neighbourhoods tried to realize their visions of modern architecture on the locations at the edge of the town, meanwhile they tried to build the workers dwellings near their factories, on worthless locations. Their dwellings were also worthless and without quality.

We deal with new problems today: half a century old non-quality architecture got the status that it wasn’t destined for and which it shouldn’t have. But, because of the logical development of a town and extension of its structure outwards it became a part of the town. The old workers residential neighbourhoods got the new social-economic status and became interesting on the market because of this allocation. The intensive mix of working and dwelling environment, which slowly form a new way of life, stimulates decentralization of urban environment and revitalization of unsuitably designed architecture. The urban environment is more multifunctional as a result of the modified way of life; so different, totally restructured spatial urban and residential planning appeared. The revitalization of old and the integration of new places can be found anywhere in bigger towns or cities.

Working and living environment refurbishment must be planned, from the sustainable point of view, with efficient use of energy (EUE) and introducing the renewable sources of energy (RSE), therefore in low energy level or using passive technologies; which enables:

- High quality working and living environment, considering sustainable principles.
- Energy demand of the buildings is lowered to a level that energy systems are changed; Energy savings and consecutive lower operational costs make higher investments in working and living environment possible.
- Using new technologies of EUE and RSE while energy retrofitting public, residential and other building lead to better economical, social, living and ecological parameters.
- Architecturally interesting and recognizable solutions also promote integral retrofitting of buildings at low energy and passive technology level.

Planning measures of integral energy retrofitting with a goal to reach the near-level of passive technology includes, beside architectural and constructional interventions, changes on building's envelope and installations:

- Elements of building's outer shell are refurbished according to low energy or passive criteria, with modern energy efficient and visually recognisable solutions.
- Increasing energy efficiency of refurbishment is linked to new approaches in the planning of energy systems for heating and ventilation.
- Introducing central ventilation of the building with a technology for heat recuperation that also enables winter heating and summer cooling functions.
- Use of RSE is actively involved in energy production for heating, hot water supply and passive summer cooling.

The goals of the integral energy retrofitting and working environment renovation in public and other buildings are:

- Maximal energy saving and building operational cost reduction with higher parameters of living and working quality achieved.
- Assuring higher air quality leads to better working conditions, higher motivation and better results in work and learning, absence from work is less frequent.
- Efficient utilization of existing space in building and also acquiring new area by architectural measures available within the framework of total building renovation.
- Natural lighting is improved, adequate lighting of working and other surfaces is assured, also prevention of glare; Optimization of artificial lighting enables reduction in electric energy usage.

One of the key psychological concepts within the market strategy is the one of the high and low interference, which is a category of a great influence on the individual behaviour. The questions on customer behaviour are the ones on informational and buying processes, while from the marketing point of view we can talk about effective marketing communication. The insertion is a process of interest or motivation, which is stimulated and directed by internal and external variables. The external one is captured in the communication situation, the internal one in internal i.e. ego values. The internal one is also connected with the different personal characteristics and perception of us. In the reconstruction case, we can talk about long term insertion, which depends on internal variables: how important is the product for individual existence or quality of life, what are the individual experiences connected with the product and the responsible insertion of talking about actual energy politics and teaching processes, which has an influence on the actual behaviour.

THE PERCEPTION OF THE LIVING ENVIRONMENT

Some of the results of the extended research shown in the first part are connected with the perception of the real estate elements in relation to physical and social environment. On the basis of extensive research aided by the questionnaire about real estate and life-style evaluation we continued the studies on particular segments. In the first part the given problem is an importance of social and value orientation, a perception of life style and national stereotypes, which appear at the beginning, during the preservation and a change of social perceptions with references to the space, environment and real estates. The interest was in what extent individual infrastructure and real estate characteristics connected with workplace influence the feeling and conditions at work?

For the purpose of verification a research was carried out on different groups of participants with a wide set of different questionnaires, scales and differentials. The research comprised four groups of participants, chosen to reflect the various of life style, social and value orientation, demographic, socio-economic and socio-culture style: students of psychology (n=25, mean age=25.80, SD=5.8, 0.9 women, 0.10 men); owners or employees of real estate agencies (n=31, mean age=43.55, SD=12.66, 0,4 women, 0.6 men); employees in the public institutions (n=24, mean age=39.20, SD=14.00, 0.6 women, 0.4 men); employees in the field of construction business (n=28, mean age=37.36, SD=10.82, 0.6 women, 0.4 men).

The structure of the perception, in what extent individual infrastructure and real estate characteristics connected with workplace influence the feeling and conditions at work

Table 1. Statistics of Factor Analysis

Variable	Communality	Factor	Eigen value	Percent of explained variance	Cumulative %
Location	1	1	3.92	35.7	35.7
Transport	1	2	1.88	17.1	52.7
Parking places	1	3	1.26	11.5	64.2
Age	1	4	1.12	10.2	74.4
Material	1	5	0.75	6.8	81.2
Floor	1	6	0.58	5.3	86.5

Note. Only some variables with their own value < 1.00 are presented in the table.

Table 2. Matrix of Factor saturation (VARIMAX rotation)

Variable	Factor 1	Factor 2	Factor 3	Factor 4
Location	.07	.89	.15	-.05
Transport	.21	.88	.12	-.02
Parking places	.52	.58	.22	-.01
Age of the building	.12	.12	.85	.10
Building material	.07	.20	.87	-.07
Floor of the workplace	.52	.07	.53	-.08
Accessibility	.68	.36	.09	-.01
Arrangement of rooms	.80	.22	.16	-.07
Colours in office	.77	-.04	.04	.31
New technologies	-.13	-.09	-.06	.92
Clime, info- systems	.25	.03	.05	.88

The four factors were extracted: 'functional accommodation', 'transport accommodation', ‘contemporary' and ‘technical’, all together they explain 74,4% of the whole variance. The first factor, 'functional accommodation' correlates with the variables: parking places, floor of the building, accessibility, arrangement of rooms and colours. The most influential elements are accessibility and colours. As Koželj (1987) said the layout of rooms and also their correct arrangement is one of the fundamental steps of architectural designing. Layout of rooms takes account of the internal functional logic and its dependence on external spaces’.

We found out that the colours surrounding us in the living or working place are very important for our working conditions. Neutral colours in the workplace are acceptable from the neutral influence on feelings, but the most effective is to give employees the opportunity to choose the colours of their offices. On our additional question from the questioner: if you could influence one of the elements from the questionnaire, which one would you change? 62% respondents answered colours. The influence of various colours and light effects are used for different purpose in architecture: psychological-mood, character, view and distance from the social-metropolitan environment, national identity, game of the light as a functional and designed element…

The connection between the attribute ‘floor of the office’ and working buildings were seen in several questioners. The high buildings represent a symbol of social, economic power, reputation and progress of civilisation or state (Barnard, Correa, Moser, 1987). As a symbol they are notable from three aspects: 1/ for national pride, 2/ for individuals in high buildings, 3/ for habitants that accept them as an identifying part of their urban environment. Regarding the ‘transport accommodation,’ we can say that one of the main problem in bigger urban areas in Slovenia is the lack of an efficient public transport system, in spite of the fact that new residential building are built on the peripheries of towns. The last two contemporary and ‘technical’ factors show us the importance of the problem of old buildings and new technologies. Nowadays-modern information links and modern microenvironment are normal conditions for working processes regardless if they take place in old or new buildings.

All correlations show different principles of design in the past and in the present, including functional character of spaces, dimensions, orientations, useful surfaces per number of employees, organization of spaces, and the use of material and accessibility of location in regard to traffic facilities. Today one of the main investment orientations is economical feasibility and this also determines the design in order to attain the best efficiency for the minimum invested means. One of the major current impacts on urbanization is the economical influence, it could be said that urbanization transforms the society. A successful design of urban systems has to take into account modern economical factors.

The example of integral working and living environment refurbishment and its impacts

In the following text the case study of refurbishment of older public building is presented to show the possibilities or potentials for energy and environmental retrofitting, also improving the quality of the living environment. The main goal of the refurbishment is better energy and environmental characteristics whilst architectural improvements are achieved. Energy retrofitting of older public buildings in many countries serves as illustrative showcase of potentials for energy and environmental retrofitting.

Energy retrofitting of public buildings – typically these are schools, kindergartens, elderly institutions, care homes – can even perform reduction of primary energy in proportion of 10:1, while the respective living working conditions are usually substantially improved at the same time. Retrofitting is however not only limited to energy conservation as in many cases new "bio-insulation" materials are build in order to replace less sustainable respectively environmental friendly solutions. In those cases the retrofitting is therefore integral since planners are introducing broader spectrum of environmental criteria for improving performance and extending the lifetime of the building.

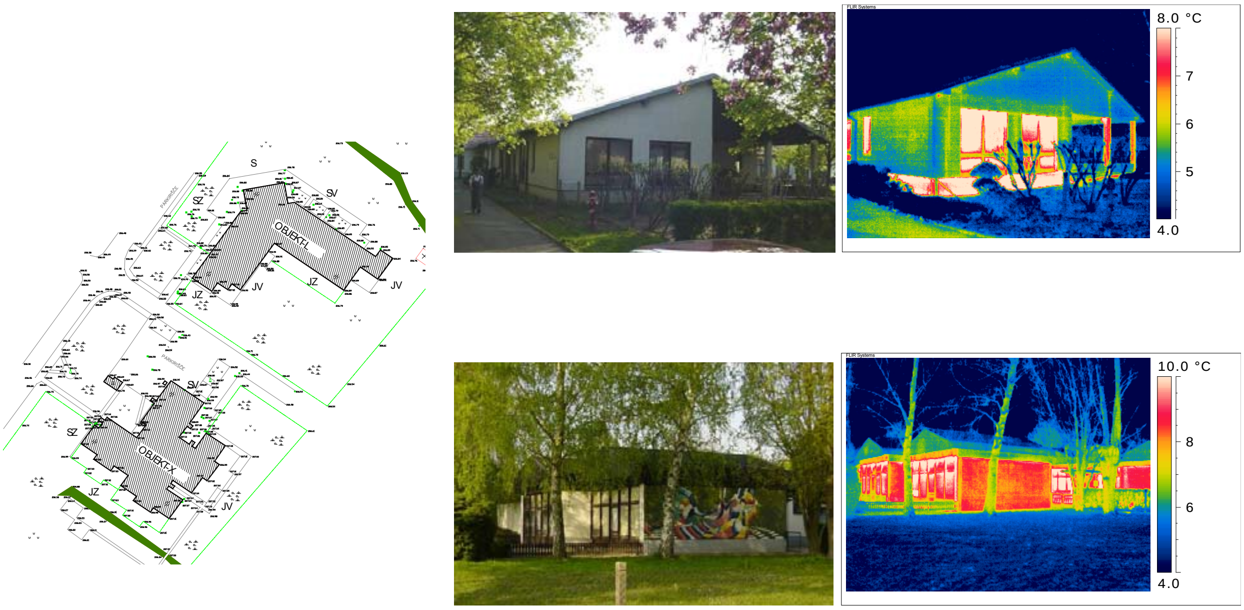

Figure 1: Location; Digital and IR photo

Manko Golar kindergarten in Gornja Radgona consists of two single floor buildings, each around 900 m^2 of net heated area: the older building at Kocljeva street 2 (further on building »X«) that was built in 1975 and a more recent building at Kocljeva 4 street (further on building »L«) that was built in 1982. The project of integral energy retrofitting is introducing energy conservation measures and is proposing the use of renewable energy that are oriented to approach the standard of passive energy building. Following the significantly reduced demand on energy also the energy supply technology must be replaced. With the implementation of new energy conservation and renewable energy technologies while respecting the criteria of sustainable building the renewed kindergarten will achieve better economic, social and environmental baselines for its operation.

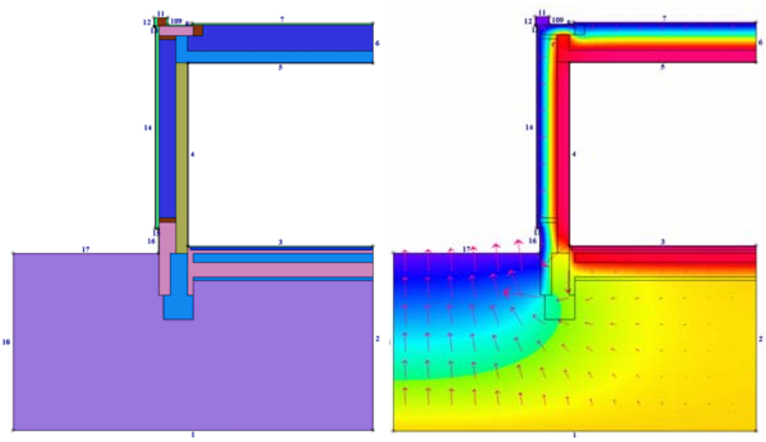

Figure 2: Example of reduced heat bridge through optimisation of price performance ratio

Planning of this “passive technology” demands interrelated knowledge from architecture, civil engineering and energy sciences and contemporary multi-criteria optimization of proposed solutions that are based on the knowledge of interactions among each of the proposed measures. The basis for the project has been established by a former study on energy retrofitting of the kindergarten that has been ordered by municipality. The study has envisaged three basic scenarios of investment: reference scenario without change of existing technologies (at 160 €/m^2 of minimal requested investment), minimal new energy performance standards energy retrofitting based scenario (at 300 €/m2) and advanced scenario of integral retrofitting with passive technology design guidelines (at 500 €/m2).

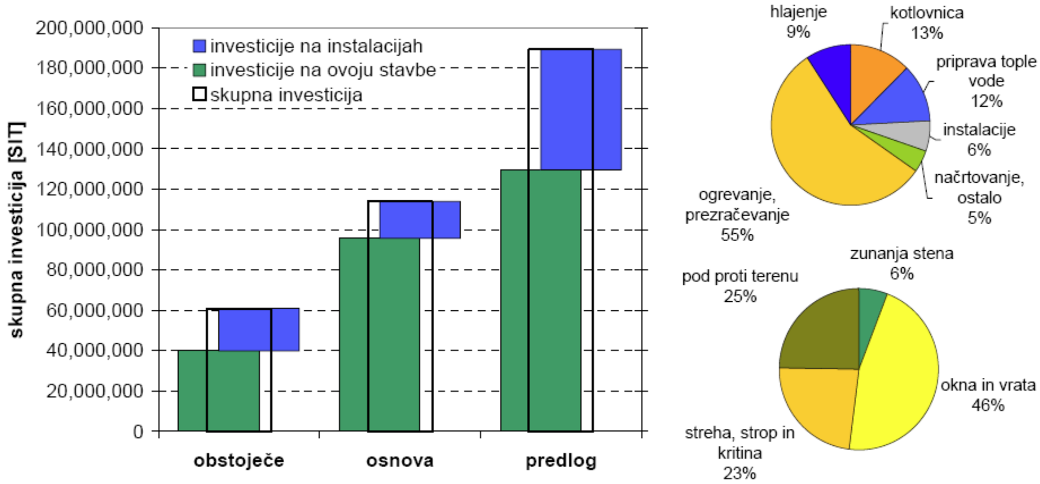

Figure 3: Investment estimation for measures on building envelope and installations.
Overview on investment segments for proposed variant of energy retrofitting

Long-term economic evaluation of scenarios has however generated the conclusions that the second and the third scenario have identical long-term financial output! That means that at the same financial background in case of implementation the users will gain better living/working conditions throughout all seasons.

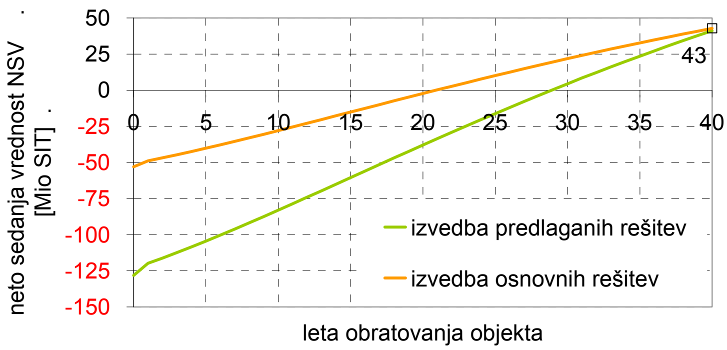

Figure 4: The present value

Unfortunately, indirect long-term financial outputs gained by efficient working and living are hard to be measured precisely. We could assume that these external outputs are significantly larger than the cost savings of the building operation. According to the investment point of view, integral retrofitting of the public building is cost-effective. Evaluation of retrofitting measures on building’s envelope and energy system shows that the annual energy demand for heating will be reduced from 100 to 120kWh/m^{2}a or 14 to 18kWh/m^{2}a – that is a reduction in ratio of 7:1! Changes in the total energy consumption and the structure of used fuels will reduce the annual CO_2 emissions from 100 to 60 ton/a and the total primary energy use in kindergarten's buildings will be reduced from 300 kWh/m^2a to 140 kWh/m^2a.

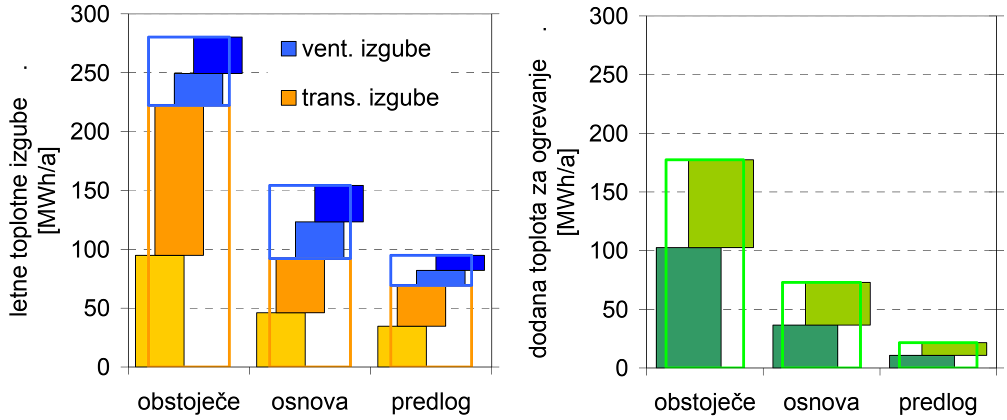

Figure 5: Annual energy loss and additional heating need

The integral approach of building refurbishment on project levels includes the use of sustainable, natural building materials. The advantages of integral sustainable refurbishment in passive standard have long-term effects in improving ecological characteristics. Annually, such buildings need very low amount of energy, but low amount of energy is also needed during refurbishment measure implementations and while producing such biomaterials. After the buildings life span has concluded and after the final disassemble the environment is not additionally burdened. During refurbishment of the building the façades of both buildings are unified. The old parapets were removed and raster of glass surfaces were changed to achieve the repetition of new elements. Such approach is drastically decreasing the total amount of investments. The glass surfaces are almost the same before and after the refurbishment measures. The external screens were installed on windows. The abundance of broadleaf trees around the buildings has a positive influence on natural shading of terraces during the summer time. In parts of the building where children are playing and moving, there are clay plasters, wooden floor and other natural building materials suitable for the children. The colours, which are used, are selected to stimulate the creativity of the children. The wooden terraces by the playrooms are interfaced between the inside and outside living area.

Beside energy retrofitting measures there are also other building measures, which do not influence energy, constructional and functional characteristics of both buildings: sanitary facilities are renewed, the inappropriate asbestos cement roofing tiles are replaced, hydro insulation is repaired, floors are substituted, drainage is improved, plumbing and sewage are modernized, etc.

CONCLUSIONS

This research presents the interdisciplinary of real estate field, where the resolving of real estate problems should also be viewed from the socio-psychological aspect, where the threads of attentions, interests, wishes, and desires interlaces with the productive-technical threads of everyday. The modern time, which is marked by the speed of life and adaptability on everyday modifications, expanse of obligations and efficiency, dictates different comprehension of nature and built environment. Our surroundings is consciously and unconsciously observed, percepted and recorded in our minds. Physical characteristics influence the social behaviour in specific areas, e.g.: size, disposition, sonority, colours, age, height, floor, view, side, access, nearness of the markets, services, largeness, furniture, warming, humidity, technologies, status of the neighbourhood

The project of technical renovation reaches the analysis phase and will be implemented in the beginning of May. We would like to emphasize that the energy improvement gives access to the wider architectural renovation of the final elements, which help to create a better atmosphere in the working and living environment. At the end of the renovation, when buildings will be turned over to it's users, an additional inquiry would be taken to gather data about the well-being in new premises. From the economical point of view the positive results of the renovation are already uncontested.

REFERENCES

Barnard, P.R., Correa, C.M. in Moser, M.M. (1978), Philosophy of tall buildings. New York: American Society of Civil Engineers.

Edvinsson, L. (2007), The intellectual capital of Universities and how it can be developed. Competitive Campuses, 13-15. June 2007, Trondheim.

Goodall, B. (1978), The Economics of Urban Areas. Oxford: Pergamon press.

Holm, L. (1988). KTH , Stockholm, predgovor k knjigi Ivanšek, F. Družina, stanovanje in naselje, Krt, Ljubljana.

Koželj, J. (1987), Tipologija mestne stanovanjske arhitekture in njena sovisnost z morfologijo mestnega prostora, Krt, Ljubljana.

Peters, T. & Waterman, R.H. (1982), In Search of Exellence: Lessons from America's Best – run Companies, New York: Warner Books.

Pirih, O. (2007), Barvna kreativnost, seminarksa naloga, Fakulteta za arhitekturo, Ljubljana.

Praznik, M., Kovič, S. (2006), Elaborat za energetsko sanacijo vrtca Manka Golarja v Gornji Radgoni, Gradbeni inštitut ZRMK, Ljubljana.

Rus, V. S. (1997), Socialna psihologija: teorija, empirija, eksperiment, uporaba, Davean, Ljubljana.

Temeljotov, A., Zupančič, D. (2005), Odnos do nepremičnin in organizacijskega okolja, Slovenski inštitut za revizijo, Ljubljana.

FM TOOLS TO ENSURE HEALTHY PERFORMANCE BASED BUILDINGS

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ABSTRACT

The paper is aimed at presenting the needs to monitor building performance and a description of tools for the purpose. The need arises mainly from the necessity to observe compliance, and the need to provide consistent performance to the clients of the spaces. As various user groups are utilizing the same performance data to ensure optimal and healthy conditions, the integration of performance data to deliver meaningful and exploitable results for each user needs (1) collection of the relevant data, (2) compilation of data into information, and (3) delivery of user specific information to the correct instance. For this need, a performance sensing system with data management was developed into facility management tool. The paper discusses it's usefulness for coping with performance based healthy facilities. Such tools are becoming necessity for facility management because of the profession is turning increasingly into the provider of performance to meet the user requirements.

KEYWORDS: performance based buildings, healthy buildings, sensing, data management

INTRODUCTION

The necessity for improved performance and condition monitoring in structures arises from the recent performance-based building methodologies. Performance based building (PBB) has come to the fore over the last ten years, when changes in the client – provider relationship were mandated by the World Trade Organization (WTO, 1997) with the 1997 Agreement on Tariffs and Trade - "Whenever appropriate, Members shall specify technical regulations based on product requirements in terms of performance rather than design or descriptive characteristics." The U.S. government has made performance-based contracting mandatory (The USA Federal Acquisition Regulations, 2000). In Europe, there are many initiatives, both at the national and at the Union level, such as the Construction Product Directive, to promote the same end. This necessitates a standardization effort to describe the target performance rather than the structural solution, and has led to developments such as the CIB Proactive Programme for Performance Based Building Codes and Standards (Foliente et al., 1998).

Whether the PBB approach is used explicitly or not, a required performance is always embedded in the building process. It is important for the project delivery team to be able to predict not only the performance of the parts, but also how the whole will perform when all the parts are synthesized (Szigeti and Davis, 2001). During operation, both performance and condition must be monitored with sensors. The statements of user requirements (i.e. according to definitions by ISO, 1984) provide the reference point of a facility or constructed asset, as a complete product. PBB changes the time scale of the contracting process. Traditionally the contractor produces a structure to some stated specifications as to materials, assembly method, finish, etc. mandated by the architect/engineer. Once the building is accepted by the owner, the design/build team no longer plays a role. In the PBB environment the design/build team must warrantee and maintain structural performance to the level stated in the contract, for the extended duration of the contract. This requires measurement, hence sensors.

The two key parameters selected here for the observation of the performance of a building are humidity and temperature. In terms of healthy indoors conditions, hygrothermal performance is essential; it plays a major role in follow-up of the healthiness of a facility. For facility management, optimisation of temperature has also significance for economic aspects, and in a wider context, for the sustainability at large as an energy use issue.

HUMIDITY AND HEALTHY PERFORMANCE

Known critical items for condition and healthiness related performance monitoring are the aspects of humidity and temperature. Hygrothermal analyses have become more important in building design as moisture damages have become one of the main causes of building envelope deterioration. Water and moisture can cause structural damage, reduce the thermal resistance of building materials, change the physical properties of materials, and deform materials. Not surprisingly, moisture problems are the main cause of building damage. It is estimated (Ronald 1994, Bomberg and Brown 1993) that 75-80 % of all the problems with building envelopes, to a certain extent, are caused by moisture. Haverinen (2002) has classified moisture damages. In her cross sectional analyses of moisture findings in the Finnish housing stock she has reported that some 38 % of the detached houses and 26 % of the apartments have notable or significant moisture problems. Similar results are found in other Nordic countries. The presence of home dampness and/or moulds (that is damp spots, visible mould or mildew, water damage, and flooding) was reported by 38 %in Canadian study (Dales et al. 1991). These estimates show that moisture problems are a serious issue and have a strong economic effect. In fact, repair of extensive problems is very expensive. According to estimates by Pirinen et al. (2005), expenses to repair microbiological damages causing health effects, are in the magnitude of 10000-40000 € per case. But even worse are the excessive moisture related health effects on the occupants. The evidence of a causal association between dampness and health effects is strong. However, the mechanisms are unknown, as shown in comprehensive reviews by Bornehag et al. (2001 and 2004). Common symptoms associated with moisture problems are respiratory symptoms, sensitization to house dust mites, asthmatic symptoms or emergency room visits due to asthma as well as tiredness and headaches. Causal association between dampness and health effects shows that avoidance and control of moisture problems should be an essential concern in public health issues.

Hygrothermal analyses are needed to demonstrate the acceptable performance of structures and to construct healthy buildings with good indoor air quality. Hygrothermal models are useful tools in assessing the heat and moisture performance of building envelope systems and optimizing these systems for maximum hygrothermal performance and longer service life, but they also need correct climatic data for boundary conditions. Moisture conditions in building envelopes depend strongly on indoor and outdoor climatic conditions. Standardized methodology for dynamic moisture design and hygrothermal loads does not exist yet (Kalamees, Vinha and Kurnitski, 2006). Therefore sensing offers a way to both observe the actual hygrothermal performance and monitor safety both in structural and occupational sense.

As the excessive humidity is a known degradation factor, and in particular a major contributor to the adverse heath effects both in residential and other indoors spaces, its monitoring and resulting control are a major technical performance factors.

ENERGY AND ECONOMIC PERFORMANCE

A key economic performance indicator of a building is energy consumption. According to the common European energy policy Green Paper, the major guidelines of the energy policy are sustainable development, competitiveness, and security of supply (European Commission, 2006). To achieve that goal, the consumers need to be motivated and able to make choices. A large fraction of the potential savings from rational use of energy can be attained if governments give the responsibility for implementation to the proper actor. A proper actor is one who does not suffer a financial loss due to implementation. To be able to act rationally, the actual energy consumption and costs needs to be known to the decision makers. If the provision of the needed information comes with ease and at minimal cost, the demand-side management decisions can be guided to actual energy savings.

For electricity, production and consumption is simultaneous – it is not readily storable. In the Nordic countries, the peak consumption of electricity is reached only on a few winter days of the year, namely the coldest morning and afternoon hours. In many industrialized countries with warm climate, the peak consumption occurs on the hottest summer days as a consequence of cooling systems operating during times of high consumption of electricity for other purposes. There are obvious reasons – high peak demand requires commissioning expensive power plants to be used only for peak periods. (There are also elaborate pump-storage and compressed air schemes, but they also are enormously expensive.)

In California, peak load is strongly dominated by air conditioning, followed by commercial lighting and miscellaneous. Residential air conditioning alone accounts for nearly as large a portion of peak load as the entire industrial sector (Brown and Koomey, 2003). Although high rates remain a focus for the state, the challenge of ensuring adequate electricity supplies, especially during high-demand peak periods, has emerged as the critical issue. The 2004 Energy Report Update expressed serious concern over dangerously low reserve margins, especially in light of the expected retirement of aging power plants.

Demand rates are usually cheapest during the hours between 10 PM to 7 AM, when grid demand is lowest. In Finland are also specific winter rates valid from the beginning of November until the end of March. The intention is to cut peak consumption rates, in particular during the coldest periods, with the incentive of cheaper night time rates. Preferably, domestic heating will be mostly during the night, with massive structures and hot water containers to store the heat.

The use of locally measured data has the potential to spur a reduction in electricity consumption during the peak hours. In Finland this means reduction of heating and unessential electronic equipments during the coldest times. In California this would cause lower consumption of domestic electricity during the hottest hours. To truly motivate the users, there needs to be clear real time indication of both the consumption and its cost.

A TOOL TO MANAGE THE PERFORMNCE OF A FACILITY

A facility manager is a professional decision-maker. Informed decisions rely on originally correct data reduced into valid information. This encompasses a process of data collection, reduction of data into relevant concise information, and presenting the information in a user friendly manner. Notably the same data can be processed for various needs and displayed according to the specific interests of a particular user. A powerful facility management tool needs to be able to handle collection of massive amount of data and communicating it as information to the facility manager (and other actors of the facility use and maintenance).

Sensor data collection

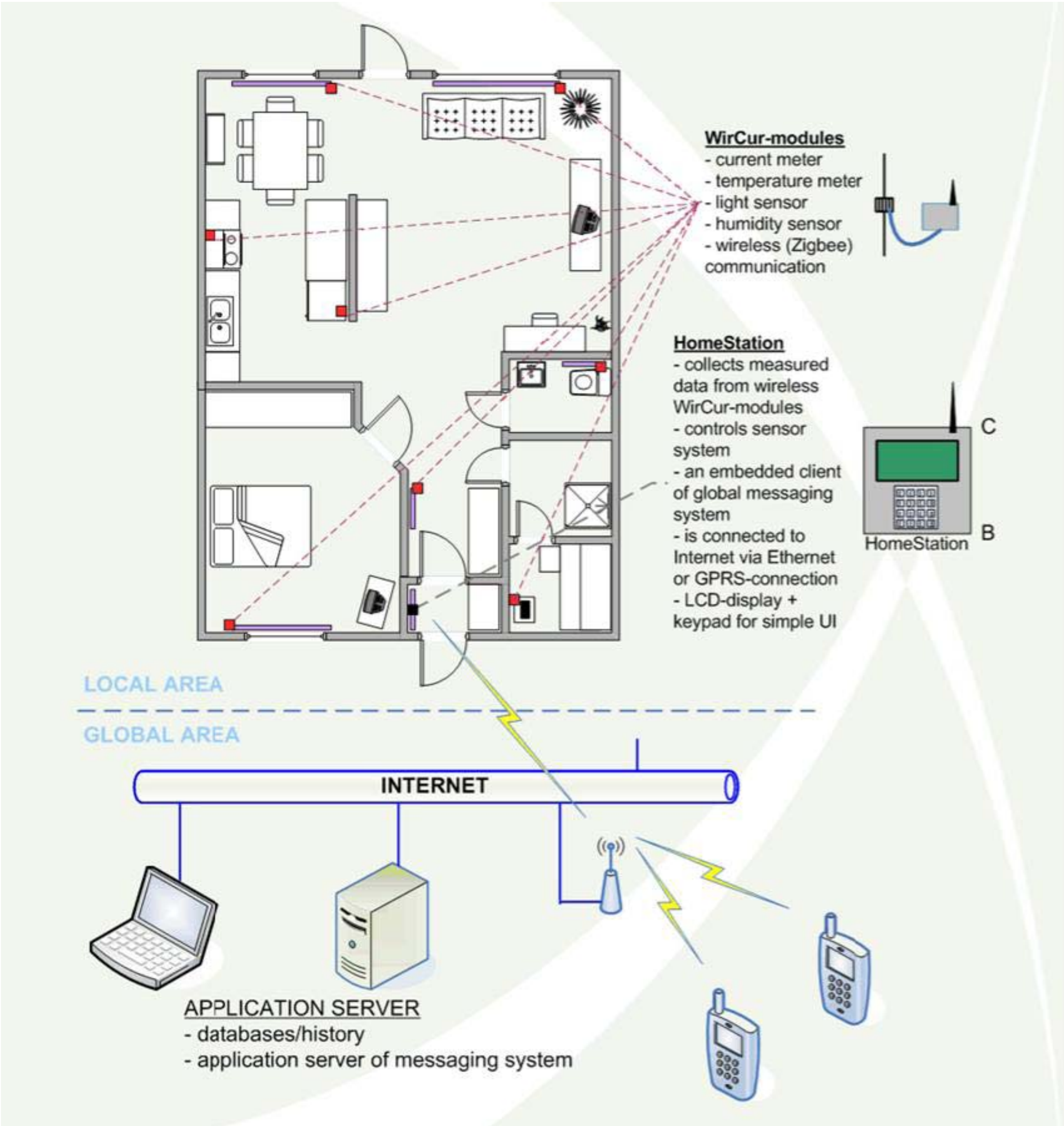
Dense sensing offers a powerful mechanism to observe the actual hygrothermal performance, building safety in the structural and occupational sense, and power consumption. In order to monitor hygrothermal conditions in real time and with fine granularity, VTT (Technical Research Centre of Finland) commissioned a Mote called WirCur. This is a multi-sensor Mote, including electric current flow, temperature, humidity, and illumination transducers, and data transmission via Zigbee wireless. This device can be manufactures for a reasonable cost since MEMS (Micro-Electro-Mechanical Systems) technology makes available inexpensive and accurate transducers to measure all these variables. For instance, hygrothermal data is extremely simple to measure with current sensors, such at the Sensirion SHT15 (CMOSens®) relative humidity sensor (range 0 - 100% rH, accuracy ±2%) which also measures temperature measurement with an accuracy of ±0.3°C, linearizes and temperature compensates the data, and digitizes it, at a cost of $12. Illumination sensor is commercial Osram SFH2400FA photodiode connected to 10-bit AD-converter of multisensor node. The described WirCur Mote can be utilized for several needs. It is a tool for observation of performance compliance enabling proactive condition control for several environmental variable, and serves as a source of data for optimizing energy consumption. The same data can be refined into relevant information for various user groups, with user interfaces essential to enable genuine decision support.

Utilization of the data for facility management

The data is accordingly to the set of sensors. In this case, sources of data are (1) multisensor nodes (WirCur, including electric current and temperature meters, humidity and illumination sensors, a electric current meter, and wireless Zigbee communication) which measure environment conditions and transmit measurements to a building terminal over wireless or wired communication or (2) individual sensors (selected upon special needs) which are connected directly to the building terminal.

The data flow from the sensors occurs as wireless short range radio communication between the multisensor nodes and the house terminal, where the data can be stored. (The multisensor nodes may be connected to the terminal either via wireless or wired media, and individual sensors can be directly connected to the terminal.) The terminal collects and saves the measured data from multisensor nodes (or individual sensors) and transmits data to the server (figure 1). The communication with the server is either via Ethernet or GPRS (General Packet Radio Service) connection using standard XMPP (Extensible Messaging and Presence Protocol) instant messaging protocol. The server saves the measured data to a database. The data management (command and control messaging) is using standard hybrid person-to-person messaging protocol XMPP.

Figure 1. Data collection with sensors and utilization with different applications i.e. through PC or mobile phones.



Different terminals or equipment are same level peers of the system as the data storing terminal, also one or more software agents for autonomic computing and data saving to database are same level peers of the system. WWW (World Wide Web) command and control UI (user interface) is provided using software agent as a gateway. Communication between peers is routed confidentially and securely. Dynamical WWW pages offer different instances of the saved data (i.e. through PC, pocket PC, mobile phone), as e.g. graphs of room temperature during the past three months

The use of sensor output data has i.e. the potential to reduce electricity consumption during the peak hours. User interface with display to see the consumption and the cost of the consumption may direct the user decisions towards allowing deviation from the optimal comfort zone. In Finland this would mean reduction on heating and reduction of redundant use of electronic equipments during the coldest winter period. In California this would cause lesser domestic electricity use for hottest time. To truly motivate the users, there needs to be clear real time indication of both the consumption and its cost.

The WirCur Mote is not unique in the sense that a similar operating sensor system has been developed and utilized at the University of California, Berkeley (Wright, 2006). Simultaneous to the development of WirCur, Wright spearheaded a CITRIS project for the California Energy Commission to optimize domestic energy use. The balancing of occupant comfort versus energy price has been made simple with user-friendly displays and a preference slider for adjustments of conditions. Within each house, the electricity meters are capable of receiving real-time electricity tariffs and automatically initiating responses that reduce overall energy cost, while being responsive to occupants' preferences. The meters also act as a platform to support other sensors and actuators, with a good portion of the development effort spent on providing a user interface that is clear and intuitive to typical residential users (Arens et al., 2005). The system will be rolled out state-wide beginning in 2008.

CONCLUSIONS

PBB evaluations can and should be performed in a routine manner. In practice, evaluations are often made only as part of commissioning or shortly thereafter, or when there is a problem. In order for any measurement and evaluation to be truly meaningful, they should refer to explicit requirement levels against which they can be judged. The performance of a building has some physical factors that serve as principle indicators. For condition monitoring, temperature and humidity are key indicators, which are also major factors for performance evaluation. In the use phase, maintenance and energy consumption are the main cost components, and directly relate to user comfort and services. All these items can be objectively evaluated by sensor data. In all, the only way to quantify performance is to measure performance indicators. This requires proper sensors and measurement techniques. The wider the variety of performance metrics that need to be determined, the more sensors are needed. This requires small, inexpensive sensors placed in dense arrays, with simple communications (Glaser et al., 2005).

Sensing is becoming an essential element in facility management, from procurement to operation. Its importance is obvious for validating of the outcomes in performance based commissioning and construction, which is being pushed by US and EU. Sensing provides a tool to observe the output of the whole system in actual operation, which is the actual target of commissioning and continuous commissioning. In case of disputes, all parties benefit from sensor data.

The future scenario for the construction industry is that increasingly more the clients will purchase the performance of the structures in stead of the physical means for providing it.

The decision making of the operation phase then becomes an integrated part of the initial design and construction. When operation period is taken under consideration, changing on circumstances became more critical. Sensor data is becoming essential for professional operation of built environment. The tools to deliver the sensor data refined into user specific information will be an element of facility management.

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REFERENCES

Arens, E., Federspiel, C.C., Wang, D., and Huizenga, C. (2005). “How Ambient Intelligence Will Improve Habitability and Energy Efficiency in Buildings” in W. Weber, J.M Rabay and E. Aarts (Eds.) Ambient Intelligence, Springer, 63-80.

Bomberg, M. and Borwn, W. (1993). Building Envelope and Environmental Control: Part 1- Heat, Air and Moisture Interactions. Construction Canada 1993; 35 (1): 15-18.

Bornehag, C.G., Blomquist, G., Gyntelberg, F., Järvholm, B., Malmberg, P., Nordvall, L., Nielsen, A., Pershagen, G., Sundell, J. (2001). Dampness in Buildings and Health. Nordic Interdisciplinary Review of the Scientific Evidence on Associations between Exposure to "Dampness" in Buildings and Health Effects (NORDDAMP). Indoor Air 2001; 11 (2): 72-86.

Bornehag, C. G., Sundell, J., Bonini, S., Custovic, A., Malmberg, P., Skerfving, S., Sigsgaard, T., Verhoeff, A. (2004). Dampness in buildings as a risk factor for health effects, EUROEXPO: a multidisciplinary review of the literature (1998-2000) on dampness and mite exposure in buildings and health effects. Indoor Air 2004; 14 (4): 243–257.

Brown, R.E. and Koomey, J.G., (2003). Electricity Use in California: Past Trends and Present Usage Patterns. Available at: *Energy Policy*, 31(9), 849 – 864.

Dales, R. E., R. Burnett, H. Zwanenburg. (1991). Adverse Health Effects Among Adults Exposed to Home Dampness and Molds. The American review of respiratory disease 1991; 143: 505-509.

Glaser, S.D., Shoureshi, R., and Pescovitz, D., (2005), Future Sensing Systems. Smart Structures & Systems, Vol. 1No 1, pp. 103 - 120.

European Commission (2006). “The GREEN PAPER Energy.” Avaiable at: http://ec.europa.eu/energy/green-paper-energy/index_en.htm

Foliente, G.C., Leicester, R.H., Pham, L. 1998. Development of the CIB Proactive Programme for Performance Based Building Codes and Standards. Council for Recearch and Innovation in Building and Construction (CIB). CSIRO Building, Construction and Engineering, Australia. 71 p.

ISO 6241-1984 (E). (1984). Performance standards in building - Principles for their preparation and factors to be considered. International organization for standardization. 10 s.

Haverinen, U. (2002). Modeling moisture damage observations and their association with health symptoms. Doctoral Thesis, National Public Health Institute, Department of Environmental Health, University of Kuopio, Kuopio, Finland. Report A10/2002.

Kalamees,T., Vinha, J. and Kurnitski, J. Indoor humidity loads and moisture Production in Lightweight Timber-frame Detached Houses. Journal of Building Physics, Vol. 29, No. 3 – January 2006.

Pirinen, J., Karjalainen, J., Kärki, J-P., Öhman, H., Riippa, T. (2005). Homevauriot suomalaisissa pientaloissa (Mould damages in Finnish detached houses). Sisäilmastoseminaari 2005. SIY report 23, SIY Sisäilmatieto Oy, Espoo (in Finnish).

Ronald, P.T. (1994). Relevant moisture properties of building construction materials. In: Trechsel, H.R. (editor). (1994) Moisture control in buildings. ASTM Manual series, MNL 18, Philadelphia, USA.

Szigeti, F., and G. Davis. (2001). "Functionality and Serviceability Standards: Tools for stating functional requirements and for evaluating facilities, in Federal Facilities Council, Technical Report 145." In Learning From Our Buildings: A State-of-the-Art Practice Summary of Post-Occupancy Evaluation. Washington, DC, USA.

U.S. Federal Government. (2000). Federal Acquisition Regulations 2000. Washington, DC, USA.

Wright, P., (2006). The Built Environment, Energy, and Sustainability, or, Intelligent Infrastructures. *CITRIS in Europe*. June 2006, 27 p. Available at: http://www.citris-uc.org/files/2006-06-20-CITRIS_Europe/6.1-PAUL-WRIGHT.pdf

WTO. 1997. First Triennial Review of the Operation and Implementation of Agreement on Technical Barriers to Trade. Document G/TBT/5 Attachment, Committee on Technical Barriers to Trade. World Trade Organization. Geneva, Switzerland.

UNLOCKING CREATIVITY WITH THE PHYSICAL WORKPLACE

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ABSTRACT

Today's businesses have to become more creative and innovative to deal with growing competition and globalization. The physical workplace can be of value for facilitating creativity. This paper reports on research conducted on the aspects that determine creativity and a case study which investigated the relations between creativity, creative work and creative work environment with a creative organisation. The paper proposes a model to position relations, elements and forces that determine the match of a creative workplace and its occupiers. The framework positions creativity, creative work and an appropriate work environment. It helps to unravel the complexity of facilitating creativity and creative work processes. The case study emphasizes the importance of clear definitions, and illustrates the meaning of lay-out, colour, light and space for presenting ones work.
The framework is a hypothesis. The application of the model still relies heavily on the insight and current knowledge of facility managers about their organisation and context. The paper offers guidelines and ideas for facilities managers to understand how creativity can be unlocked with the physical workplace.

Key words: creativity, creative work, workplace, workspace

INTRODUCTION

Company performance is becoming more and more dependant on an organization's ability to be creative. Businesses distinguish themselves through their capacity for continuous innovation (Nonaka and Takeuchi, 1995, DeGraff, 2002). Innovation can be seen as the successful introduction of new products and services. Creativity is necessary for innovation (Jacobs, 2005).
Office work is becoming less administrative and also less time and place dependent. At the same time work is becoming more complex, creative and knowledge intensive (Hazeveld, 2006, Kampschroer et al, 2007, Becker, 2007). Office space can contribute to company performance (Allen, 1997, Becker, 2001, Brill, 2001, Croon et al, 2003, Voordt, 2003) . Literature further suggests that the physical work environment can have a positive effect on the creativity of an organization (Nonaka, 2000, Worthington, 2000, Florida, 2002, Becker, 2007). However it stays unclear how and under what conditions this added value can be realised.

This paper aims to further conceptualize the creative potential of the physical work environment by identifying and exploring the various relationships between creativity, creative work processes, and the physical workplace. Furthermore it proposes a model to position the relations, as well as the elements and forces that determine the match of a creative workplace and its occupiers.

APPROACH

The knowledge and framework presented in this paper is based on the following three research projects undertaken by the Center for People and Buildings in the period 2005 to 2007.

1. *People, work en work environment in the IT-age*, is a research program which included five research projects focussing on the impact of ICT on office accommodation (Martens, Hazeveld, Achterberg, Pullen, 2005 and 2006)
2. Literature study on creativity and the physical workplace: Literature review, aiming to identify a theoretical framework for exploring the variables for unlocking the creative potential of the physical work environment. Method: exploratory, snowball sampling.
3. *Stimulating Creativity with StudioMingle*, a case study with a creative organization on the impact of the physical work environment on creativity (Gielen, 2006)

Towards a model for the creative work environment

In order to distinguish the variables between creativity, creative work processes and the physical work environment I have designed a research model based on two earlier models:

- a model for the quality of an office by Wentink (1999), and
- a conceptual framework on the relationship between office innovation and the performance of the organisation by Van der Voordt & Vos (1999).

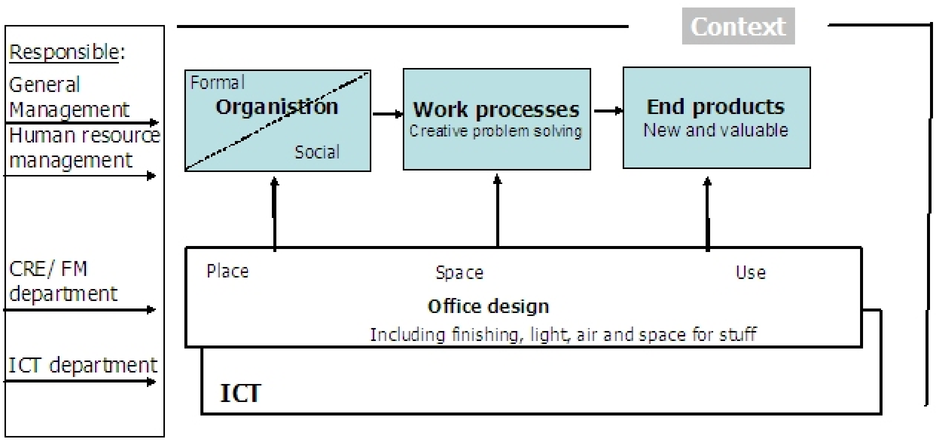

Figure 1. Framework: the contribution of the physical work environment for creativity and creative work processes

The framework presented is an amended version of Van der Voordt & Vos (1999) model. The model (Van der Voordt & Vos (1999) portrays the interaction between facilities (Housing, ICT, other means and services), organisation and work processes within a business context. Adjustments in one of these variables will affect the quality of the end product.

Insight from literature and the experience with Wentinks model lead to modification. A distinction is made in the formal and social part of 'Organisation'. Literature point out that creativity within organisations is highly influenced by the social work environment.
Wentinks model makes a clear distinction between a social subsystem and an organisational subsystem, next to a spatial and technological subsystem. Wentink sees the office as an open

system with a structure of subsystems and relations. Three case studies and interactive sessions with participants from six different organizations, showed this model is useful in discussion with office end-user organisations as the subsystems are easy to translate to responsible departments: ICT, HRM, GM and CRE/FM. Both literature and the cases indicate that organizations awareness, alignment and integrated management on all four subsystems, are useful in order to fulfil organizations objectives. The adjustments in Voordt and Vos model emphasize the importance of the subsystems and will also help to communicate better.

Creativity, creative work processes and the creative workplace

Empirical research (Csikzentmihaly, 1996) shows that the right place and the right time are essential for creativity. Buildings and the configuration, design and management of space can both constrain and support the exchange of ideas and the flow of knowledge. The challenge for a firm to grow and prosper, is to have the ability to capture, share and innovate from that knowledge (Worthington, 2000).

Creativity, productivity and the work processes

Creativity is “the ability to create”. Creativity can be defined as:

- “the imaginatively gifted recombination of known elements into something new “(Ciardi 1956)
- “The ability to fluently solve problems with original, innovative, novel and appropriate solutions (Guilford 1967)
- Creativity is doing new things with old things (Sutton, 2001)

Creativity is about breaking through existing patterns and realising new combinations. Csikszentmihaly (1996) discusses two terms which are important to indicate if something is creative: new and valuable. New means unusual, unique, new points of view, varied, original, breaking from existing patterns. Valuable means useful, effective, efficient and contributing to society.

Creative workplace

Literature (Andriopoulos, 2001) highlights five organisational factors that enhance creativity in a work environment: organisational climate, organisational culture, leadership style, resources and skills and structure and systems. Mathissen and Einarsen(2004) mention that creative and innovative behaviours at work seem to be promoted by a cognitive flexibility created by a combination of both personal qualities and work environment factors (West & Richards, 1999 in Mathisen and Einarsen, 2004). Work environment factors that promote creativity are: a feeling of shared, clearly-specified objectives, as well as a possibility to challenge them; exchange of opinions or ideas; constructive controversies; freedom; challenges at work; trust and safety; team participation and collaborative idea flow; and open relationships between colleagues, as well as between supervisor and subordinates. Most of these factors have demonstrated predictive value in relation to creativity and innovation (Mathissen and Einarsen, 2004).

Creative work processes

Creativity and innovation depend on the free flow of information, but also on the recombination of non-obvious knowledge in ways that trigger novel solutions to complex problems (Hargadon and Sutton 1997 in Becker 2007). Creative work is mainly project work in circles with both intense and slower periods. Creative work requires enormous concentration, and people require flexibility so they can have some personal downtime even during the day (Florida, 2002).

Kristensen (2004) states that creative processes are mental processes. Creative thinking is hard to turn on and off (Florida, 2002:125): when people have the flow of their creative work interrupted it typically takes them 20 to 30 minutes to refocus.

Creative knowledge work is both highly cognitive and highly social (Heerwagen, 2004). Workers need time alone to think and develop ideas, drawing on their own memory, insight and analytical skills. “Creative moments exist by the sake of breaks” (Interview Prof. J. Buijs, 2007). They need ‘hassle-free’ time for non-conscious processing that aids creativity and imagination (Claxton, 2000 in Heerwagen, 2004). In order for ideas and concepts to become useful to an organization, they must be made available to others for examination and further development.

Wallas (1926 in Kristensen (2004)) recognises four phases in a creative process: 1) preparation (facilitating data and information for the process) 2) incubation (implicit cognitive process, primarily individual) 3) insight (a ‘flash’ that occurs when the wining concept cuts cross the barriers of consciousness) 4) elaboration and evaluation (comparing results to the goals of the preparation stage: are goals and values met?).

The creative process can be seen as a process with different stages with different activities. Generating ideas and coming to new and valuable insights, though important, are only a small part of the process. The whole process includes highly cognitive individual and collaborative tasks. In order to create, ordinary tasks which are less cognitive are required. The different stages could indicate that in modern organisations different people with different tasks and competencies are involved. Another possibility is that workers are involved in various creative processes which are in different stages. Different simultaneous projects would require them to be analytic at one moment and highly communicative a minute later. Facilitating creativity from a creative process and activities perspective could mean different workspaces for different activities, but also one workspace that supports all the entwined activities.

Creativity and the physical workspace

Creativity can take place everywhere. Archimedes was taking a bath when he yelled *eureka*. Technology provides creative office workers with the tools to work wherever one goes. Office work is done in different places (at home, on the road, or at the office) (See Vos at all , 1999) and knowledge workers need mobility and spend a lot of time out of their offices. They spend up to half of their time out of their offices, either in meetings, talking informally in other peoples' offices, or travelling (Davenport, 2005).

In the context of independence of time and place, knowledge workers don’t want to consider their home office, or matter of transport to be their office(Van Meel and Vos, 2001). It is extremely important for workers to have a common space where they meet colleagues, learn, have small talks with their boss (if they have one) and catch up with all the new gossip.

New workspaces that accommodate creativity share a number of practical features (Florida, 2002, Worthington, 2002):

- Corporate real estate has to serve a statement and is used as a marketing vehicle.
- The workplace has an experimental component: creative workers like visual stimulations.

- The new workspace is productive in the sense of being adjusted to the flow of modern creative work. It provides diversity: a wider and richer range of work settings that can support creative and collaborative work.
- Sharing: increased amount of shared space, space that is not owned and can be used by different staff over time.

Creative interactions can just as well take place in individual offices. Grajewski (Grajewski, 1993 in Kornberger and Clegg, 2004) found that 64 percent of all interactions happened in individual offices, and not, as intended by the planners, in the multi-rooms, café shops, and meeting rooms. The major task becomes how to combine the protection of the solitary with the natural generation of more randomised with others. (Hillier 1996:265 in Kornberger and Clegg, 2004).

Stimulating Creativity with Studiolab

At the same time research was undertaken (Gielen, 2006) with our colleagues from the faculty of Industrial Design. Their workgroup StudioLab focuses on four research lines: Designing for the Senses, Design and Emotion, Inspiration Engineering, Intelligence in Products.

Studiolab had at that time four connected studio's, StudioSay, StudioMake, StudioDo and StudioMingle, with each their own goal: StudioSay is their meeting space. StudioMake and StudioDo is the space where prototypes are made and tested. StudioMingle is a collaborate space with individual workstations to provide researchers a workspace. This space was evaluated.

The basic idea about StudioMingle was as followed:
- Crosspollination through interaction and informing each other through speech and exposed work.
- Intensively used, over 30% of the desks should be occupied at all times.
- A protected environment for its users.

The research investigated the perceived contribution of the office space to creativity. A literature study primarily based on McCoy and Evans (2002) narrowed the aspects of the physical environment to be investigated to lay-out, furniture, colour, finishing and light.
A questionnaire was set out under all workers within StudioMingle. They were asked about their accommodation needs in relationship to creativity, their satisfaction on these points and the required adjustments. Both open and enclosed questions were asked. Additional interviews and observations were undertaken to enrich the data and elucidate findings. Nineteen of twenty-one end-users responded to the questionnaire. Fifteen questionnaires were eventually suitable for analyses.

StudioMingle is open plan workspace measuring 10 by 18 meters. The details are as follows:
Lay-out
- 18 workstations, a small break-out couch and table and a little kitchen.
- total of 180 m2 for 18 workstations
- Workstations are 4 m2 with 1.5m2 of desk space.
- 40% percent of the floor area is covered with furniture.
- Visual contact is possible from 12 of 18 workstations.
- 6 workstations are positioned towards a wall or filing cabinet

- The main route leads right through the centre of the office. The printer is on one end, and the water tank on the other.
- All workstations are personal but (temporarily) unoccupied workstations can also be used by other researchers.

Furniture

The furniture in StudioMingle is limited to desks, chairs, filling cabinets and one couch. The higher filling cabinets (approximately 2m) are placed against the wall so the whole room remains visible. Smaller filling cabinets of 1,30 meter high, are situated next to the workstations.

Colour

The used colour within StudioMingle is mainly white and grey. All walls, pillars and ceilings are white, all filing cabinets are grey, as is the floor and the frames of the desks. Thirty percent of the room is filled with colour: mainly in the break out and small personal belongings

Finishing

Variables	**Percentage of total area space**	**Finishing in StudioMingle**
Natural materials	15%	Desks, plants, homemade bamboo furniture
Stone based Materials	25%	Walls
Transparent materials	10%	Windows
Synthetic	38%	Linoleum floor and personal belongings
Metals	9%	Frames of desks, rolling cabinet, trash cans
Cloth	3%	Break out: couch and carpet

Light:

Light comes from a natural source through 26 m2 of window, artificial lighting is provided by TL (Tube Light) and 18 small desk lamps adding a maximum of 80 lux.

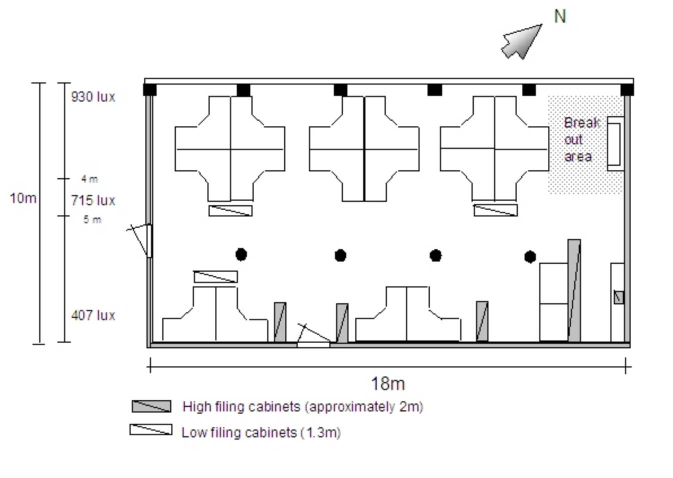

Figure 2 Floorplan StudioMingle

Figure 3 Interior of StudioMingle

Organisation

StudioMingle is occupied by a diverse group of researcher. The fifteen responding users consisted of students (3), PhD-students (5), a researcher (1), guest researchers (2), a teacher (1), teacher and researcher (2) and a teacher and support staff (1). Most of them work les than one year (7) at StudioMingle and four work longer than five years. Ten users are between 21 and 30 years old, three were between 31-40, one between 41-51, and one user was over 61 years old.

Five employees work 40 hours per week at StudioMingle, all other researchers work less hours at StudioMingle: 3, 8, 18, 20 (=2persons), 23, 24, 30, and 36 hours. So five workers work permanently in StudioMingle, the others together 20 hours average. At StudioMingle they primarily do ‘working with the computer, reading and writing’ (66% of the time). Ten percent of the time is spend on informal meetings. No information was collected and no questions were asked and about the social work environment.

Creativity and creative work

Users had different opinions about what creativity is. Some feel it is a mental state: feeling sparked, bending existing rules or just sensing. Others considered it a process of thinking and building, communicating towards novel, useful and creative outcomes or thinking and shaping old things into new things.

Creative work was also perceived divergently. The users perceived they were creative in StudioLab by ‘thinking of new products, ways of working etc’, ‘meeting with others’ and ‘having a different view of something that already exists’. Designing by making drawings and sketches was mentioned as well. Although the users in StudioMingle spend most of there time on reading, writing and working with the computer, this was not seen as ‘being creative’.

User perceptions

Users of StudioMingle think that ‘light’ and ‘lay-out and the way it facilitates contact with colleagues’ were most important for the stimulation of their creativity. In the lay-out the openness was especially appreciated as it provided physical space for thought: “creativity needs a horizon”.

The contribution of colour seems relevant to creativity, but can be seen from different perspectives. Almost all of them would like some more warm colours, as it would be nice and could affect their mood. It could be of value for creativity, as the current colours were perceived as boring and not a comfortable atmosphere. Four respondents explicitly mentioned colours to have an effect on the creative potential of the physical work environment.

A physical aspect that hindered their creativity most were the lack of wall space to present their work. Users responded ambiguous to noise and the many objects and stuff in the room. Most of the users think that the objects are stimulating; some think the mess hinders their creativity.

Some workers thought it was too noisy in StudioMingle, one thought it was to quiet.

Recommendations from users for improving creativity with(in) StudioMingle were:

- More space (walls) to present their work;
- Better informed about colleagues’ work;
- More colour;
- Fresh air.

Current status

The work environment has been subject to few changes over de last 2 years. Several industrial designers feel responsible for making this environment work. The lay-out remained the same but more colours on the walls and columns have been added to the room as well as presenting space on whiteboards and panels. The two researchers spoken with state an important change has been the use of the space. With two 'loud' colleagues, who perceived creativity with music and noise leaving it has become more quite. Showcase products have been moved away from the workspace, which reduced the number of interruptions by visitors.

We did not carry out a new evaluation, but responses in informal discussions indicate more satisfied users on the changes. Still they state that as with the organisation, the work environment is never finished neither perfect.

DISCUSSION

The case illustrates that the office space can be of value for an organisations creativity. Among workers there seems general agreement that, a more colourful environment, with some fresh air and space for presenting personal work can contribute to the end-users well-being and creativity.

Crosspollination is marginally fulfilled. Researchers would still like to be better informed about one another's work. This would indicate that situating everyone in one room is not yet a recipe for crosspollination. More space for presenting their work was mentioned as a solution, which can lead to more awareness and discussion about one another's work. This would take in account that most workers work part-time. But the problem could well be that there is no direct need for discussing one another's work. Maybe it is the open work environment that has a negative effect on communicating or as two researchers indicate they lack time to inform themselves on each others work when there's no direct (perceived) need.

The case also pleads for clear definitions, especially when using questionnaires. Creativity, being creative and stimulating creativity are ambiguous terms and have different meaning to respondents. The definitions mentioned in this paper can be of value for further research. For further explanation of the framework clear definitions of different space types are also required.

Finally it is apparent that the physical work environment can contribute in different ways to creative organisations:

- Express creativity to outsiders and its users: by using colourful materials, unusual furniture and presenting physical representations of the organisations work (models, posters, artefacts). An appearance which reflects the identity of its users can also lead to higher satisfaction and a greater sense of belonging
- Stimulate the mental process of creativity: by providing comfort and well being for individual creativity, and spaces for objects and presentations to be inspired by these artefacts and the work of colleagues.
- Facilitate creativity, by designing dedicated spaces which support the number of users, the required noise level (enclosed/ open) and stimulate the senses (relaxed or triggered and inspired).

References

- Achterberg, J (2006) *Relaties tussen mens en werkomgeving, ICT en management*, Delft: Center for People and Buildings.
- Allen, Thomas J. (1997) *Architecture and Communication Among Product Development Engineers*, Cambridge MA: Massachusetts Institute of Technology September, WP # 165-97
- Andriopoulos, Constantine (2001), Determinants of organisational creativity: a literature review, *Management Decision*, Vol.39, No.10,
- Becker, Franklin (2007) Organizational Ecology and Knowledge Networks, *California Management Review*, Winter, Vol.49, No. 2, pp. 42-61
- Becker, Franklin and William Sims (2001), *Offices That Work, Balancing Communication, Flexibility and Cost*, Ithaca – New York: Cornell University, International Workplace Studies Program, October
- Brill, Michael (2001) *Disproving Widespread Myths about Workplace Design*, Jasper US: Kimball International.
- Buijs, Jan, (2007) Interview with professor Jan Buijs by Joost Panhuizen, in *Delta* ,nr. 27, 20 September.
- Csikszentmihaly, M. (1996). *Creativity: Flow and the psychology of discovery and invention*, New York: Harper Collins.
- Davenport, Thomas H. (2005) Why Office Design Matters, *Harvard Business School Working Knowledge*, http://hbswk.hbs.edu /9/12/2005
- Dobbelsteen, Andy van den (2004) *The sustainable office*, Dissertation, TU Delft
- Florida, Richard (2002) *The Rise of the Creative Class, And How It's Transforming Work, Leisure, Community and Everyday Life*, New York: Basic Books
- Gielen, Karianne (2006) *Winst voor de organisatie door creativiteit stimulatie: Een onderzoek naar de invloed van de fysieke werkomgeving op creativiteit*. Bachelors Thesis, Delft: Center for People and Buildings/ Haagse Hogeschool, May.
- Heerwagen, Judith H., Kevin Kampschroer, Kevin M. Powell and Vivian Loftness (2004) Collaborative knowledge work environments, *Building Research & Information*, 32(6), pp 510-528.
- Kornberger, Martin, and Stewart R. Clegg (2004) Bringing Space Back In: Organizing the Generative Building, *Organization Studies*, 25(7), pp. 1095-1114
- Kristensen, Tore (2004) The Physical Context of Creativity, *Creativity and Innovation Management*, Vol. 13 No. 2, pp 89-96
- Leupen Bernard (2006) *Frame and Generic Space, A study into the changeable dwelling proceeding from the permanent*, (Dissertation TU Delft), Rotterdam, 010 publishers
- McCoy, J. and G.W. Evans (2002) The Potential Role of the Physical Environment in Fostering Creativity, *Creativity Research Journal*, Vol. 14, No. 3&4, pp. 409 - 426
- Mathisen, Gro Ellen and Stale Einarsen (2004) A Review Assessing Creative and Innovative Environments Within Organisations, *Creativity Research Journal*, Vol. 16, No. 1, pp 119-140.
- Meel Juriaan van, and Paul Vos(2001) Funky offices: Reflections on office design in the 'new economy', *Journal of Corporate Real Estate*, Vol. 3, No. 4, pp. 322-334.
- Sutton, Robert (2001) *Weird Ideas That Work. 11½ Ways to Promote, Manage and Sustain Innovation*, London: Alan Lane/Penguin.
- Sutton, Robert (2004) Bringing Creativity into an Organization, *Entrepreneurial Thought Leader Speaker Series*, Stanford University, available at: http://edcorner.stanford.edu/authorMaterialInfo.html?mid=1193
- Voordt, D.J.M. van der, P.G. Vos e.a. (1999), *Model en methoden voor evaluatie van kantoorinnovatie* (Model and method for evaluating innovative officing). Faculteit Bouwkunde, Delft University of Technology.
- Voordt, D.J.M. (2003) *Cost and benefits of office innovation*, Delft: Center for People and Buildings

- Voordt, D.J.M. van der, J.J. van Meel, F. Smulders, en S. Teurlings (2003), Corporate culture and design, the hard impact of soft factors. Theoretical reflections on case-studies in the web design industry, in: *Environments by DESIGN*, vol. 4, no. 2, London: Kingston University.
- Voordt, D.J.M van der, M. Maarleveld, J. Attema, (2006) *Gebruikers over hun kantoorhuisvesting: crosscase analyse van acht projecten,* Delft: Center for People and Buildings
- Ware, James and Charles Grantham (2003)The future of work: Changing patterns of workforce management and their impact on the workplace, *Journal of Facilities Management*, Vol. 2 No.2 pp. 142-159
- Worthington, John (2001) Accommodating change — Emerging real estate strategies, *Journal of Corporate Real Estate*, Vol. 3 No. 1, pp. 81–95.

CREATIVITY DEMANDS NEW OFFICE DESIGNS

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ABSTRACT

The aim of the paper is to present results of how spatial and social/work configurations interact and impact on knowledge development and creativity in office activities. In our latest study the subjects logged their interaction on a floor plan, which in combination with space syntax analysis, social network analysis and data from observations and questionnaires, gives more insight into the interaction pattern. 95 percent of all interaction within the sample company with an open plan office, occurred between colleagues within the same department. We conclude that with regard to noise disturbance, for those who manage what we call long questions, open spaces can be an obstacle. For those engaged in short questions noise disturbance in the open office situation is however offset by its positive aspects. Creativity however is dependent on good conditions for both managing long questions, and horizontal interaction across borders within the organisation.

KEYWORDS: work space design, office work, interaction, spatial configuration

THE PROBLEM

When it comes to the configuration of work processes, or, in other words, the design of the work organisation, many concepts and developed strategies exist. However, when considering the other configuration of significant importance, the configuration of space, the field is lacking. Thinking is often limited to the question of openness and the presumption that more openness will lead to more interaction. Openness is also assumed to symbolize a pleasant open corporate image. The dominant strategy whereby to give staff in an office relevant working conditions is to provide various different spaces to use depending on momentary requirements (Duffy, 1997; Becker and Steele, 1995).

In earlier studies we have shown (Steen et al, 2005; Blombergsson and Wiklander, 2006; Markhede and Steen, 2006) that average levels of interaction are not influenced by the degree of openness when comparing different departments with different office concepts. Of greater significance is the role a person has within the organisation and the kind of main tasks that person performs. However we have seen that visibility has an impact. Individuals with similar working roles gain more interaction with other colleagues when sitting in more visible positions (ibid.).

Furthermore we have shown that 90 percent of spontaneous interaction in offices, excluding interaction in planned meetings and break areas, occurs at workstations. This is the same for different office concepts (ibid.). Certainly some of this interaction is programmed in the sense that person A wants/needs to talk to person B when opportune. But some of this interaction is not programmed in this way in advance. Here it is obvious that configuration of space – and the location of common functions within space - will have an impact on how office workers are distributed in relation to their colleagues (ibid.; Grajewski, 1993; Penn et al, 1999).

But even if we have quite a good picture, from observations and questionnaires, of the pattern of interaction, we have not been able to understand the impact of the configuration of work processes. We think this is crucial because interaction within an organisation unit is presumed to be more of a reproductive nature than interaction between people belonging to different units, which is presumed to be more productive (Allen, 1977; Hillier, 1996). In other words that you are presumed to do your work within the group to which you belong and if you wish to push ideas for change you are supposed to, and get credit for, adapting them to the accepted way of thinking. But those outside your group are not presumed to be so well informed and it is therefore more acceptable to pose more provocative questions about your work and thereby prompt new thinking, irrespective of whether the question is uninformed or grounded in information garnered from “outside”.

The problem lies therefore in the question of *who is interacting with whom*. The importance of the question affects organisations' possibilities for efficiency and competence when developing businesses in relation to market changes etcetera. The latter is especially a question of creativity in the sense that the basis for new thinking is to question commonly accepted ways of handling problems and issues.

AIM

The aim of this paper related to our research of offices is to show how spatial and social/work configurations interact and what impact this has on knowledge development and creativity in office activities.

METHODS

Broadly we can say that we study the interrelation between the spatial and the social by describing the spatial system and make observations for how it is used. We then look at correlations and try to understand them as a consequence of the spatial or social system respectively. We are keen to keep our studies to a principal level and therefore require large samples in order to discern general patterns. By experience we have learned that it is very difficult to get reliable answers from individuals when asking about, for example, interaction and knowledge sharing. That is why observations are important. Observations alone however restrict what can be studied. We will therefore have to undertake questionnaires and interviews in order to complete the observation data.

With Space syntax analysis (Hillier and Hanson, 1984; Hillier, 1996) we can describe spatial systems with regard to accessibility both for movement and visibility. Within Space syntax integration is a key parameter: a more integrated place in a spatial system is relatively closer to other parts in the system in terms of configuration, as opposed to metric distance. By deciding which level to analyse we can describe the system for movements (floor level) or the isovist, which can then be surveyed from a chosen point (eye level for sitting or standing person). The program for these analyses gives every chosen point an integration value, either if you look at the system globally (the whole system) or locally (within one to three configurative steps away).

Use of the spatial system (the office workers behaviour in the office), is studied by different observation methods. One of these is the snapshot technique: all human actions within a defined area are noted on a floor plan. Actions are classified as observable activities such as sitting, standing or walking, talking to colleagues face to face, talking on the telephone or working with both high and low levels of concentration.

This data is then completed with the experiences of office workers gathered from the questionnaires. It is especially information regarding the experience of different kinds of disturbances that is accumulated in this way.

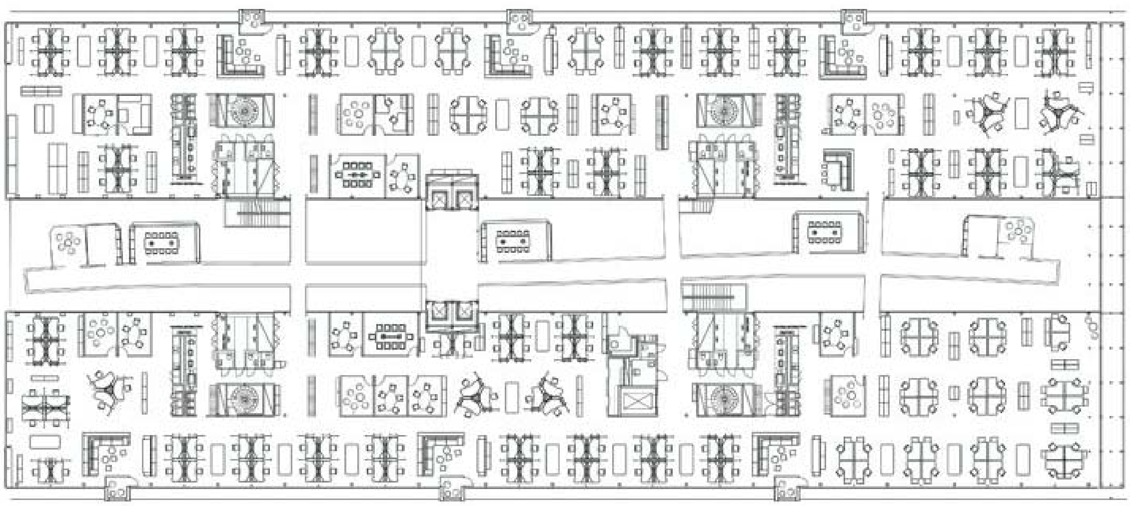
Our latest study differs in that questionnaires are not anonymous and that everybody in the studied office was asked to log their interaction on a floor plan over the two days we conducted our observations. This way we can gain information connected both to the specific person and their workstation and relative to, for example, experiences of disturbances disclosed in their questionnaires.

However, this data and possible correlations do not directly address our question of knowledge development and creativity – to do this we will have to interpret the data and apply logical reasoning.

THE CASE

For this study we were invited to the office of the headquarters of the Swedish company Posten, located in Solna just north of Stockholm. The building, accommodating 900 people, was finished in 2004 and was designed to be open and modern, in the sense of stimulating interaction and with standardized work stations to enhance changes. Each floor is constructed with two parallel naves with a communication area, for both vertical and horizontal movements, and with meeting rooms in between.

Figure 1. Posten, floor plan on level 10



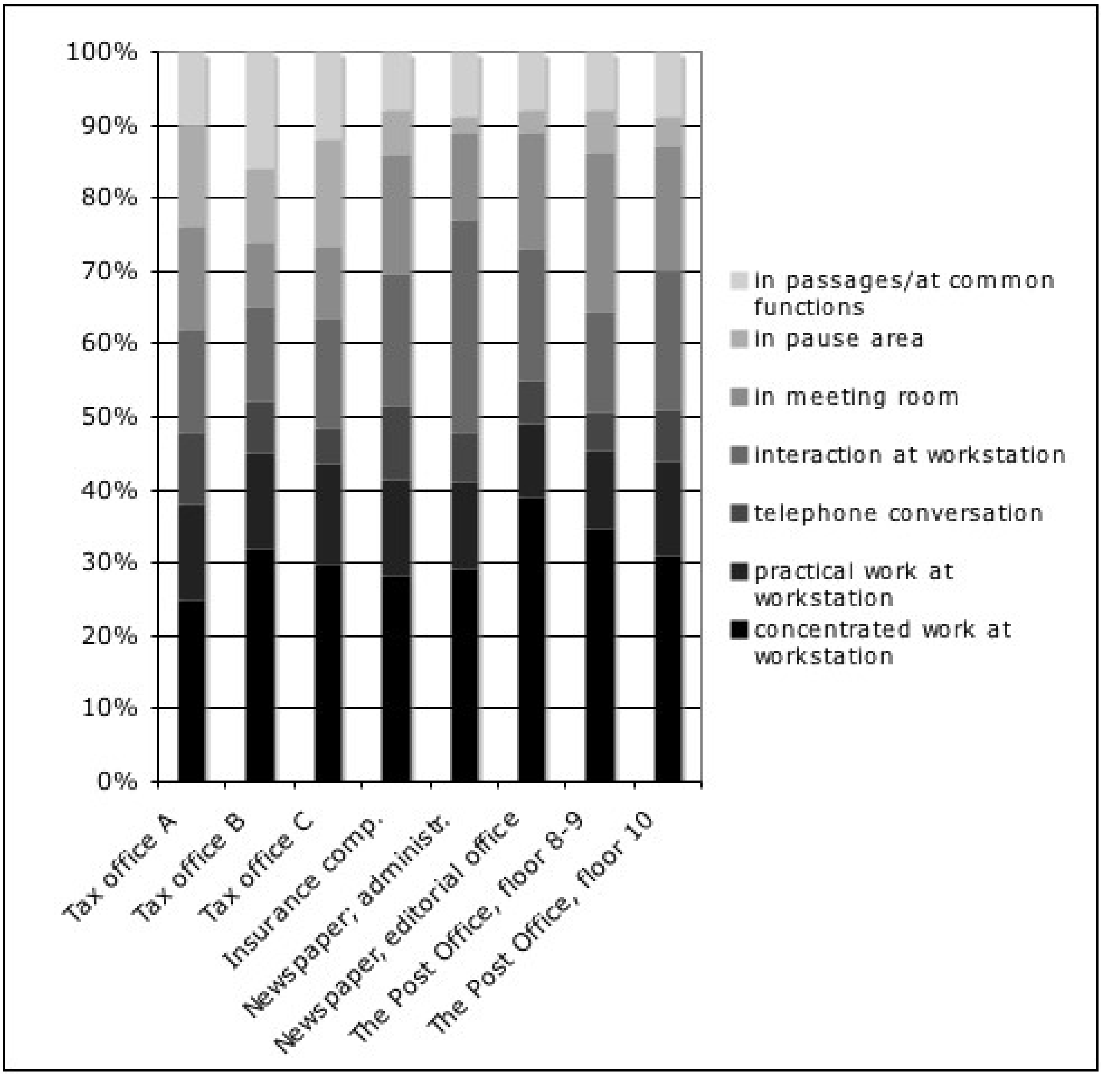
Each nave is open along the facades, with the exception of screens around the break areas in some places, and along the core where openness is disrupted by meeting rooms, printers, kitchenettes and toilets.

Our study involved 600 office workers across three floors: 8, 9 and 10. There are differences in work processes between the departments; for the purpose of this study we will note only that the sales department on floor 10 was presumed to behave differently than the other.

RESULTS

We start with the work pattern and put the observation data from Posten in a diagram which shows the corresponding data from former studies: Three tax offices (A=cellular office; B=cellular & combi office; C=cubicles), the head office of an insurance company (cellular & landscape) and the administration and editorial offices of a daily newspaper (landscape).

Diagram A. Observed activities distributed in space and time, eight cases



We can see that the office workers spend an average of 40-50 percent of their time at their workstations with individual tasks, either with concentrated work or more practical tasks. Interaction at workstations and telephone calls occupy 20-35 percent of their time. Time spent in rest/break areas and in meeting rooms shows the biggest differences – and has an impact on the general pattern of each column. It is evident that coffee break routines vary between organisations. For example in the newspaper office it is common practice to sit at one's work station. We found similar differences between meetings procedures – to some extent probably a consequence of how easy it is to coordinate work processes in a more informal way.

If we look only at interaction, excluding interaction in rest/break areas and meeting rooms, we can see that the distribution between interaction at workstations and in common areas/ functions is quite alike, about 9 to 1, despite differences in production and in spatial concepts.

After these overall data we will look at differences in the Posten case regarding different positions within the floor plan. We used the Space syntax measurements, global and local integration as well as more simple parameters such as proximity to a main passage. The most striking correlation between integration values and social data is found in the location positions of members of management. Top management have their workstations well integrated globally and department heads sit in locally significant, well integrated positions. But when we correlate experienced disturbances from the questionnaires and position values we find no correlation. So in this aspect, even if the spread of the values is substantial - from 5 to 50 for local and 5 to 14 for global integration values - the layout works in a “flat way”.

It is now time to look at the interaction pattern, in other words the potential for the exchange of knowledge or expertise.

If we look at the concentrations of observed interaction in some positions they can only sometimes be explained by their high integration value. We have to look elsewhere for other influences. As we conducted these special investigations with individually-made log maps, we could load the computer with data both as individual layers and summarized in organisational units. When we marked the organisational borders and coloured the noted interaction spots in relation to where the interaction occurs, we gained a better understand of the distribution of interaction. The organisation borders are significant when determining who is interacting with whom. A very small percentage of all face to face interaction involves people from different departments. There is evidently not a great deal of informal general chat. One reason could be the obligation to restrict spontaneous chat to save time; interaction would therefore be concentrated on that needed for common production (within the unit).

Let us now go back to the spatial data and see what happens if we use both organisational division and spatial values. We keep it simple, taking one department and dividing it into three parts in the centre and the periphery. We can see that every person's amount of interaction remains constant but those with their workstations in the peripheral parts move more to the centre and interact there, while those with stations in the centre conduct more of their interaction there. One obvious reason is that if person A in a peripheral part moves to person B in the other peripheral part then person A will pass person C in the centre twice and therefore gain the opportunity to interact spontaneously. In addition the needs for all people to see and be seen by others can play a role in movement and interaction behaviour.

When we make a social network analysis we can see how interaction relates to distance. In the questionnaire we asked the respondent to name the five people within Posten which the respondent had most contact with: a) face to face, b) by mail and c) by telephone. To describe the spatial relations we divided each nave into about 30 parts where every part contained 2-4 workstations. 41 percent of face to face contact was among people with workstations located in the same part, 76 percent sit in the same or one step away and 88 percent within a configurational distance of 0-2. When it comes to contact via mail and telephone the physical distance will naturally not have the same impact. But it is striking that spatial proximity has so much influence, especially regarding the five most frequently mailed contacts. It can therefore obviously be concluded that both mail and face to face interaction both complement and compensate each other.

As a result of these findings concerning the interplay between space and the social we have attempted to develop an analysis tool for spatial systems with regard to their use. A prototype of such a tool is presented within the Space syntax community (Markhede and Koch, 2006; Markhede and Carranza, 2007).

THE QUESTION OF KNOWLEDGE

We have stated earlier that it is hard to study the processes of knowledge development in isolation and we have to include other data in order to build an argument. First we can note that in all office work there is a balance between individual work and interaction. Even in the most project-oriented work organisation every member has to perform tasks individually in a process of refining information. This could be expressed in that the exchange of knowledge between co-workers implies that the refining process is functioning – otherwise the sharing of information will not contribute to progress, it will simply be a social process.

As we have seen that work patterns, especially the change between individual work and interaction, change a couple of times an hour, we can hardly claim that a good solution would be to make office workers change between different spatial solutions in order to manage their jobs. The workstation must consequently be positive for both individual thought and for interaction. This also reduces the possibilities for working remotely.

But what about the positive effect of being in an open space with the possibilities of overhearing what other people say? To some extent we think that these effects can balance the problems of disturbance from the chat of others. It depends on the kind of work. We have found it relevant to talk about working tasks as *long questions/problems* or *short questions/problems*. By long questions we mean tasks which require longer chains of thought in the individual situation and more reasoning back and forwards (to understand the context etc.) in the interaction situation. By short questions we mean tasks, which require shorter chains of thought, where it is easy to ask people about the task; easy because there is a straight answer.

All office workers can be said to work with both long and short questions, the point is that some office workers have a main emphasis on either long or short questions respectively. And here we come back to the issue of disturbance. To be disturbed when you are working with long questions cost a lot of both time and energy. But to cut short a dialogue with a colleague to avoid disturbing others will restrict knowledge processes.

Is then the open office a good solution for workers occupied with short questions? Well, is it of interest to distinguish some jobs from others with long questions, to conserve that distribution and to create a less general concept when it comes to further changes? If we however, highlight the introduction process to any office work, it is obvious that learning is very much a matter of copying the more experienced – and here there is no doubt that overhearing has a positive effect. Still, as we will argue for a continuous learning process for all in which especially processes of judgement and discernment play an important role in both reproduction of the "culture" of the organisation and production of new knowledge, we will again point to the need for undisturbed workstations.

Let us at last get to the discussion of how people are interacting within groups or between groups. On one hand it is very efficient if people keep to the current paradigm, it stands for order and individuals know what to do. On the other hand, we do not want the group to be too isolated, and feel too safe, so that they do not notice the changing context. We want the group to have a degree of transparency with its surroundings. And experience shows that other people within the same organisation can have an important role in this. But how can these interactions be arranged so that they will produce this kind of content? As we have seen, people do not talk to those belonging to other groups very often. So even if we design the global spatial system so that people are likely to be in the same space at the same time it is not certain that any sharing of knowledge or provocation will occur in these encounters. Our conclusion is that the spatial system must be completed with a social artefact: we suggest special hearings in which the different departments (in big organisations) tell the others about the main questions they are tackling in their work. This would enable all to become more informed of the core businesses as a whole, encourage curiosity and associations and lead to horizontal and creative discussions.

CONCLUSIONS

Organisational borders act strongly in programming interaction between co-workers.
The configuration of space and the positioning of common functions within space distribute movements of office workers with regard to individual workstations and thereby create the potential for spontaneous interaction.
Within a spatial system the degree of visibility has an impact on interaction – people who are more visibly integrated have more interaction.
Individuals who you see often, usually sitting nearby, are considered more useful.
Managers use the space in a strategic way by positioning themselves in visible well-integrated positions in relation to their staff.
Exposure to noise is problematic for those working with "long questions" – both concentrated individual work and reasoned dialogue are disturbed.
The need for recurrent organisational changes – the path to rationalize office work – make standardized workstations which function for both short and long questions interesting.
It seems to be constructive to admit that there can be a conflict between efficiency and creativity as the former calls for existing solutions and the latter for new solutions - it illustrates a conflict between the short and long term.
To encourage colleagues from different units to meet is a question of time and space; but to create the potential for knowledge development and creativity in these interactions there seems to be a need for deeper mutual knowledge of the core content of work processes.

To support these findings there is a demand for new architectural office solutions. And there is a need of more elaborate strategies to integrate managerial and organisational strategies with spatial strategies. In these processes of development, looking at premises as a source for interaction, it will hopefully be possible for organisations to handle the balance of maintaining existing production and developing new products and situations for a changing world.

REFERENCES

Allen, T. (1977), Managing the Flow of Technology, MIT Press, Cambridge, MA. ISBN 0-262-01048-8

Becker, F. and Steele, F. (1995), Workplace by design: Mapping the High-performance Workplace, Jossey-Bass, San Francisco, CA, ISBN 0-7879-0047-8

Blombergsson, M. and Wiklander, J. (2006), ”Spatial Support for Key Usability Factors: Spatial Influence on Interaction Patterns for 800 Office Workers”, in Proceedings for Trondheim International Symposium CIB W70,12-14 June 2006: Changing User Demands on Buildings, pp 542-550, edited by Haugen, T., Moum, A. and Bröchner, J., Trondheim 2006, ISBN 82-7551-031-7

Duffy, F. (1997), The New Office, Conran Octopus Ltd, London, ISBN 1-85029-891-2

Grajewski, T. (1993), ”The SAS Head Office – Spatial Configuration and interaction Patterns”, in Nordisk arkitekturforskning 1993:2

Hillier, B. (1996), Space is the Machine – a Configurational Theory of Architecture, Cambridge University Press, UK, ISBN 0-521-56039X

Hillier, B. and Hanson, J. (1984), The Social Logic of Space, Cambridge University Press, UK, ISBN 0-521-36784-0

Markhede, H. and Steen, J. (2006), ”Analysing Open Space Offices”, in Proceedings for Trondheim International Symposium CIB W70, 12-14 June 2006: Changing User Demands on Buildings, pp 533-541, edited by Haugen, T., Moum, A. and Bröchner, J., Trondheim 2006, ISBN 82-7551-031-7

Markhede, H. and Koch, D. (2007), ”Positioning Analyses: social structures in configurative modelling”, in Proceedings for the 6th International Space Syntax Symposium in Istanbul June 2007, vol. 2, no 069, edited by Kubat, A. S., Ertekin, Ö.,Güney, Y. I., Eyüboglu, E., Istanbul 2007, ISBN 978-975-561-305-5 (v.2)

Markhede, H. and Carranza, P. M. (2007),”Spatial Positioning Tool: a prototype software and some background correlation data”, in Proceedings for the 6th International Space Syntax Symposium in Istanbul June 2007, vol. 2, no 102, edited by Kubat, A. S., Ertekin, Ö.,Güney, Y. I., Eyüboglu, E., Istanbul 2007, ISBN 978-975-561-305-5 (v.2)

Penn, A., Desyllas, J. and Vaughan, L. (1999), ”The Space of innovation: Interaction and Communication in the Work Environment”, in Environment and Planning B: Planning and Design 1999, vol. 6

Steen, J., Blombergsson, M. and Wiklander, J. (2005), ”Useful Buildings for Office Activities”, in Facilities, Vol. 23, no ¾, pp 176-186, available at www.emeraldinsight.com, presented at Euro-FM, Rotterdam 2003

THE IMPACT OF WORKPLACE REDESIGN ON CUSTOMER PERCEPTION

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ABSTRACT

The paper reports on the impact of the workplace design on customer perceptions in two Finnish government agency offices. The difference in workplace design between the two public service offices is predominantly a difference between a cell office setting, where the customer is visiting the service agent in a personal office, and an open office environment, where the service agent is placed visibly for all customers and employees alike. The same questionnaire was given to the clients of both offices. The findings show that perceived customer comfort, level of noise, the amount of space, and furniture are rated better in the open office environment. Also, the age of the customer had a significant effect on whether they perceived the environment peaceful enough to talk about confidential and private issues.

KEYWORDS: servicescape, service encounter, workplace design, POE

INTRODUCTION

Service orientation and customer perspective are more and more determinant approaches in all customer processes both in private and public sector organisations. A service encounter is a specific period of time during which the customer interacts with a service (Shostack, 1985). It encompasses interactions that the customer has with service personnel face-to-face (Chandon *et al.*, 1997; Solomon *et al.*, 1985; Suprenant and Solomon, 1987) but also interactions with a website (Liljander and Mattsson, 2002) or the physical elements of the servicescape (Bitner, 1992).

Bitner (1992) has coined the term 'servicescapes' to describe how the physical surroundings can facilitate the provision of service offerings to customers. She found the effect that atmosphere, or physical design and décor have on consumers and workers has been recognized in virtually all marketing, retailing, and organisational behaviour literature. According to her, customers perceive the servicescape as a composite of three dimensions: ambient conditions; spatial layout and functionality; signs, symbols, and artefacts.

Lin (2004) states that people perceive their environments holistically and links these perceptions to the concept of Gestalt psychology. Thus, while one perceives stimuli from the different servicescape dimensions discretely, it is the total configuration of stimuli that determines responses to the environment.

Because people perceive environments holistically it may be necessary to vary several environmental dimensions (e.g., artefacts, layout, colour, tidiness) simultaneously to achieve an overall perception of the surroundings that will have significant effects on behaviour. (Bitner, 1992)

Previous research however, has shown a lack of empirical research into the servicescape phenomenon (Exeh and Harris, 2007; Lin, 2004). The purpose of this paper is thus to expand the knowledge on the servicescape and its experience in public sector service encounters.

The research was led by the question: “What are the effects of different servicescapes in two public sector service agencies on the customer experience and the perception of the servicescape?”

The paper reports on the impact of the workplace design on customer perceptions in two Finnish government agency offices. A comparison of these two offices was conducted by means of a survey. Comparing the two offices varies several environmental dimensions (e.g., artefacts, layout, colour, noise) simultaneously and thus was expected to alter the customer experience of the servicescape.

While one office had undergone a workplace redesign to accommodate a more customer focused business strategy, the other office’s workplace design had remained unchanged. The difference in workplace design between the two offices is predominantly a difference between a cell office setting, where the customer is visiting the service agent in a personal office, and an open office environment, where the service agent is placed visibly for all customers and employees alike.

The findings indicate the main differences between the two servicescape experiences to be located in the servicescape domain. Significant differences were found in the variables for comfort, level of noise, amount of space, and furniture. Experience variables however, did not show significant differences.

In the following this paper will first set out to introduce the methodology of the study. It continues to show the background of the study setting through a description of the two different public office designs. Finally, the survey results are analysed and conclusions and limitations are drawn.

METHODOLOGY

The contexts of the organizations’ operations were assessed through interviews with the office managers, while the evaluation of the impact of the design was carried out as a survey of the customers of each office.

The purpose of the survey was to establish customers’ perceptions of the servicescape and experience of the public agency offices. The deployed questionnaire was the agency’s own that had been used to survey customer’s opinions of the redesigned office design. The researchers deployed the same set of questions to the traditional office design to identify possible differences. The selection criteria for the traditional office were: a) an office design following the traditional concept, b) accessibility for the researchers and willingness to administrate the questionnaire.

The questionnaire consisted of eight items that were evaluated on a four point scale from very bad (1) to very good (4). Items ‘comfort’ and ‘level of noise’ addressed the ambient control dimension of the servicescape and items ‘amount of space’ and ‘furniture’ the layout dimension. The four remaining items in the questionnaire focused on the experience of the office: ‘functionality of information desk’, ‘ease of finding the correct service agent’, ‘peacefulness of customer service’ and the ‘accessibility of staff’. As a possible dependent variable the questionnaire included the respondent’s age and gender. Also, in the traditional office, the department which the customer visited was documented.

The questionnaire was handed out during a one week period to the redesigned office in autumn 2006 and to the traditional office in autumn/winter 2007, in the latter with the aim of a similar sized sample. The questionnaire was given to customers personally by the service agent, and it was filled in immediately at the end of a service interaction.

The questionnaire was kept short in order to get as many responses as possible. The sample size was 93 in the redesigned office and 82 in the traditional office. That is, 175 all together. No exact response rate could be obtained, however it is assumed that very few if any of the customers declined to give their opinion given the way the survey was distributed.

BACKGROUND

While the public service agency with the ‘traditional’ or unchanged office design is located in the capital region, the office featuring the redesigned office is situated at the Finnish west-coast in a more rural setting. With regard to the size of the agencies, the one in the capital area has a staff of about 130 persons (including two specialised departments), whereas the West-Coast office employs about 18 people.

Both agencies are Finnish government agencies and have the same public assignment. The nature of this assignment requires them to interact with citizens as well as with other public and private organisations. Furthermore, their task requires them to routinely deal with confidential customer information (e.g. social security information[1]). However, as positive customer sentiment towards these institutions cannot be taken as granted, security is an issue.

The agency featuring a traditional office design is located in a copper walled governmental office building from the beginning of the 1970’s. The agency resides on 2 different floors: the ground floor (1st floor) and the 2nd floor with an internal staircase connection. The total amount of the office space accumulates to 3430sqm.

The workspace is predominantly arranged in a cell office layout with the cell offices at the perimeter of the building (see Figure 1). The cell offices differ in size from about 8sqm to 20sqm and feature a work desk with an angled customer service section as well as file cabinets and shelves. Most of the employees have a dedicated cell office where the customer interactions take place. The cell offices typically feature an escape to another cell office as well as a ‘traffic light’ signalling system at the outside door. Customers are predominantly served on an appointment bases, however on a rotating base some agents serve customers immediately. Customers wait for admission in dedicated areas in the corridors.

[1] In Finland the social security number is routinely used to verify once identity beyond the borders of the social security system.

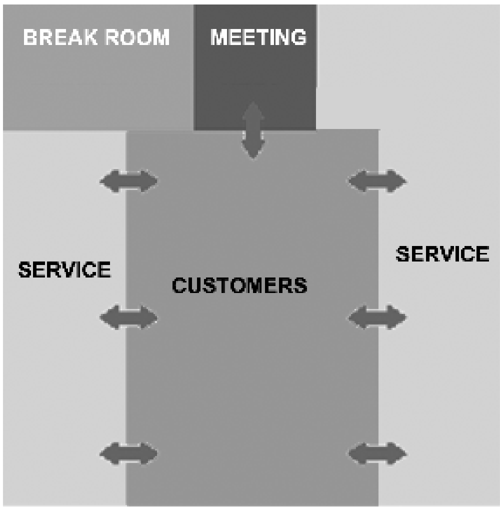

Figure 1. Traditional office concept

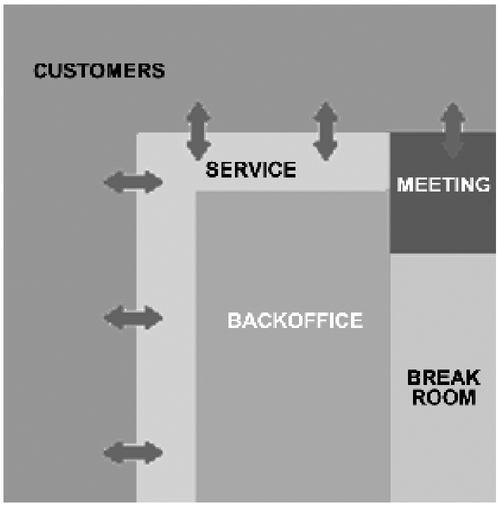

Figure 2. Redesigned office concept

The premises of the agency with the redesigned office (see Figure 2) are located on one floor and occupy about 500sqm. It is located on the 2nd floor of a shopping mall in the centre of town.

The workspace is generally divided into a public space (the customer area) and a private space (the back office area). The customer service is conducted at the interface of these two spaces. While the back office design is an open plan design with workstations for 13 persons, the customer service is conducted in glass walled cabinets at the perimeter of the back office space. A cabinet offers space for 2 customers and a service agent with an extra wide desk separating them and blocking the customers' way to the back office area. The customers are predominantly served on a 'come as you go' basis and are directed to a service cabinet by an information desk in the customer space.

Table 1. Comparison between servicescapes of the two offices

	Traditional office	Redesigned office
General	Capital area; outside city center; Government administration building	A 20 000 citizen city; shopping center
	c. 3400 sqm	c. 500 sqm
	c. 130 members of staff	c. 18 members of staff
Layout	Cell office; appointment	Service cabinet; on-call duty
	Two floors	One floor
	Long corridors	Open area
	Queuing system	No queuing system
Signs, symbols, artifacts	Many noticeboards	No noticeboards, information available in binders
		Table divides customer and employee space
Ambient controls	Dark	Modern office building standards
	Low quality air conditioning	
	Busy, noisy	Low customer flow

RESULTS

The mean averages of redesigned design and traditional design solutions differed significantly on four variables: comfort, level of noise, the amount of space, and furniture (see

Figure 3). On all the other variables differences were small (less than 0.1). The highest difference between the offices was on the variable 'the amount of space' (0.394). Comfort (0.377) and furniture (0.377) came close, in level of noise the difference between the offices was smaller (0.283).

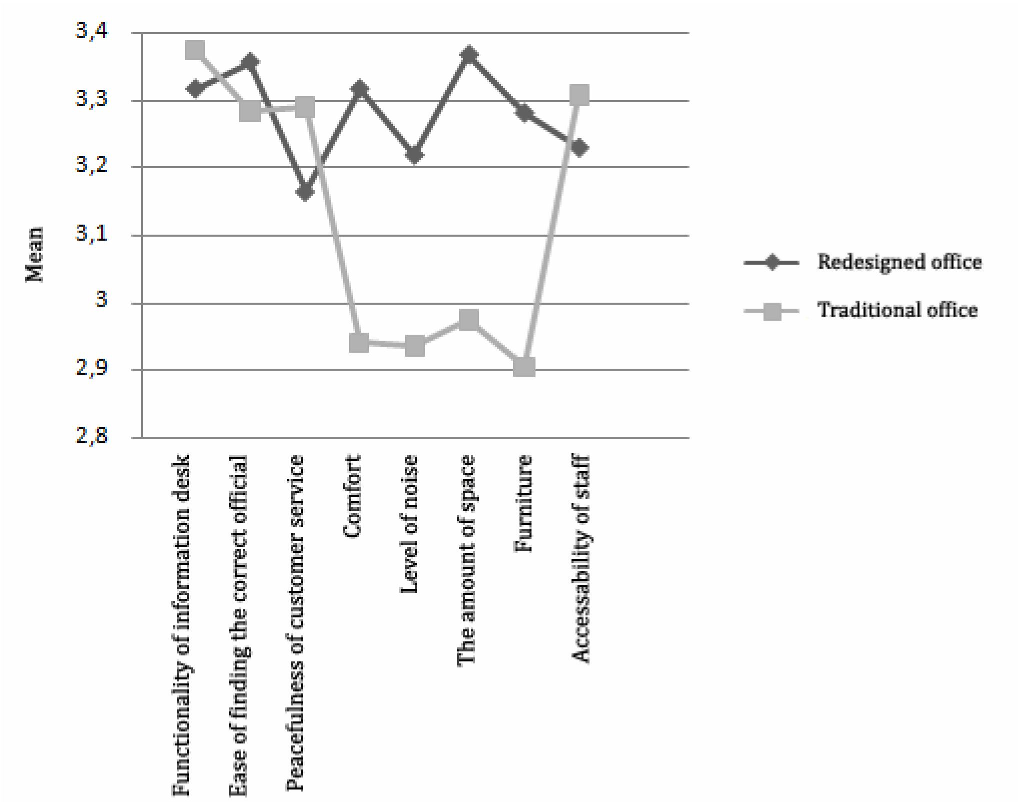

Figure 3. Comparison of means for the redesigned and traditional design

In

Figure 3 it can be seen that the redesigned workplace solution received slightly lower evaluations on the variable of 'peacefulness of customer service situation'. However, this effect was not statistically significant.

The results of analysis of variance are presented in Table 1. The analysis showed that all of the previously mentioned differences were significant. Namely, comfort $F(1,174) = 16.768$, $p = .000$, level of noise $F(1,176) = 6.577$, $p = .011$, the amount of space $F(1,179) = 13.482$, $p = .000$, and furniture $F(1,178) = 14,274$, $p = .000$.

Table 2 - One-way analysis of variance (ANOVA) results

Item	Sum of Squares	df	Mean Square	F	Sig.
Functionality of information desk	0.129	1	0.129	0.487	0.486
Ease of finding the correct official	0.282	1	0.282	0.561	0.455
Peacefulness of customer service	0.983	1	0.983	1.773	0.185
Comfort	6.248	1	6.248	16.768	0.000
Level of noise	3.135	1	3.135	6.577	0.011
The amount of space	6.922	1	6.922	13.482	0.000
Furniture	5.894	1	5.894	14.274	0.000
Accessability of staff	0.259	1	0.259	0.805	0.371

The age of the customer had a significant effect on whether the environment was perceived peaceful enough to talk about private issues $F(3,175) = 3.279$, $p = .022$. Figure 4 shows a mean plot of this effect. The effect was present in an equal manner in both offices. In the traditional office, the peacefulness factor was the only statistically significant variable in the in-between department ANOVA analysis $F(3,85) = 6.440$, $p = .001$. The mean of the peacefulness variable was 0.7 points lower in one department which takes care of clients with special health issues. In open comments five respondents from that department mentioned that speech and sounds can be clearly heard through the walls of the cell office. In the redesigned design office sound isolation was mentioned 7 times by the customers in open comments which made it the biggest area of improvement according to the study. In addition to this 4 customers wished they had had a private room.

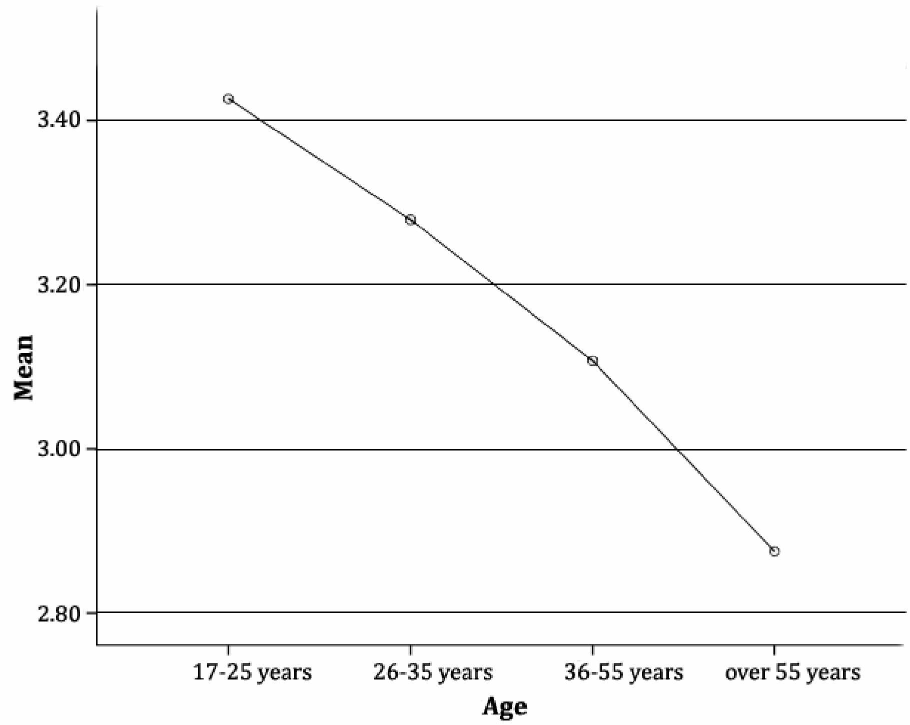

Figure 4. Relationship of age and customers perception on whether the customer situation is peaceful enough to talk about own private issues

In the open comments section, 35 comments were received from respondents of the traditional office. 15 people said that the current office is just fine and there is nothing to improve; in the office with the redesigned design this was the opinion of 21 out of 40 respondents. The traditional office received most complains (7) concerning general atmosphere and comfort of the office. Comments included: old fashioned, not very comfortable, shabby, waiting areas could be cosier, weird coloured walls and a lack of art paintings/posters and plants. The redesigned office had only one person with such concerns.

CONCLUSIONS

The study revealed the way in which customers experience the difference in the servicescape between two considerably different office layouts in two public service agencies. The plot in

Figure 3 suggests that the new office design improves some of the shortcomings that customers perceive in the traditional design.

Lin's (2004) statement that: "Servicescapes [...] are not only an important component of a customer's impression formation, but also an important source of evidence in the overall evaluation of the servicescape itself and the service organization in general." can said to be supported by the findings of this research. A clear effect of the different servicescape experiences between the two agencies could be identified.

In which categories the offices differed was however not expected. Why were the customers more satisfied with the level of noise and the amount of space in the redesigned office? It can be speculated that the level of noise might be explained by the bigger customer flow of the traditional office and the fact that some of the walls isolated sound poorly. Another possibility is that visual cues enabled by the glass service cabinets in the redesigned space resulted in lower noise levels.

Furthermore, the customers stated they did not have enough space in the traditional office. However, in the traditional office the amount of space per customer service station was about double that of the one in the redesigned cell office. A possible explanation is that the small size of the cell office rooms in the traditional office has been an acknowledged problem. Because of big desks and shelves in the room, the customers have to sit with their backs almost against the wall in many offices. In the redesigned office the customer has an obvious place to sit with enough room around him.

The finding that the customer's age affects how good he/she perceives the environment for talking about intimate issues can be interpreted in many ways. Maybe the elderly have more private issues that they talk about in a government office. Another explanation may be that older people are used to being served in a traditional cell office environment, whereas younger people are used to more open service desks. This result can also have practical implications in making sure that especially older people will be comfortable talking about their personal issues during service encounters.

Since the agency that occupies the redesigned office had previously also had a traditional office layout, the ideal setting for the study would have been to study customer's perception of the old premises. Since this was not possible another office with a traditional layout had to be chosen. This puts especially our assumption of equal variances that the ANOVA analysis bases on open to doubt. That is, are customers in the capital area different than those in a smaller town along the west coast? Also, it is questionable whether the two offices are comparable due to the fact that they were of different size, and therefore had in some ways different operational processes. This critique can be disputed by saying that the questionnaire focused mainly on the space where the customer service interaction took place, not the whole customer process.

As part of a larger research project the implications of the changed servicescape for the work processes as well as the internal customers and their perceptions will be subject of further analysis. Further research will also focus on the effect of the work environment on security and dangerous incidents.

REFERENCES

Bitner, M. J. (1992) “Servicescapes: The impact of physical surroundings on customers and employees”, Journal of Marketing, Vol. 56, pp. 57–71.

Chandon, J. L., Leo, P. Y., and Philippe, J. (1996) “Service encounter dimensions— A dyadic perspective: Measuring the dimensions of service encounters as perceived by customers and personnel”, International Journal of Service Industry Management, Vol. 8, pp. 65-86.

Czepiel, J. A., Solomon, M. R., and Surprenant, C. F., (eds.) The service Encounter, New York: Lexington Books.

Ezeh, C., and Harris, L. (2007) “Servicescape research: a review and a research agenda”, Marketing Review, Vol. 7, No 1, pp. 59-78.

Liljander, V., and Mattsson, J. (2002) “Impact of customer preconsumption mood on the evaluation of employee behavior in service encounters”, Psychology and Marketing, Vol. 19 No 10, pp. 837- 860.

Lin, I. Y. (2004) “Evaluating a servicescape: the effect of cognition and emotion”, International Journal of Hospitality Management, Vol. 95, No. 23, pp.163–178.

Shostack, G. L. (1985) "Planning the Service Encounter", in: Czepiel, J. A., Solomon, M. R., and Surprenant, C. F., (eds.) The service Encounter, New York: Lexington Books, pp. 243-254.

Solomon, M. R., Surprenant, C., Czepiel, J. A., and Gutman, E. G. (1985) “A role theory perspective on dyadic interactions: The service encounter”, Journal of Marketing, Vol. 49, pp. 99–111.

Surprenant, C. F., Solomon, M. R. (1987). “Predictability and personalization in the service encounter”, Journal of Marketing, Vol. 51, pp. 86–96.

AN EPISTEMIC ANALYSIS OF PER CAPITA WATER CONSUMPTION IN RESIDENTIAL BUILDINGS OF HONG KONG

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ABSTRACT

Up-to-date 'per capita' freshwater consumption and its profile are essential parameters for planning and estimating the sizing of water plants, storage tank and system operations for high-rise residential buildings. In this study, Bayesian estimates of the 'per capita' freshwater consumption profiles in some residential buildings were developed from the existing domestic water consumption patterns and the latest regional survey studies of households. The results showed that the best estimates of the 'per capita' freshwater annual consumption in Hong Kong residential buildings were between 59.6 m^3 hd^{-1} yr^{-1} and 69.4 m^3 hd^{-1} yr^{-1}, equivalent to 43 to 50 % of the total freshwater consumption in Hong Kong, with prior estimates of 60 m^3 hd^{-1} yr^{-1} and 102 m^3 hd^{-1} yr^{-1} respectively. The epistemic approach would be useful for evaluating the domestic water consumptions that are under continuous monitoring.

KEYWORDS: water consumption, per capita estimate, high-rise, residential building

INTRODUCTION

As a major concern in water resource management, freshwater consumption is one of the key issues in sustainable environmental management for developed cities. Hong Kong is a developed city having a population of 7 million on an area of 1067 km^2. Over 40% of the total water consumption goes to residential buildings (Water Services Department, 2004). The estimated daily per capita domestic freshwater consumption from 1991 to 2004 was ranged from 210 to 230 L hd^{-1} d^{-1}. The water conservation issues have become a concern of the city, such as engagement in water conservation practices, cooperating with a conservation campaign, and paying less for low water consumption or punishment (i.e. fine) for high consumption users (Corral-Verdugo et al., 2003). The identification of the 'per capita' water consumptions of a user would be useful in promoting water conservation, planning and estimating the sizing of water plants, storage tank and system operations for high-rise residential buildings. Periodical regional survey would be conducted so that up-to-date and accurate 'per capita' freshwater consumption would be available (Bailey et al., 1986; Edwards and Martin, 1995; Hall et al., 1988; Mukhopadhyay et al., 2001).

Prior to any intensive region survey for Hong Kong, this study proposed a simple epistemic approach to estimate the 'per capita' freshwater consumptions for residential buildings from the existing domestic freshwater consumption patterns and the latest regional survey results. This approach enables a rapid estimate of domestic 'per capita' freshwater consumptions in Hong Kong based on the available understandings. The feasibility of the proposed approach was tested with the input parameters from a small-scale survey of freshwater consumption in 60 apartments of Hong Kong and various prior professional estimates from the reported water consumption worldwide.

BAYESIAN APPROACH

The process in obtaining the best estimate of the 'per capita' water consumption using sample survey studies is epistemic that the latest information would be used to update the earlier believes based on limited samples. Bayesian analysis was applied in some analysis of engineering epistemic problems, such as indoor air quality assessment and indoor environmental control system and showed that the estimation would be improved at the early stage of smaller-scale supplementary investigations. (Hui et al., 2007; Lee, 2004; Wong et al., 2007). In this study, the Bayesian approach was applied to estimate the parameter 'per capita' freshwater consumption of Hong Kong. In the current water consumption context of Hong Kong, the 'true' value of the freshwater consumption, which would be considered as a random variable, is still unknown. Various estimates based on professional judgments would be used to formulate the probability statement of the parameter, which could be interpreted as 'degree-of-believe'. This belief could be revised after getting the observed data by using Bayes' theorem and the approach would give a posterior distribution from two sources: (1) the prior distribution and (2) the observed data. In this approach, the rules of probability were used directly to make inferences about the parameter 'per capita' consumption.

Generally, the occupant load was used as a normalizing parameter of the average daily consumption and the (average) 'per capita' demand was specified as an indicator of domestic water consumption and used for various water management issues (Cheng, 2003; Ligman et al., 1974; Lazarova et al., 2003). The average yearly per capita water consumption Y_i (m^3 hd^{-1} yr^{-1}) can be used to determine the average daily per capita consumption $Y_{i,d}$ (m^3 hd^{-1} d^{-1}) as shown in Equation (1), where N_d (d) is the total number of days in a year, y_i (m^3) and $N_{p,i}$ are the yearly water consumption and the number of occupants in an apartment i respectively,

$$Y_i = \frac{y_i}{N_{p,i}};\ Y_{i,d} = \frac{Y_i}{N_d} \qquad \ldots (1)$$

Assuming Y_i is normally distributed with a mean θ and a variance σ^2, i.e. $(Y_i|\theta,\sigma^2) \sim N(\theta,\sigma^2)$, then an estimate acted as a 'prior understanding' of the per capita consumption patterns, can be parameterized by a mean ν and a variance τ^2, i.e. $(\theta\ |\nu,\tau^2) \sim N(\nu,\tau^2)$. The posterior distribution of θ given Y_i is expressed by (Lee, 2004; Wong et al., 2007),

$$\left(\theta\middle|Y_i,\sigma^2,\nu,\tau^2\right) \sim N\left(\theta_1,\tau_1\right);\ \theta_1 = \frac{\sigma^2\nu + \tau^2 Y_i}{\sigma^2 + \tau^2},\ \tau_1^2 = \frac{\sigma^2\tau^2}{\sigma^2 + \tau^2} \qquad \ldots (2)$$

PRIOR ESTIMATES

Domestic water consumption can be extremely capricious due to a range of factors including climate, culture, economy, individual demands, occupant attributes and appliance characteristics. For example, the estimated daily per capita domestic water consumptions (excluding WC flushing) based on in-house metering figures or from metering records of water authorities, is ranged from 65 to 175 L hd^{-1} d^{-1} in some European countries, from 105 to 237 L hd^{-1} d^{-1} in the USA, and from 150 to 365 L hd^{-1} d^{-1} in some Asian cities (Bailey et al., 1986; Cheng, 2003; Edwards and Martin, 1995; Hall et al., 1988; Kose et al., 2004; Ligman et al., 1974; Lazarova et al., 2003; Mukhopadhyay et al., 2001). The averages could be approximated by a normal distribution ranging from 65 to 365 L hd^{-1} d^{-1} (24 to 105 m^3 hd^{-1} yr^{-1}), with an average of 164 L hd^{-1} d^{-1} (60 m^3 hd^{-1} yr^{-1}) and a standard deviation (SD) of 81 L hd^{-1} d^{-1} (30 m^3 hd^{-1} yr^{-1}) ($p \geq 0.3$, Chi-square test). These average values would not be used directly as the best estimate of freshwater consumption in Hong Kong, although they would give some information for freshwater estimation. Therefore, in this study, the first prior estimate (denoted as 'Prior I') would be formulated from these historical regional freshwater consumption records.

Figure 1 shows the annual freshwater produced and supplied to the freshwater supply networks in Hong Kong from 1991 to 2004; with the 'per capita' freshwater production calculated from the Hong Kong population. It was reported that the average annual 'per capita' freshwater production was 292 $m^3\ hd^{-1}\ yr^{-1}$ (SD = 9.3 $m^3\ hd^{-1}\ yr^{-1}$), and it was believed that 20% to 50% of these productions were consumed in residential buildings of Hong Kong, i.e. the average prediction was 102 $m^3\ hd^{-1}\ yr^{-1}$ (SD = 38 $m^3\ hd^{-1}\ yr^{-1}$). This average value was used as an alternative prior estimate (denoted as 'Prior II').

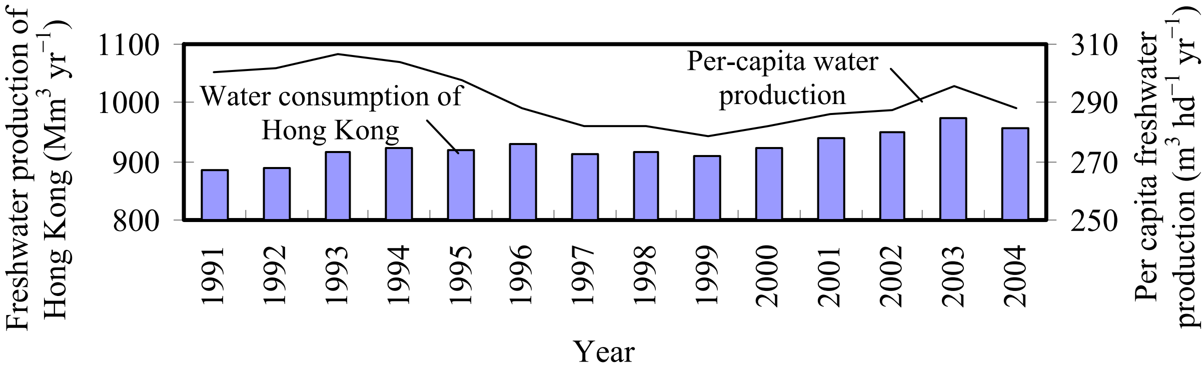

Figure 1: Freshwater production supplied to water networks of Hong Kong (1991-2004)

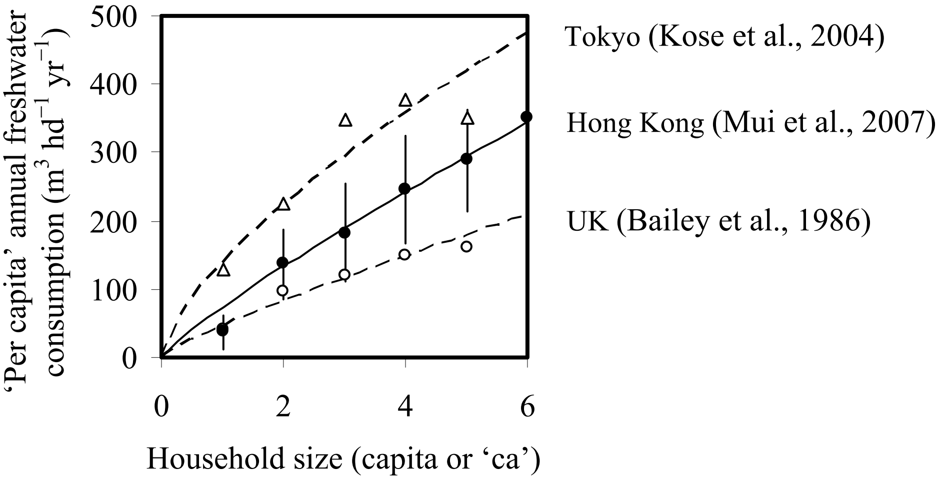

Figure 2: Annual freshwater consumptions in residential apartments

NEW OBSERVATIONS

A small-scale survey was conducted at 60 apartments in Hong Kong. The water consumption patterns obtained were used as a template for developing the 'per capita' water consumption and testing the feasibility of the proposed epistemic approach (Mui et al., 2007). The survey samples were selected based on their demographic data, geographical locations, building ages and architectural designs. Representatives of each of the respective households participated in a face-to-face interview in which procedures similar to those used in some earlier survey studies were applied (Wong and Mui, 2004; 2005). Water bills of the apartments over the past years were collected; and so were the type, brand name, power consumption and capacity of each installed appliance. The occupant load variations during a day throughout a week were also surveyed (Wong and Mui, 2006). Most of the interviewees were those occupants who spend the longest time at home. During the interviews, they were asked to provide information of the appliance usage patterns on the day prior to the interview, and the hourly usage patterns on weekdays, Sundays and holidays respectively. The average time between appliance demands was investigated. The average flow rates of water taps installed at the sink, washbasin, shower and bath were measured with some sample operations by the occupants; the discharge and refilling times of a WC cistern were measured as well. Floor area of each apartment was obtained from the facilities management, direct measurement, or record drawings of piping arrangements.

Figure 2 shows that water consumptions varied with the household size. The survey averages of Hong Kong residential apartments were significantly higher ($p<0.05$, t-test) than the UK average (Bailey et al., 1986), yet significantly lower ($p<0.05$, t-test) than the Tokyo's one (Kose et al., 2004). It was reported that the 'per capita' annual freshwater consumption of 59.4 m^3 hd^{-1} yr^{-1} (SD=20.8 m^3 hd^{-1} yr^{-1}) was observed in the surveyed residential apartment buildings of Hong Kong. The population mean at 99% confidence intervals was 55.5-66.3 m^3 hd^{-1} yr^{-1}.

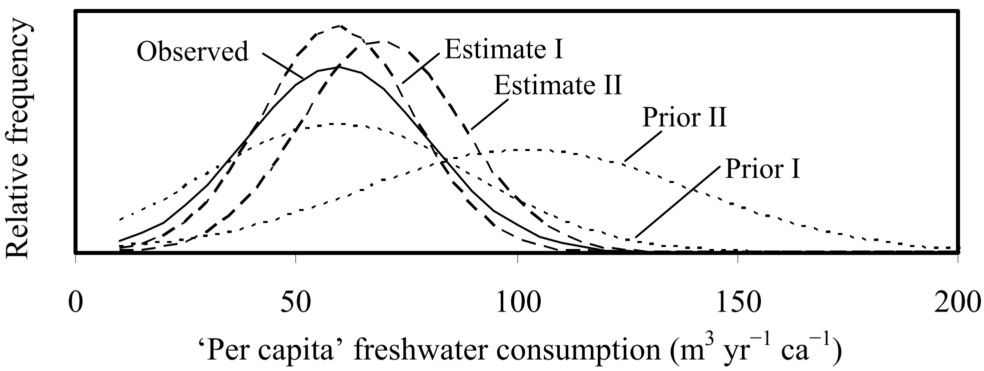

Figure 3: Prior, observed and posterior predicted 'per capita' freshwater consumptions for residential buildings of Hong Kong

POSTERIOR ESTIMATION

Figure 3 shows the distributions of the mean annual per capita freshwater consumption determined from Equation (2) with the observed mean and the prior estimates I and II. The posterior means with the low and high predictions were 59.6 m^3 hd^{-1} yr^{-1} and 69.4 m^3 hd^{-1} yr^{-1}, i.e., 43-50% of the Hong Kong total consumption (140 m^3 hd^{-1} yr^{-1}) in 2005, with the prior estimates of (I) 60 m^3 hd^{-1} yr^{-1} and (II) 102 m^3 hd^{-1} yr^{-1} respectively. The posterior estimate (I) laid between the 95% confidence intervals (54-65 m^3 hd^{-1} yr^{-1}) of the observations. It was noted that the prior estimate II was 70% significantly lager than the prior estimate (I) ($p<0.01$, t-test). It was not surprising that the posterior estimates would be influenced by the ‘large’ prior estimate. It was also reported that the observed mean θ had no significant difference from the posterior estimate I $\theta_{1,I}$ ($p \geq 0.9$, t-test) but had a significant difference from the higher posterior estimate (estimate II) $\theta_{1,I}$ ($p<0.01$, t-test). The results showed a significant difference between the posterior estimates I and II ($p<0.01$, t-test), however, the difference was only 19%, which indicated that the new observation of the freshwater consumption would improve the predictions.

CONCLUSION

The identification of the ‘per capita’ water consumptions would be useful in promoting water conservation, planning and estimating the sizing of water plants, storage tank and system operations for high-rise residential buildings. This study proposed a Bayesian approach to determine the ‘per capita’ domestic freshwater consumption of residential buildings in Hong Kong. It would be applicable in future regional surveys. For determining the ‘per capita’ freshwater consumption profiles in residential buildings of Hong Kong, from the existing domestic water consumption patterns and the latest regional survey studies of households, sample estimates, with various regional reports of water consumption as a ‘prior estimate’ and a survey of 60 typical apartments in Hong Kong as a ‘new observation’, were presented as a template of the ‘per capita’ freshwater consumption. The estimated ‘per capita’ freshwater annual consumption in Hong Kong residential buildings were from 59.6 m^3 hd^{-1} yr^{-1} to 69.4 m^3 hd^{-1} yr^{-1}, which were equivalent to 43 to 50 % of the total freshwater consumption in Hong Kong, with the prior estimates of 60 m^3 hd^{-1} yr^{-1} and 102 m^3 hd^{-1} yr^{-1} respectively. The output of this study would also be useful for evaluating the freshwater consumptions and providing a reference to the professionals involved in designing, operating and managing water supply systems of residential buildings in high dense cities.

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REFERENCES

Bailey RJ, Jolly PK and Lacey RF (1986). Domestic water use patterns. Water Research Centre, UK.

Cheng CL (2003). Evaluating water conservation measures for green building in Taiwan. Building and Environment; 38(2): 369-379.

Corral-Verdugo V, Bechtel RN and Fraijo-Sing B (2003). Environmental beliefs and water conservation: an empirical study. Journal of Environmental Psychology; 23(3): 247-257.

Edwards K and Martin L (1995). A methodology for surveying domestic water consumption. Journal of the Chartered Institution of Water and Environment Management; 9(5): 477-488.

Hall J, Hooper BD and Postle SM (1988). Domestic per capita water consumption in South West England. Journal of the Chartered Institution of Water and Environment Management; 2(6): 626-631.

Hui PS, Wong LT and Mui KW (2007). An epistemic indoor air quality assessment protocol for air-conditioned offices, Indoor and Built Environment; 16(2): 139-149.

Kose H, Sakosuke S and Iizuka H (2004). Measurement of water, electronic power and gas consumption and questionnaire about act of water usage in the apartment house. Proceedings of the 30th CIBW062 International Symposium for Water Supply and Drainage for Buildings, First session: supply systems. 15-17 September. Centre Scientifique et Technique du Batiment, Paris, France.

Lazarova V, Hills S and Birks R (2003). Using recycled water for non-potable, urban uses: a review with particular reference to toilet flushing. Water Science and Technology: Water Supply; 4(4): 60-77.

Lee PM (2004). Bayesian statistics: an introduction. 3rd Edition, London: Arnold.

Ligman K, Hutzler N and Boyle WC (1974). Household wastewater characterization. Journal of the Environmental Engineering Division; 100(EE1): 201-213.

Mui KW, Wong LT and Law LY (2007), Domestic water consumption benchmark development for Hong Kong, Building Services Engineering Research and Technology; 28(4): 329-335.

Mukhopadhyay A, Akber A and Al-Awadi E (2001). Analysis of freshwater consumption patterns in the private residences of Kuwait. Urban Water; 3 (1-2): 53-62.

Water Services Department (2004). Annual Report 2003-2004. The Government of the Hong Kong Special Administrative Region.

Wong LT and Mui KW (2004). Determining the domestic drainage loads for high-rise buildings. Architectural Science Review; 47(4): 347-354.

Wong LT and Mui KW (2005). Determination of domestic flushing water consumption in Hong Kong. Facilities; 23(1-2): 82-94.

Wong LT and Mui KW (2006). An occupant load survey for residential buildings in Hong Kong. International Journal for Housing Science and its Applications; 30(3): 195-204.

Wong LT, Mui KW, Fong NK and Hui PS (2007). Bayesian adaptive comfort temperature (BACT) of air-conditioning system in subtropical climate, Building and Environment; 42(5): 1983-1988.

ONLINE BENCHMARKING OF A SUSTAINABLE INITIATIVE IN SLOVENIA

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ABSTRACT

Municipality Jesenice, a steel industry city in Slovenia, went through economic problems and political changes in the 1990s. Due to the Residential law the former rental flats in poorly maintained social housing stock were in 90% privatized, at a very low price, mainly by low income inhabitants. The city district heating company identified over 40 buildings (1400 flats) with delivered energy consumption for heating exceeding 150 kWh/m^{2}a, where interventions are needed. As a part of EIE project EffCoBuild and in cooperation with local authority the measures, like web-site benchmarking, progressive subsidies and pilot energy certification of buildings, were prepared aiming to help the large residential buildings in Jesenice to develop sustainable maintenance and renovation projects. The paper presents more in detail the energy indicators in existing buildings, CO_2 saving potentials, the municipal measures for stimulating the refurbishment and clients' acceptance as well as good practice cases.

KEYWORDS: apartment buildings, sustainable management, benchmarking

INTRODUCTION

The majority of the social housing sector in the municipality Jesenice was built after the WW2, moreover in the period of rapid development of steel industry between 1960s and 1970s. The dwellings were originally property of the state, rented out at a low social rent, which was sufficient neither for proper building maintenance nor for technical improvement. In the 1990s the economic situation in the steel industry in the region became worse. This led to massive layoffs and often to unemployment of residents in the social housing stock. In the mid 1990s the Residential law encouraged privatisation of former rental flats in poorly maintained social housing stock. About 90% of rental flats were privatized, at a very low price, mainly (64%) by low income inhabitants (Figure 1). In addition, many inhabitants of these neighbourhoods are today retired, often with small pensions, and thus they are not financially able to keep up with the maintenance or even renovation costs of their apartments/buildings. In some cases they even face fuel poverty.

Currently, one can observe that over 80% of 304 existing big apartment buildings in Jesenice need intensive renovation, due to functional reasons, energy and environmental challenge and high running costs. On the other hand city district heating company, which delivers heat to 130 apartment buildings, identified over 40 buildings (1400 flats), large energy consumers, with delivered energy for heating over 150 kWh/m^{2}a. As a part of EIE project EffCoBuild and in cooperation with local authority and municipal key actors (utilities, building owners, building management companies, technology suppliers) the energy saving potential of the existing building stock was evaluated and the municipal measures were prepared aiming to help the large residential buildings in Jesenice to develop sustainable maintenance and renovation projects.

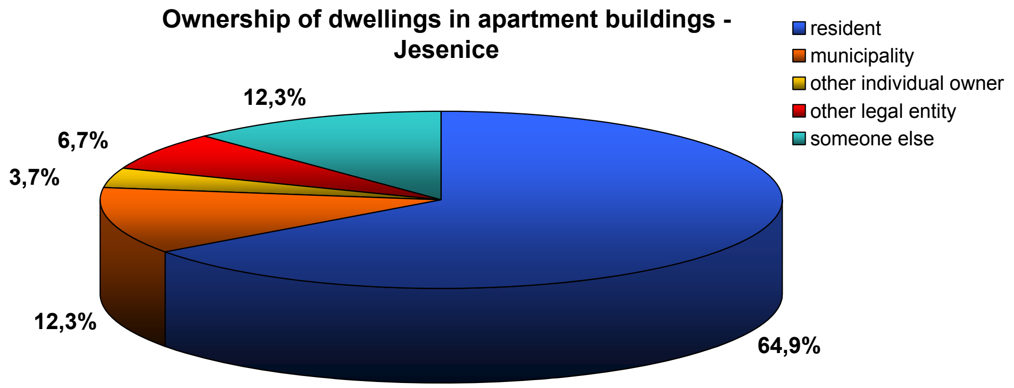

Figure 1. Ownership of apartment buildings in Jesenice (Source: Statistical office of Slovenia, Census 2002)

BUILDING STOCK IN JESENICE

Currently the total residential building stock area covers 546.500 m^2 , i.e. 60% of the stock, the non-residential building floor area is estimated at 364.300 m^2; i.e. 40% of the stock, and from that the public buildings floor area is 43.000 m^2. 58% of dwellings were erected in the period 1945-1980, and therefore exhibit high energy saving potential, due to the low insulation of the envelopes and old-fashioned HVAC technologies. Renewable energy sources come to the agenda but a break through for their wider implementation is still to be reached.

These technically based difficulties are combined with continuative decrease of steel production, decrease of workers income and consequently with lower capability of inhabitants to invest in maintenance or event energy efficient refurbishment of the building stock. In the last 20 years the environmental issues came strongly to the agenda of Municipality Jesenice. The environment, once polluted because of the industrial emissions, is being continuously improved. The emissions caused by low quality of buildings and low efficiency of heating systems have been systematically focused since 1999. To complement the existing awareness raising activities and programmes of subsidies also additional programmes are needed to inform and teach the building owners and users about the energy efficiency and to stimulate the realisation of energy savings through EE investments as well as through behavioural change, not neglecting more and more important public participation decision making

The central part of the municipality is heated by district heating. The town has the sixth largest (according to heat capacity) district heating system in Slovenia that covers 43% of demand in building sector. Around this area at the outskirts the natural gas network is being developed, that contributes 7% to the energy supply; while 48% of the building sector in more distant locations are supplied by oil, biomass and combined systems. In more scattered locations there are still the individual heat generators using coil. The reduction of the latest is planned, either to switch to natural gas or to use alternative energy sources (preferably wood biomass).

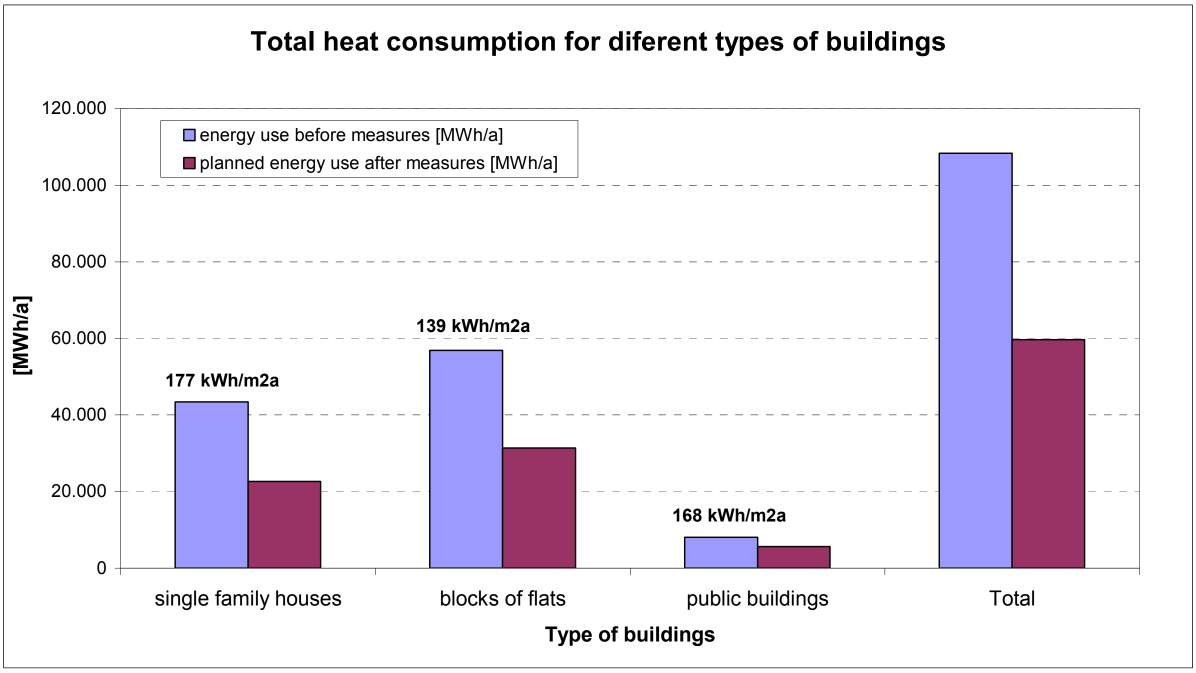

Figure 2. Total energy consumption in the building sector in Jesenice municipality before (indicated figures are related to existing situation) and after the theoretical implementation of identified energy saving potentials

The estimated energy savings in residential and municipal housing stock could reach 45% (48.642 MWh /year) in case of implementation of the most important energy saving measures (envelope insulation, refurbishment of heating systems and heat generators, improved local and central regulation, hydraulic balance of the heating system, installation of thermostatic valves, heat metering and billing according to actual energy use) (Figure 2). 30% of the identified energy saving measures exhibit the payback bellow 10 years.

In the case of the implementation of the proposed measures, the municipality Jesenice could reduce CO_2 emissions in the building sector by 8.4 million tones per year in single family houses, by 6.0 million tones per year in apartment buildings and by 0.6 million tones per year in public building sector.

MUNICIPAL MEASURES TO STIMULATE BUILDING REFURBISHMENT

On the basis of detailed analysis of the energy saving potential, it was concluded, to build the concept of measures for Jesenice around the most problematic municipal sector – the existing apartment building sector. This sector has on one hand the highest saving potential and on the other hand the biggest problems with realisation of this potential, due to well known barriers in recently privatized apartment buildings: building owners and / or tenants with low income, low “social capital” in residential building sector, lack of building users’ interest and motivation for improvement, scattered ownership of recently privatized existing apartment buildings, and thus the lack of consensus for common actions; lack of interest and expertise for EE projects at building management companies, organisational barriers due to building regulation (consensus, loan guarantee), lack of technical information and lack of best practice information from the neighbourhood.

On the basis of workshops in the local community, in cooperation with key actors on the national level, following the existing boundary conditions in the municipality and international consultation in the EIE EffCoBuild team, possible municipal measures were highlighted and finally confirmed. The ideas for the municipal measures were developed around the four main activities.

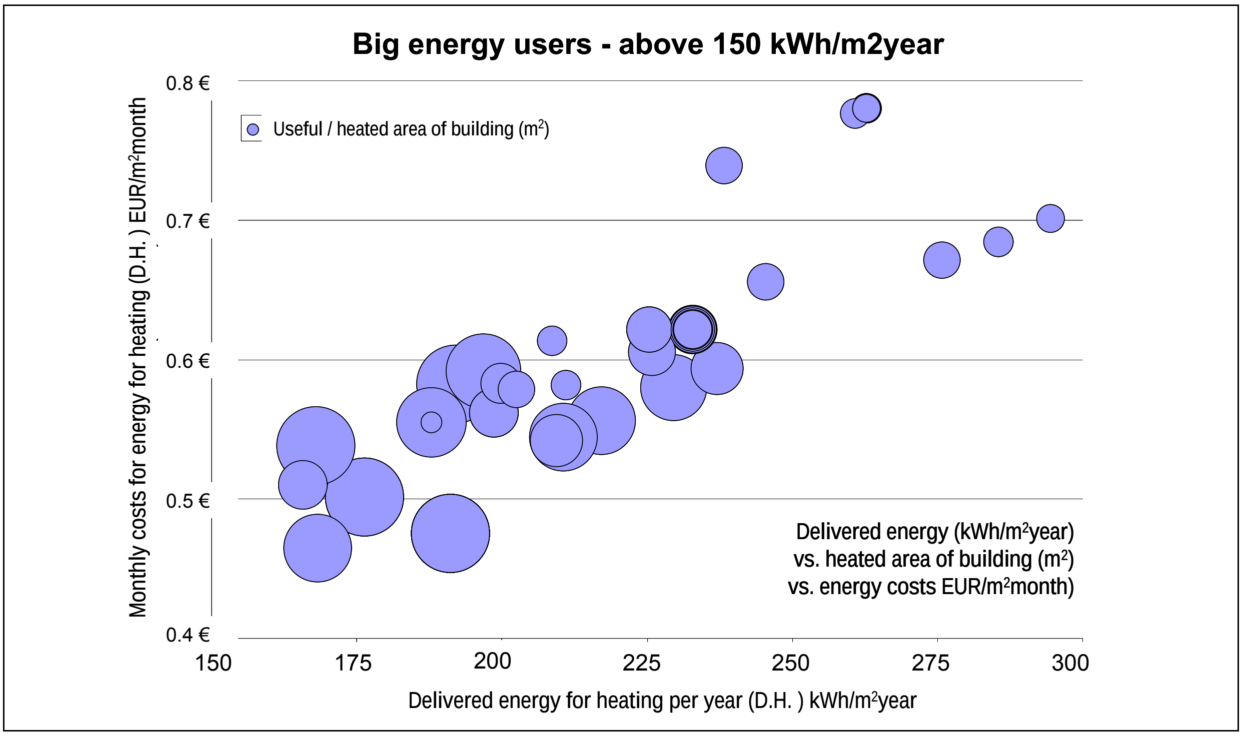

Figure 3. Energy use and energy costs indicators for 40 older apartment buildings - big energy consumers in the municipality Jesenice, the core target group for the implementation of the concept of measures

Progressive municipal subsidies

Municipality Jesenice introduced a municipal “150 subsidy programme” for RES and RUE investments back in 2000. The grants are available for big energy consumers (above 150 kWh/m^{2}a) (Figure 3). The problem of this existing measure is relatively low yearly budget and secondly the grant is to low to re-move the »lack of many« barrier, which is the main barrier in the worst condition buildings. The new idea was to allocate additional municipal budget in of 45.000 EUR in 2007 to develop progressive subsidies scheme for 40 big energy consuming buildings, based on diversification of percentage of subsidy according to the energy consumption: 10% - 15% for 150 – 180 kWh/m^{2}a buildings (24 potential cases according to 2006 status), 15% - 20% for 180 – 210 kWh/m^{2}a buildings (17 potential cases), 20% - 25% for 210 – 230 kWh/m^{2}a buildings (7 potential cases) and 30% for more than 230 kWh/m^{2}a buildings (1 or 2 cases expected). The aim is to actually offer bigger contribution to the worst buildings.

In practice the biggest energy consumers are apartment buildings from 60-ties, with low insulation, insufficient maintenance, used by owners and/or tenants with low income (retired, unemployed). Co-financing 30% of investment in combination with additional subsidies at the national level and soft loans should enable the financing of the measures even in the described conditions. Eligible measures are the insulation of the envelope, replacement of windows, connection to district heating, installation of heat pumps and solar systems or hot water generation and installation of wood biomass boilers.

Contracting in top 40 apartment buildings

Municipal district heating company JEKO-IN and recently privatized company for heat generation in Jesenice ENOS have developed the idea to stimulate energy performance contracting projects in Jesenice buildings. In spite of the fact that not all measures in the building sector are interesting enough for energy service companies (ESCOs) (long pay back period of building envelope measures), the actors believe that these projects are feasible with the financial participation of building owners.

Successful energy performance contracting has certain rules, like creation of the pool of buildings with big saving potential to reduce the risk and the freedom to implement only the most cost effective measures, which normally exclude measures regarding envelope (insulation, windows). The later are highly needed in Jesenice building stock also because of the maintenance reasons.

Being aware of contracting rules and on the other hand taking into account the broader aspect of good building management the contracting actors decided to further develop the idea of contracting with involvement of owners in part of the investment (related to maintenance works). For the contracting period such participation model was considered, that users participate in the savings, in order to increase the interest in project.

Training of building managers

Building managers and/or building management companies are obligatory in Slovenian apartment buildings based on the Residential Act. Based on the management contract, signed with the building owners, their role is to prepare the maintenance and investments plan and to organize all kind of refurbishment works. For the technical improvements the 100% consensus of building owners is needed. The role of building managers in identification of the energy efficiency projects may be crucial, since many of measures are linked with regular maintenance works or can be done at the lowest price in such a moment. There are already some best practice cases available of such a successful interaction between building manager and the owners, but in general such companies need additional education in identification of the most feasible projects, stimulation building owners to come to a consensus, detailed technical knowledge, preparation of tenders and evaluation of bids, and in financing possibilities; above all, they need to share the information about overcoming the barriers and best practice cases.

Web-site benchmarking

“Web-site benchmarking” is an umbrella name for a set of measures using internet for communication with the target group: building owners (incl. users, tenants) and/ or building managers in order to stimulate the EE renovation projects in building sector in Jesenice and to facilitate the use of available municipal co-financing instruments and other national supporting instruments. Currently, the biggest problem is to build a refurbishment project, i.e. to move from the identified energy saving potential to actual decision for the implementation of the measure. Internet was considered to be a powerful tool to bring the general information about the actual energy use, the actual building condition, the energy saving potential to the relevant target group (building managers, building owners, ESCOs, technology suppliers and building contractors). Communication with key actors through a home page of municipal district heating company JEKO-IN is used also to present energy performance certificates, thermographic pictures, available financial incentives, energy advisory options; as well as it is planned to disseminate the useful results of other EIE projects in the field of municipalities, social housing, energy certificates and passive house renovation.

Web-site benchmarking of delivered energy for 40 big apartment buildings in the centre of Jesenice, connected to district heating. and considered as big energy consumers in the heating season 1998/99 due to delivered energy above 150 kWh/m2a, was developed. The data are available on the EffCoBuild section at JEKO-IN homepage (http://www.jeko-in.si/index.php?i=137). JEKO-IN, as a municipal utility, can provide updated data on energy consumption which can be compared with the data for recent years as well as with almost 10 years old information on energy consumption. In addition all 40 buildings are presented also with pilot energy performance certificates (Figure 4), thermographic pictures and various energy indicators (Figure 5). A recommended scenario of building refurbishment is based on energy audit results and on life cycle thinking in planning of sustainable maintenance and refurbishment.

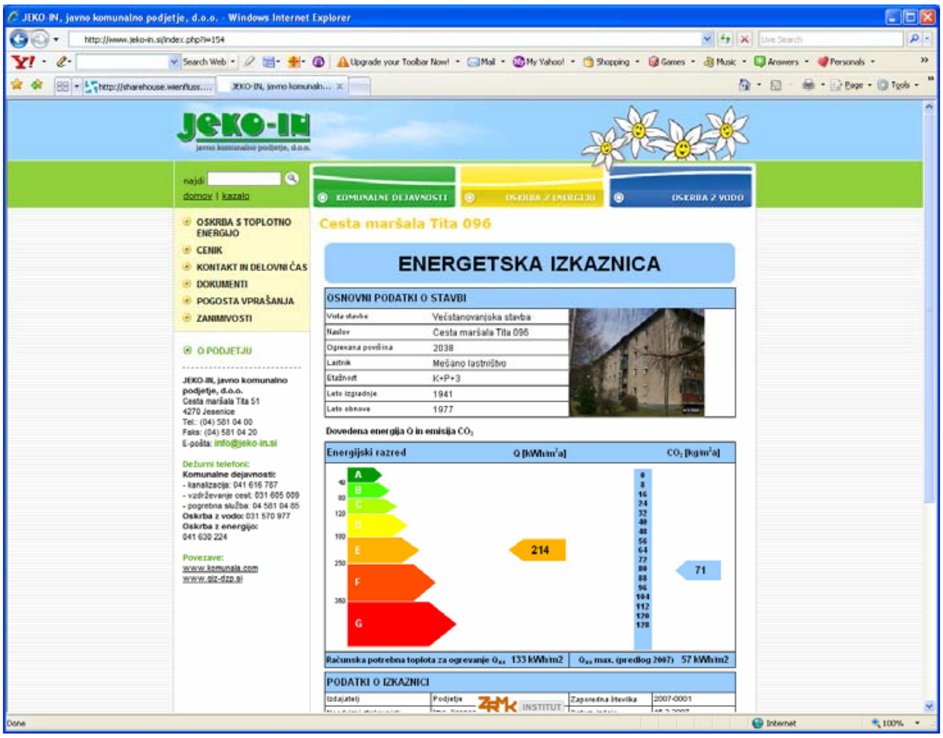

Figure 4. Example of an energy certificate, available on-line, for 40 top energy consumers

The specific energy indicators of 40 big consumers are compared also with the energy indicators of all 130 residential buildings in the municipality, connected to the same district heating system. The observation showed that 46 buildings with the lowest energy consumption (65 – 120 kWh/m^{2}a) have heat metering devices installed and they have billing by actual energy consumption established. It is interesting that in this group of buildings the envelope insulation level did not have the prevailing impact on the energy consumption, the users' behaviour and motivation for savings was of utmost importance. The existing buildings with renovated heating systems but without heat metering and billing demonstrated higher energy use (130 kWh/m^{2}a).

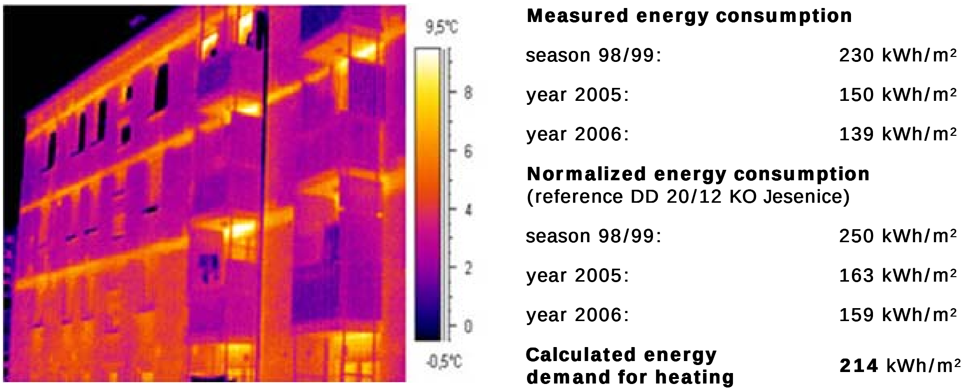

Figure 5. Example of IR themography and energy indicators, available on-line

The selection of 40 buildings originates from almost ten years ago when municipality Jesenice financed an energy audit for them. Since that time some buildings already implemented renovation measures while the other remained the same. Based on this follow-up activity the key actors can be informed about the saving potential and the impact of the implemented measures. The information is presented graphically, using Google map tool, with indicated ranking by red colour – for a big potential, yellow colour – for an average condition, green colour – for good buildings, already refurbished in recent years. Further information on energy use can be obtained by clicking on the selected building on the map. The aim of the measure is information and awareness raising of key actors, and further deployment of successful renovation cases.

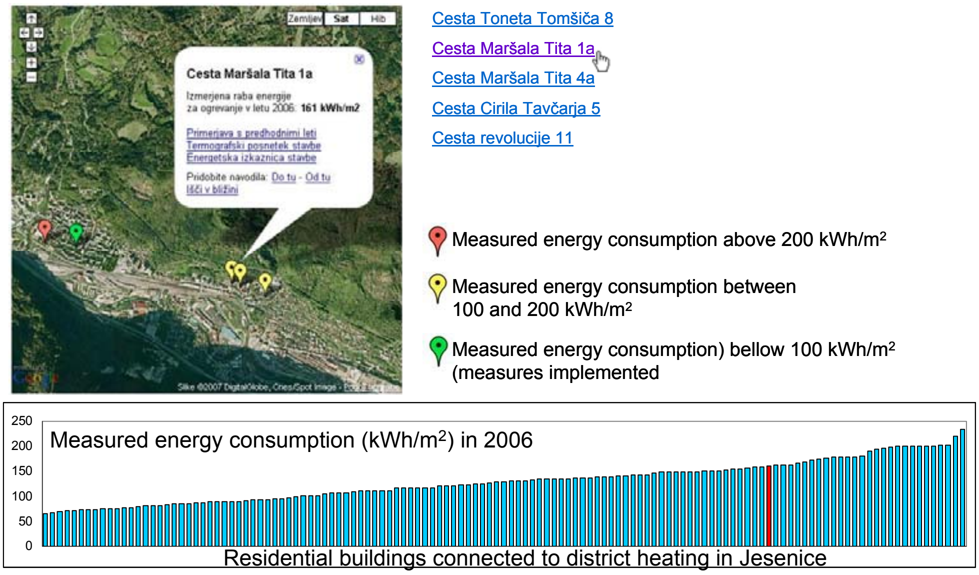

Figure 6. Ranking of buildings on-line (http://www.jeko-in.si/index.php?i=179)

Best practice in renovation is important due to the replication possibility; therefore a brochure with 10 best practice cases in Jesenice was prepared. A case study of renovation of an apartment building at address Cesta marsala Tita 16, built in 1966 and refurbished in 2000 demonstrated 40% of absolute energy reduction per a building as a whole, and 50% reduction of specific energy savings, from 165 kWh/m^{2}a to 86 kWh/m^{2}a. In the building with 7 floors and 1412 m^2 of floor area the wall and roof insulation was added (29.500 EUR) and windows were replaced (26.000 EUR). Specific investment in renovation was 39 EUR/m^2 of useful floor area. In addition the connection to district heating system was done. CO_2 emissions were reduced by 18 t/a.

CONCLUSION

Preliminary field trial of the Jesenice homepage for web-site benchmarking demonstrated a great interest for the available information among the key actors (building management companies, housing companies, building owners and technology providers). Once the home page is completed (planned in March 2008) the dissemination phase will begin, which is the most important for achieving the actual goal – development of energy renovation projects. Utility JEKO-IN has a possibility as well as a commitment by the Energy act to disseminate the information about the energy efficiency status to the customers. The municipality believes that the described set of municipal measures gives a necessary framework conditions for generation of renovation projects. The later is important since Slovenia has not only the aim to improve the buildings technical and aesthetic quality, to reduce the energy costs and to improve the indoor comfort parameters, but also to reach ambitious CO_2 reduction targets, set by Kyoto protocol, EU directive on Energy performance of buildings (2002/91/EC) and EU directive on Energy end-use efficiency and energy services ESD (2006/32/EC).

ACKNOWLEDGEMENTS

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REFERENCES

Sijanec Zavrl, M. and Skubic, M. (2007), “EffCoBuild - WP4 - Concept of measures for the community of Jesenice (Slovenia) – final”, BCEI ZRMK and JEKO-IN

Sijanec Zavrl, M. and Noc, B. (2006), “EffCoBuild - Existing Framework and Instruments Country Report – Jesenice, Slovenia”, BCEI ZRMK and JEKO-IN

SUSTAINABLE HOUSING – PART OF A HEALTHY AND ATTRACTIVE COMMUNITY

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ABSTRACT

United Kingdom cities have been subject to severe social and economic pressures over the past few decades, which have had an uneven spatial impact on the urban environment and have given a rise to the concentration of the most deprived households in the worst urban neighbourhoods. The current government objective can be interpreted as an attempt to implement regeneration projects or create sustainable communities to improve quality of life. Housing is a key issue to consider in delivering healthy and attractive communities. Sustainable housing should be well available, high-quality, economical, ecological, aesthetical design, comfortable and cosy one, which would better suit the needs of a person. Furthermore, dwelling houses, apartments or, in other words, housing premises, must be set out according to the conditions of that locality and must meet the established technical and hygienic requirements. The paper focuses on sustainable housing issue in the UK and a sustainable housing development model for communities is proposed.

KEYWORDS: sustainable housing, development model, sustainable communities, urban regeneration.

INTRODUCTION

Housing is an element of the community's dwelling area with its own social and spatial environment, in which exist many different forms of houses, different architectural styles and designs. A house or an apartment is usually the largest purchase that a person makes throughout his/her entire life. It satisfies one of the major personal needs, thus influences quality of life and can be considered linked with the guarantee of human rights. With changes in political and economic environment in the UK, the problem of housing has become very relevant. Population growth and real disposable incomes increase created a shortage of housing in the UK. Increased demand of housing played an important role in increase of house prices. During last seven years the house prices have doubled or more than doubled and became less affordable for wider society. There is a constant Government regulated supply of new dwelling through private enterprise in urban areas. However, even the new homes are being built continuously, they are small and poor quality by EU standards. For example, average floor area of new dwellings in England is second smallest in EU after Italy (European housing review, 2007).

Today the housing situation is a diverse one, the dual understanding and changing approach exists for the time being. A home should be chosen and changed "as many times as needed" having in minds the needs and opportunities. Available job, income, assets and education all characterise both the social status of the family and, consequently, the housing situation. In many cases, families having many children, as well as persons belonging to the lower social levels, live in homes which are of an extremely low standard if judged according to the effective minimal requirements (bearing in mind both their equipment, size and number of premises). Families with greater numbers of members usually enjoy smaller areas than those in the smaller households. However, an approach also exists in parallel that the problems of housing are related to quality aspects, and that such difficulties are also characteristic to the difficulties of other Western communities (Gondring and Lammel, 2001). It is very easy to foresee that a dwelling, which is already quite difficult to purchase, shall become even more expensive item in the event an increasing divergence between the prices of housing and mean monthly salaries. Thus, a current goal today is to search for sustainable options for housing from the economical, social - psychological and ecological point of view and to accumulate the global experience and apply it in a creative way in order to reach higher standards of economical and social welfare (Maliene et al., 2008).

The purpose of this paper is to emphasize housing as a key issue to consider in delivering healthy and attractive communities. Sustainable housing should be available in sufficient supply and with information on it, high-quality in technical and supply level, economical with opportunity to cover purchase and exploitation expenses for greater number of households, ecological having energy saving, ecological building materials, sustainable waste management, aesthetical design, comfortable and cosy having in mind social-psychological aspect, representing home, which would better suit the needs of a person. Furthermore, houses and apartments must be set out according to the conditions of that locality and must meet the established technical and hygienic requirements. In the paper are introduced criteria characterising sustainable housing and the model of sustainable housing development.

Current housing situation in the UK

A traditional UK housing has been determined by the local natural and climatic conditions, traditions of ethnic culture, and social, economical and technical progress. The majority of dwellings are single-family houses. In England in 2000, 82% of households lived in houses, 16% in self-contained flats and 2% in bed-sits and other non-self-contained accommodation. The housing stock, furthermore, is relatively old in comparison to many other European countries – with 41% built before 1945, another 45% between 1945 and 1984; and only 13% since the mid-1980s. Housing stock growth slowed from the 1970s, although with a minor revival during the boom years of the 1980s after which it decelerated again (European housing review, 2007).

Economic growth has been strong in recent years, which has a strongly positive effect on the housing market. Population growth and real disposable incomes increase created a shortage of housing in the UK. Over the last 30 years we have seen demand for new homes increase by 30% - people are living longer, and choosing to live alone - whereas over the same period house building rates have dropped by over 50%.

The quantity, quality and location of housing are major factors in determining how people live ‘healthy’ their lives and the contribution they can make to a wider society. However, the supply of new homes is now at its lowest levels for decades and affordability has fallen leading to a continued lack of demand among first time buyers. ‘The Barker Review’, released in 2003 after government intervention, set out a series of policy recommendations to address the lack of supply of housing considering the role of competition, capacity, technology and finance in the industry coupled with the interaction of the planning system and the government’s sustainable development objectives.

Britain urgently needs to build up to 140,000 extra houses a year if supply is to keep up with demand. Of this, between 70,000 and 120,000 of those homes should be provided by the private sector, while around 23,000 should be by social housing units. In 2001, only 175,000 houses were built in the UK – the lowest since World War II" (Environmental Health News Online, 2004). The government has an ambition to built 3.8 million new homes by 2016 (Littlewood and Geen, 2003).

Increased demand of housing played an important role in increase of house prices. During last seven years the house prices have doubled or more than doubled and became less affordable for wider society. The UK housing market has, in fact, been highly volatile for several decades, significantly more so than the average country experience in the EU. There is a constant supply of new dwelling through Government mainly through private enterprise in urban areas. However, the new dwellings being built are relatively small if compared to other EU countries (European housing review, 2007).

However, there have been warnings. A report by Barlow and Ball (1999) found that in the late 1990s, the demand for housing grew rapidly, notably along with production costs and consequently, much of the extra demand was soaked up in higher building costs and land prices, rather than in more housing. Housing needs were changing, shifts in household structures and lifestyles leading to demands for more varied and flexible house designs. Furthermore, the poor price responsiveness of supply exacerbates housing market cycles". Meen (1999) goes on to identify that Britain exhibits a distinct spatial pattern over time, rising first in a cyclical upswing in the south-east and then spreading over the rest of the country, better known as the ripple effect. This meant there were large regional price differences and that the southeast appeared to lead the house price cycle.

A simple overview of the UK's housing problem suggests that difficulties, which have developed, and remained unresolved, are largely down to planning (Carmona et al., 2003). However, planning is only part of the reason. Blame should also be directed towards successive national governments as they have under-invested in public services and steadily withdrawn from a social housing provision, while local providers have pushed for the wrong houses in the wrong places (Carmona et al., 2003). It is also felt that the house building industry as a whole must take some responsibility as they have pursued maximum profitability in lieu of social and environmental responsibility.

Sustainable housing - part of sustainable communities

The term "sustainability" has come to the prominence over last few decades, promoted initially by environmental concerns (Brundtland Report, 1987) and more recently addressed to the communities. Sustainable communities are places where people want to live and work, now and in the future. They meet the diverse needs of existing and future residents, are sensitive to their environment, and contribute to a high quality of life. They are safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all (Office of the Deputy Prime Minister, 2003).

For communities to be sustainable, they must offer hospitals, schools, shops, good public transport, clean and safe environment. People also need open public space where they can relax and interact and the ability to have a say on the way their neighborhood is run. Most importantly, sustainable communities must offer decent homes at prices people can afford.

Today, we speak about the sustainable housing as part of sustainable community more and more often. This is because the housing provides the personal space of the individual, the place with which the occupant identifies basic urban existence (European Press Council, 1993). It is considered a place of non-service living and, at the same time, a space for privacy where private and emotional family life goes on, protected from external factors. There are no duties executed within such housing. It is thought that housing is a place meant for leisure activities and representation. Its form, place, plan, setting out, etc, has an influence on this side of living. At the same time, a definition of a modern housing includes ecological aspects (saving of areas for building, decrease of energy consumption, etc.). There are identified the following characteristics of a modern sustainable housing (Gondring and Lammel, 2001):

- From a social point of view – apartment or house is a place for family. It has a symbolic meaning of social status.
- From a functional point of view – apartment or house is a place for leisure activities and rest, not for professional activities.
- From a social–psychological point of view – apartment or house is a place for privacy and intimacy.
- From an economical point of view – apartment or house is an article. It is reclaimed during purchase or rent.

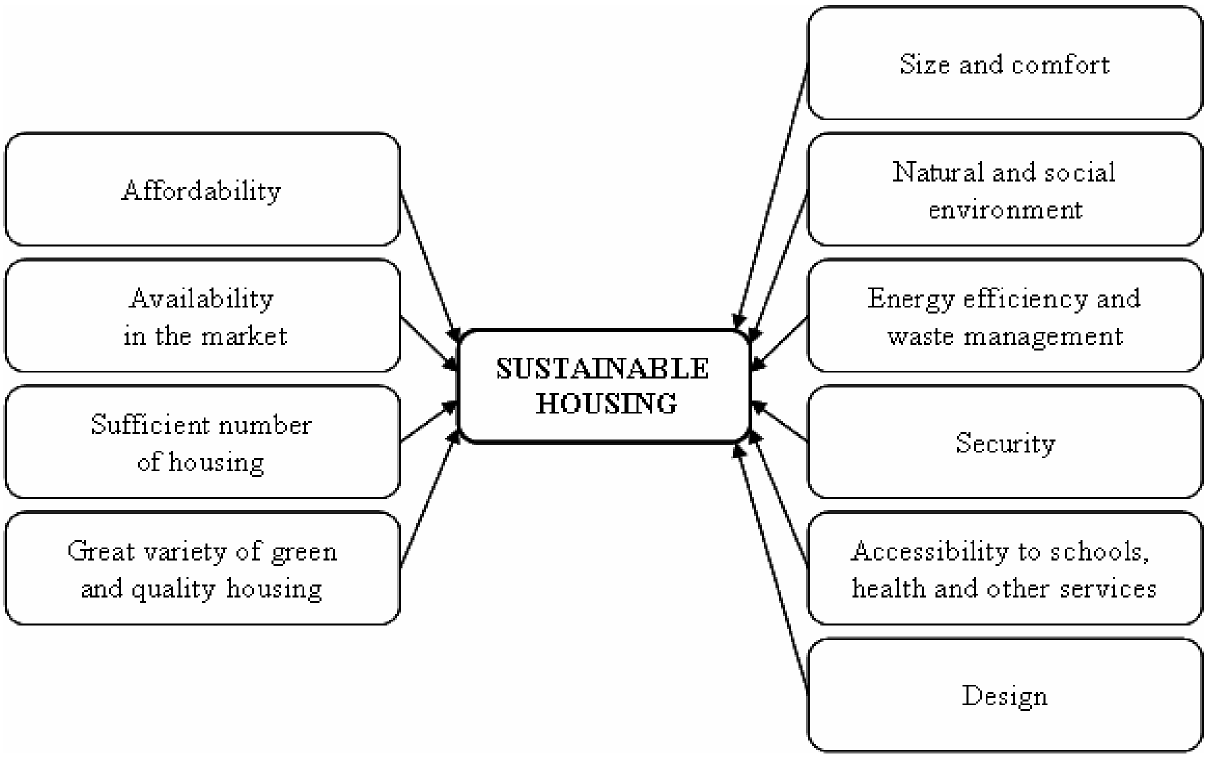

Figure 1. Criteria characterizing sustainable housing

Housing is very different now from that which used to exist within primitive society or in the Middle Ages. In the 19^{th} century, industrial workers were unable to obtain sustainable housing standards. Historical analysis shows that the first homes used to depend on natural conditions and materials found in the environment, whilst sustainable houses are equipped to ensure cosiness to our homes, including security and energy saving. These days, the part of modern homes serves for representation, the other for the living of all the family members. The design of houses and apartments is adapted to increased individuality. Such functions as food preparation, eating, sleeping, hygiene, communication, etc. were separated into special premises. Separate rooms are for separate persons, i.e. parents and children, sons and daughters and, in many cases, wives and husbands. Such divisions of functions and persons are a good precondition to even more private housing space. This could be one of the features of a sustainable housing. The Latin word *rationalis* means *clever*. Therefore, the sustainable housing is housing planned in a clever way. One is able to high-quality (in technical and supply level), economical (opportunity to cover purchase and exploitation expenses for greater number of households), ecological (energy saving, ecological building materials, etc.), comfortable and cosy (having in mind social-psychological aspect) one, which would better suit the needs of an individual (Maliene and Ruzinskaite, 2006). Besides that, houses, apartments or, in other words, housing premises, must be set out according to the conditions of that locality and must meet the established technical and hygienic requirements. Also other criteria are important for sustainable housing (Figure 1).

Recently, UK government proposed an ambitious 'umbrella' programme for sustainable communities. In this programme the sustainable housing is one of the major issue necessary to address in creating sustainable communities (Office of the Deputy Prime Minister, 2003; Office of the Deputy Prime Minister, 2004).

Regeneration to sustainable housing and model of sustainable housing development

New sustainable housing can be a driver of urban regeneration, and sustainable housing is an essential ingredient of any regeneration scheme. Sustainable housing stimulates physical, economic, environmental and social improvement, and the resulting enhancements in turn stimulate new investment and new opportunities as the urban environment once again become full of life and enterprise (Edger and Taylor, 2000).

Throughout the history of urban regeneration housing has been a major concern for all political parties. Housing has been in the lime light in all new interventions of policies. The nature of policy has changed direction several times. Over the last several decades, urban regeneration policy has both evolved and had various foci.

Development of sustainable housing is an important objective of sustainable communities strategy. According to the definition presented above, the sustainable housing should be well available, matching quality, economical, ecological, cosy, comfortable needs of an individual (Maliene, 2001). Based on the experience of other countries, it is quite possible to create and apply (maybe even per every town or community) a model of reasoned housing in the UK. This model would assist developing healthy and attractive communities. The new housing forms do not emerge in place of the old ones but next to them, so the said model could consist of three parts: private and social households, housing market (existing dwellings) and model of development land for new housing (Figure 2).

In the first part of this model, the purchasers of housing are described, i.e. households, which are different by their size (number of members), age, generations living together, purchasing power and subjective wishes. The following three household groups are important to UK housing market:

- Households presented to the market for the first time (insufficient means to pay for household);
- Households are wishing to improve a housing;

- Aged people (receive low income and want to move, for instance, to smaller and cheaper dwelling).

This needs a variety of housing offers.

The entire housing market with predictive households acting as the potential purchasers is divided into rent and property markets appropriately. Firstly, one should analyse the property forms. The housing demand is based on the size of housing area, so demand is the second parameter of the model. An area depends on size of households, location and part of housing market (rented or owned) and must meet the wishes and financial muscle of the inhabitants (Figure 2).

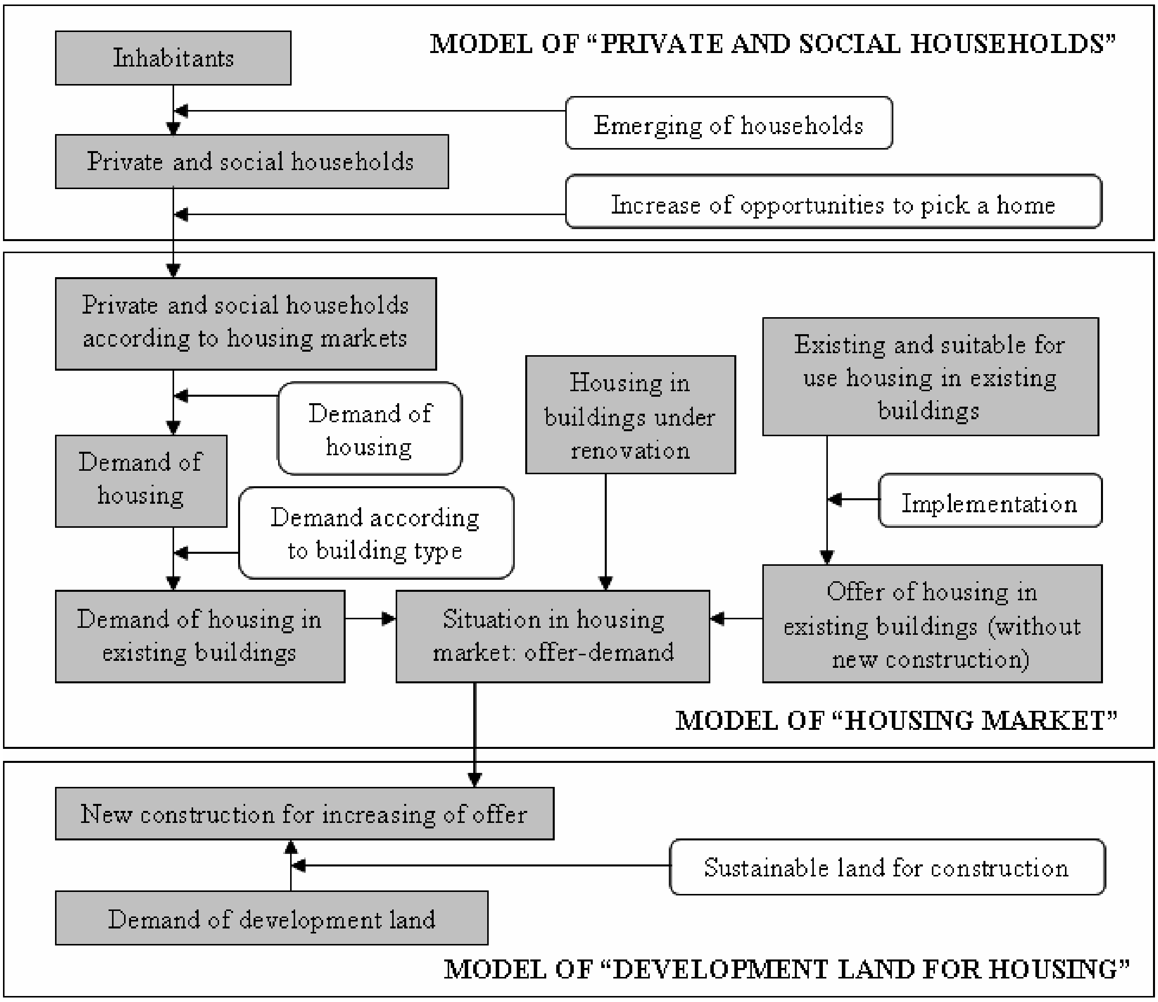

Figure 2. Model of sustainable housing development. Internal parameters of the model are in greyed rectangle. External parameters of the model are in rounded rectangle.

The sufficient amount of dwellings should be present in the market as well as their variety according to type (house, apartment, cottage, etc.), form of possession (owned, rented), standards (of accommodation) and location. The valuable housing means that there is a sufficient offer and information on it, also an opportunity to change the housing if circumstances also change, and cover the purchase and exploitation costs. At this stage a special decision support system could be used in order to assist in the choice of the best option of sustainable housing.

In the offered model of a sustainable housing development, it is advisable to highlight the structures under renovation because poor construction quality and bad engineering installations are characteristic for many housing blocks of flats, as well as low energy efficiency (no thermal insulation), no large-scale adequate reparations, high energy losses in the central heating systems and hot water production units.

Change of an area demand (in the existing and suitable for use housing buildings, as well as in buildings under renovation) during some certain period determines even greater demand or demand for an unoccupied area (in the event of emergence of more attractive apartments in the market, the same percentage of already existing apartments shall also be available for sale). When demand exceeds the existing offer, a demand for newly built dwellings emerges in order to satisfy such demand.

Developed land in settlements is needed for the building of the new housing (land for houses and infrastructure). There is a close coherence between new developed and developed land and undeveloped land needed for housing. So-called construction density is a very important factor. One should also pay attention to the location of new structures and the kind of already available ones (houses for one or many families). Speaking about a new housing with minimal costs, one should pay attention to the fact that new buildings are extremely expensive. There is a low supply of land in really good locations, along with a very long and difficult order of issuing of planning permission for construction. After analysis of the parameters of the model of a sustainable housing based on the experience of the Western countries, the local government, development agencies and developers could create sustainable housing in their communities.

Conclusions

A new understanding of the sustainable housing is in the formation process now. It is quite natural that we still do not have good examples of a new and sustainable housing. During the search for own models, it is worthy to review the experiences of neighbouring countries, develop state-of-the-art and ecological technology, and solve the organisational problems of a housing.

The sustainable housing is characterised as available (sufficient offer and information on such offers), quality (from the technical and provision point of view), economical (greater number of households have opportunities to purchase it and cover the exploitation expenses), ecological (energy-saving, etc.), comfortable and cosy (from the social-psychological point of view).

It is important to recognise that great variety of high quality housing (e.g. building construction, design, comfort, size, etc) is as important as other sustainable housing characteristics (affordability, accessibility, energy efficiency, waste management, security, etc). Increased demand for new homes cannot result in reduced quality and sustainability of housing.

In the paper proposed model is to aid a housing development for sustainable communities. The sustainable housing development model can be adapted to every town and will help to create healthy and attractive communities.

REFERENCES

Barlow, J. and Ball, M. (1999), ”Introduction – Improving British Housing Supply”, Housing Studies, Vol. 14 No. 1, pp. 5-8.

Brundtland report (1987), Our Common Future-Report of the 1987 Commission on Environment and Development. Oxford University Press, Oxford.

Carmona, M., Carmona, S. and Gallent N., (2003), Delivering New Homes – Processes, Planners and Providers, Routledge.

Edger, B. and Taylor, J. (2000), “Urban Regeneration”, in Roberts, P. and Sykes, H. (Ed.), A Handbook, British Urban Regeneration Association, SAGE, Publications, London, pp. 153-175.

Environmental Health News Online, (2004), Barker: housing shortage curtailing economy.

European housing review 2007, RICS

European Urban Charter (1993), European Press Council.

Gondring H. and Lammel E. (2001), Immobilienwirtschaft, Wiesbaden, Gabler, (in german)

Littlewood, J.R. and Greens, A.J. (2003), “A new multidisciplinary team for the UK’s 21st century homes”, International Journal of Environmental Technology and Management, Vol. 2 No. 1-2, pp. 267-278.

Maliene, V. (2001), “Valuation of commercial premises using a multiple criteria decision making method“, Property Management, Vol. 5 No. 2, pp. 87 – 98.

Maliene, V., Alexander, K. and Lepkova, N. (2008), “Facilities management development in Europe”, International Journal of Environment and Pollution, in press.

Maliene, V., Ruzinskaite, J. (2006), “Development of sustainable dwelling in Lithuania”, XXIII FIG Congress, Munich, pp.1-15.

Meen, G. (1999), ”Regional house prices and the ripple effect: a new interpretation”, Housing Studies, Vol. 14 No. 6, pp. 733-753.

Office of the Deputy Prime Minister (2003), Sustainable Communities: Building for the Future.

Office of the Deputy Prime Minister (2004), The Egan review: skills for sustainable communities. RIBA Enterprise Ltd, London.

Schiller, G. (2007) “Urban infrastructure: challenges for resources efficiency in the building stock”, Building Research & Information, Vol. 35 No. 4, pp. 399-411.

AFFORDABLE DWELLING QUALITY & PREFERENCES FOR URBAN YOUNG & POOR

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ABSTRACT

This research aims to ascertain the current affordable apartment dwelling quality situation, and the preferences of occupants, with a view to making recommendations for improvement based on findings. It precedes a larger body of research, which has a goal to develop a quality health, safety, and welfare index (HSWI) for apartment buildings in USA. Housing affordability is often associated with lower income households. Demand for affordable dwelling has been on the increase, while a corresponding decline in quality has been observed. The elevated demand for apartments relative to the state of most of the available options provoked this research concern to evaluate the quality of life they provide for the occupants. Data was collected through the questionnaire instrument administered to a representative sample of apartment dwellers. Among the key conclusions, many people living in apartments do so by choice and not due to conditions such as income as readily thought.

KEYWORDS: dwelling, health, safety, welfare

INTRODUCTION AND BACKGROUND

Typically, housing affordability is an issue associated with lower income earners (Lee et al., 1995). Making up this segment are young adults who have recently left home to go to college (e.g., college and university students), or are still in search of elusive jobs, those who have secured meager jobs, and the poor of all ages, sexes, races, and orientations. Despite the image of apartment living as second-class to home ownership (Michaux, 1996), and this concept running counter to the so-called American dream (Michaux and Kempner, 1995), this dwelling type holds a strong attraction to this group. Their demand for affordable apartment dwelling has been on the increase, while a corresponding decline in health, safety, and welfare (HSW) quality has been recorded among options available to this segment of society. This situation is contrary to the Cranston-Gonzalez National Affordable Housing Act of 1990, and 1998 as amended, which shows the Federal housing policy objectives to include increasing the supply of 'decent housing that is affordable to low income and moderate income families.' The elevated demand for apartments relative to the state of most of the available options provokes research concern to evaluate the quality of life this dwelling type provides for the occupants. It raises the debate on HSW disparity versus wealth and position within society.

Based on 1999 household income data shown in the US census of 2000, nearly 30% of the population earned less than $25,000 annually. Most urban young and poor (UrYoPo) fall within this income level. With young adults who just left home to go to college adding to this percentage, a good number of the US population and workforce is affected (Lee et al., 1995),

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and the economy will benefit from any avenues to affordable quality apartment accommodation option that can address the UrYoPo's HSW needs. Besides the Federal government and Housing and Urban Development departments, foundations such as State Street, Home Depot, and McArthur are keen to fund research that contributes to this debate.

Quality, satisfaction, or preference constitutes the parameter with which any dwelling environment can be assessed (Zwarts and Coolen, 2006). Satisfaction with dwelling space is a function of three variables: user characteristics, physical attributes of the space, and beliefs and perceptions of the user about the space (Atlas and Ozsoy, 1998). Studies have included this quality parameter and crowding in urban environments (Bonnes et al., 1991; Bratt et al., 1994; Siakavellas, 2002), satisfaction among African Americans (Cook and Bruin, 1993), satisfaction among low-income single-parent families (Bruin and Cook, 1997), the relationship of satisfaction, mobility intentions, and moving behavior (Lu, 1998), satisfaction in multi-sited public housing (Varady and Preiser). Not only is accommodation expensive for the UrYoPos, it is also deficient and over-crowed, and more likely to be contaminated and hazardous (Katrakis et al., 1994). Alleviating this situation through a study such as this research would be of immense benefit to society.

Michaux et al. (1995) provided an insight into factors that would shape the US apartment future: an aging market; shrinking entry-level groups for the housing market; a switch from baby boomers to baby busters (empty nesters); growth in the number of households, particularly through immigration; shrinking household sizes (2.69 according to 2000 census); a mobile US population; greater cultural and lifestyle diversity. All these factors point to the growing importance of apartment dwelling as a real accommodation choice for many US residents.

This research aims to evaluate the current affordable apartment dwelling quality situation, and the preferences of eastern Michigan's urban young and poor, and to make recommendations for improvement based on findings. It provides an awareness that can inform all concerned persons about HSW issues in apartments, while facilitating owners, developers, designers, and government to make informed socio-economically responsible decisions on practice improvements. Although this pilot study concentrates on eastern Michigan, it is planned for the broader research to go beyond this setting so as to make the developed index more widely applicable. Besides this conference presentation, as well as goal and research oriented impacts on students, projected outcomes of this research include the generation of the preliminary data for the broader research, which has a goal to develop a widely applicable quality HSW index for apartment buildings.

For reasons of brevity, the research aim is addressed in this paper under a few subheadings:

- Research design
- Data analysis, results and discussion
- Conclusion.

RESEARCH DESIGN

This section describes the methodology adopted in carrying out the study. Presented are the nature of the sample, with a mention of the questionnaire instrument, operational measures of the study variables and the statistical methods used for analysing the data. It is acknowledged that the design of the study, the sample size and statistical methodologies will necessarily limit the accuracy of the results, and conclusions from them.

Methodology

The questionnaire instrument was used to obtain the data. The questionnaire was developed based on a previous similar study by the first author and his student at Deakin University (Bill Botelho). In order to obtain a representative sample of the different apartment dwellers, the questionnaire was administered to randomly selected apartments from the Multiple Listing Service system and American Housing Survey for eastern Michigan. A total of 32 questionnaires were returned at this point, indicating just 14% return rate.

Some new lessons were learned from this survey. A higher rate of response was obtained when the questionnaire appeared shorter and in color. Some respondents tended to make multiple responses to a question if they felt more than one choice applied, despite the instruction to choose only one option. Based on the descriptive statistics (frequencies) women respondents (about 81) were much more than men respondents (about 19%), probably suggesting that more women than men may be dwelling in the examined apartments. This figure differed from an Australian study which showed an opposite result (Botelho, 2002). About 75% of the respondents were between the ages of 15 to 35. Over 79% of the respondents were single. The most discomforting feature to apartment dwellers was noise from neighbors reported by 72% of the respondents.

Main Study Issues

Besides demographic information, below are some of the questions asked to explore the main study issues. A determination of interrelationships would ideally require interval level of measurement. However, since many of the variables were based on respondents' assessments and not on existing records, some ordinal ranking scales were developed and treated in a quantitative manner by assigning ordered scores to the categories (Agresti, 1996). Some variables were measured using ratio scales since they have all the characteristics of an interval scale in addition to having true zero points of origin, and are independent of their units of measurement (Siegel, 1956). The interval/ratio, and ordinal measurements are however omitted here for reasons of brevity.

There were three sections of the questionnaire. Section A focused on the demographic information of the respondents.

Section B aimed to obtain information regarding the apartment complex and the facilities provided for the tenants, and included some of these questions:
Which of the following is your preferred type of dwelling?
In your opinion, how many car parking spaces should be allocated to your apartment only?
What is the maximum distance you should have to walk from your car to the entry of your apartment complex?
What is your preferred method of accessing your apartment?
Does your apartment complex provide facilities for handicapped people?
What are the main security features that should exist in your apartment complex?
What kind of social environment would you like to experience within your apartment complex?
What kind of environment do you wish your apartment complex provides in relation to crowding?
What is the preferred method of disposing your rubbish?

Section C obtained general apartment preferences information:

Apart from location, internally what are the main features you look for when choosing an apartment to live in?

What is the weekly rental value of this apartment?

For how long do you intend to live in this apartment?

What is the number of bedrooms rooms you prefer to have when selecting apartments?

Internally, which of the following floor level setups would you prefer to have in your apartment?

Which room do you use the most?

Which is your favorite room?

Which of the following rooms need to be the most spacious?

What are the major problems you encountered when moving furniture into your apartment?

What are the major problems you have encountered when re-arranging furniture in your apartment?

In which room do you normally re-arrange furniture most often?

Which of the following features do you dislike the most about your kitchen?

How do you rate the temperature in your apartment during summer?

How do you prefer to cool your apartment in summer?

How do you rate the temperature in your apartment in winter?

How do you keep your apartment warm in winter?

In which of the following rooms do you require built in storage space?

Where do you normally prefer to eat your meals?

What is your preferred floor covering for the living areas?

What is your preferred floor covering for the kitchen/laundry area?

What is your preferred floor covering for the bedrooms?

What is your preferred method of drying your laundry?

What is your preferred type of window?

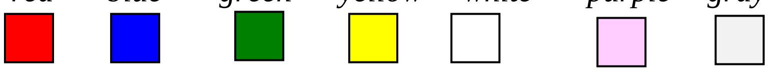
Which of the following lighting systems do you prefer?

If you could choose, which of the following outdoor spaces would you prefer to have in your apartment?

With regard to privacy, what are the most annoying aspects of living in an apartment?

From the range of colors, which would you apply to the following rooms?

red blue green yellow white purple gray

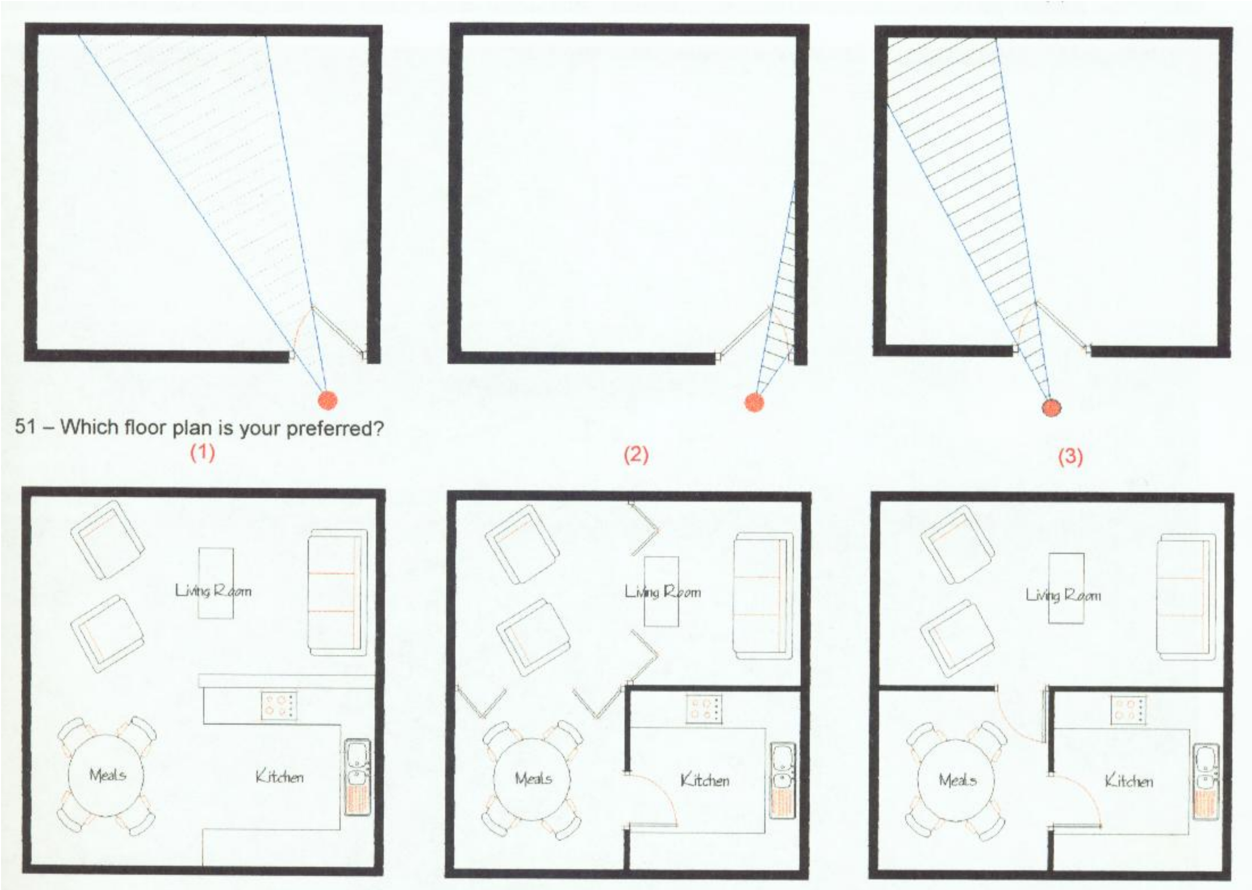


In your opinion, is there any design problems in your apartment that you are not satisfied with?

Would you pay more in rental to live in an environmentally sustainable apartment?

Would you be happy to live in an apartment for the rest of your life?

In each of the bedrooms below, the entrance door has been placed in a different position, allowing for different areas of the room to be seen from the outside. In terms of privacy and location of furniture, which door position would you choose for your bedroom?



Which of the following interior design styles do you like the most?

DATA ANALYSIS, RESULTS AND DISCUSSION

Both descriptive and inferential statistical analyses were conducted. However, only Spearman rho's correlation and Kruskal-Wallis test are presented here. Spearman rho rather than Kendall or Pearson Product-moment correlation was preferred due to the non-parametric proportion of the data. The Kruskal-Wallis *H* test for three or more unrelated samples was preferred over the Mann-Whitney *U* test for two unrelated samples due to a tiny fraction of the respondent population not declaring their gender group. To follow are the descriptive statistics (frequency distributions, histograms, and pie charts, etc.) used where deemed appropriate, and higher level inferential statistical analysis (regression and path analysis) that will later be conducted on the data. The results were interpreted and discussed based on cross-evaluation of the data, and interdependency was assumed as the direction of dependency was not beforehand determined.

The correlation coefficient, ρ, is calculated as:

$$\rho = \frac{\Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{n}}{\sqrt{(\Sigma X^2 - \frac{(\Sigma X)^2}{n})(\Sigma Y^2 - \frac{(\Sigma Y)^2}{n})}}$$

Where X and Y are two variables varying together - that is, two variables dependent on each other; and *n* is the sample size.

Considering the type of data and measurements, a non-parametric statistical method such as Spearman rho's correlation was deemed more appropriate to correlate the dependent and independent variables. The Kruskal-Wallis one-way analysis of variance test was performed as another level of test to ascertain the variation in the mean ranks of the data relative to the responses (from men, women, and unclassifieds), and to give chi-square (χ^2) values of similar distribution.

For brevity, the relationships presented are the ones found significant at the 0.05 level of significance. In addition, to shorten the discussions, a positive correlation between variables, should indicate to readers that an increase in the one variable (independent variable) is associated with an increase in the other variable (dependent variable) or vice versa. Conversely, a negative correlation between variables should indicate that an increase in one variable is associated with a decrease in the other. The correlations should be read in tandem with the frequencies, whereby the correlation results (positive or negative) are deemed to relate more to the higher frequencies.

Furthermore, where the reported probability level is higher than 0.05 in the Kruskal-Wallis test, readers should rely on the significance level of the correlation statistics, as this suggests that there is no difference between the genders in relation to the variable in question. However, this test applies to variables measured at ordinal and nominal scales. Higher than normal probability levels of significance are expected due to the relatively small size of the sample population, the sometimes wide ranges between the mean ranks, the missing cases and low frequencies. Disparate mean ranks are indices of non-homogeneous sample population which was not the case in this study. If disparate mean ranks are not the result of chance variations such as are to be expected among several random samples from the same population, then the result may explain, for instance, the differing life styles of the sample apartment dwellers. Missing cases were omitted in the Kruskal-Wallis test results.

The significance of the test results should be read in the ways suggested by Coolican (1990: 174), based on the probability level, p:
significant – $0.05>p<0.01$;
highly significant – $0.01>p<0.001$; and
very highly significant – $0.001>p$.
All probabilities reported are based on two-tailed tests, as the study was exploratory and the outcome of each comparison had two possible directions – positive or negative.

Sample Result and Discussion

Age group was found positively correlated with: the length of time respondents wish to live in the apartments (ρ=.365, p=.040, N= 32) (16 out of 32 respondents were aged 25 or below, and 24 out of 32 intend to stay less than 3 years in the apartments). Age group was however found negatively correlated with: preparedness to share facilities such as the laundry (ρ= -.386, p=.029, N= 32). Understandably, it would appear that the younger group find sharing of some facilities less appealing.

Employment group was found positively correlated with: the respondents' rating of their winter room temperatures (ρ=.466, p=.019, N= 25) (23 out of 27 respondents rated their room winter temperatures to be from mild to moderately warm) (Kruskal-Wallis test, p=.896 and χ^2=.017), and the respondents' color preferences for their bedrooms (ρ=.371, p=.043, N= 30) (majority of the respondents (10) preferred white color for their bedrooms). Employment group was however found negatively correlated with: preferences for methods of accessing the apartments (ρ= -.452, p=.012, N= 30), and crowding (ρ= -.444, p=.018, N= 28) (29 out of 32 respondents rated their apartments as low to medium crowded) (Kruskal-Wallis test, p=.589 and χ^2=.291).

CONCLUSION

Key conclusions are as follows:
Where the Kruskal-Wallis test applied, there was no observed significant difference between the male and female populations with regard to the variables.

As the younger apartment dwellers were observed to find sharing of some facilities less appealing, this must be borne in mind while designing and building apartments targeted to this group.

A single story appears more preferred by the studied population. This contrasts with the fact that most of the apartment dwellers are relatively young, and one would expect that they have potential to climb to higher floors. The implication of this observation is for designers, builders, and authorities to rethink accessibility expenses. With about equal numbers preferring access through stairs and elevators, claims of the new universal design movement are challenged as far as apartments are concerned.

It was observed that living in an apartment may be by choice, and not necessarily connected with income as readily assumed. Many observed tenants were professionals and high-ranking administrators. This, and the finding that many prefer to dwell in apartments for life, support the literature indicating that apartment dwelling is no longer a transitional form of accommodation for people waiting to be able to get a single family house (Michaux and Kempner, 1995).

Plan layout preference was layout number 1, and room color preference was “white.” This finding assists future choices while designing and building apartments that satisfies the HSW needs of the occupant. Overall, this understanding if implemented may help reduce the rate of turnover among apartment dwellers engendered by dissatisfaction occupants have towards their apartments.

Generally, at the basic level, this research can initiate a re-think that would encourage stakeholders to embrace the concept of more suitable, HSW quality-focused apartments, on realizing and recognizing apartment aspects that most appeal to the occupants. This research has the potential to make a significant national impact on the US HSW debate, as it addresses a key stipulation of the Federal housing policy objectives – the Cranston-Gonzalez National Affordable Housing Act (1990/1998). Besides increasing the sample size, further analysis and interpretation of the results are required in further future explorations of this research in order to achieve more definitive and extensive conclusions.

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REFERENCES

Agresti, A. (1996), *An Introduction to Categorical Data Analysis*, John Wiley & Sons Inc., New York.

Atlas, N.E. and Ozsoy, A. (1998) Spatial adaptability and flexibility as parameters of user satisfaction for quality housing. *Building and Environment*, 33(5), pp. 315-323.

Bonnes, M., Bonaiuto, M. and Ercolani, A.P. (1991) Crowding and residential satisfaction in the urban environment: A contextual approach. *Environment and Behavior*, 23, pp. 531-552.

Botelho, B. (2002) *Designing to client's brief: A case of apartment buildings*. Paper submitted to fulfill the research of dual architecture and construction management degree at Deakin University, Australia.

Bratt, R.G., Keyes, L.C., Schwartz A. and Vidal, A.C. (1994) *Confronting the management challenge: Affordable housing in the nonprofit sector*. Community Development Research Center, Graduate School of Management and Urban Policy New School for Social Research.

Bruin, M.J. and Cook, C.C. (1997) Understanding constraints and residential satisfaction among low-income single-parent families. *Environment and Behavior*, 29, pp. 532-553.

Cook, C.C. and Bruin, M.J. (1993) Housing and neighborhood assessment criteria among Black urban households. *Urban Affairs Quarterly*, 29(2), pp. 328-339.

Coolican, H. (1990), *Research Methods and Statistics in Psychology*. Hodder and Stoughton, London.

Katrakis, J.T., Knight, P.A. and Cavallo, J.D. (1994). *Energy-efficient rehabilitation of multifamily buildings in the Midwest*. Work sponsored by the United States Department of Energy, Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technologies, Existing Buildings Research Program.

Lee, A.D., Chin, R.I. and Marden, C.L. (1995) *Affordable housing: Reducing the energy cost burden*. Prepared for the US Department of Energy under Contract DE-AC06-76RLO 1830, Pacific Northwest Laboratory, Richland, Washington.

Lu, M. (1998) Analyzing migration decision-making: Relationships between residential satisfaction, mobility intentions, and moving behavior. *Environment and Planning*, 30(8), pp.1473-1495.

Michaux, R.L. (1996) Reconsidering the vocabulary of apartment living. *National Real Estate Investor*, 38(3), pp. 24-25.

Michaux, R.L. and Kempner, J.L. (1995) New report offers insight to industry's future ('The future of the apartment industry'). *National Real Estate Investor*, 37(5), pp. 26-27.

Siakavellas, M. (2002) Resident retention requires return to basics. *Multifamily News*, 37(8), pp.27-30.

Siegel, S. (1956), *Nonparametric Statistics for the Behavioral Sciences*, McGraw-Hill Book Company, New York.

Varady, D.P. and and Preiser, W.F.E. (1998) Scattered-site public housing and housing satisfaction: Implications for the new public housing program. *Journal of American Planning Association*, 64(2), pp. 189-207.

Zwarts, A. and Coolen, H. (2006) The meaning of preferences for features of a residential environment. *Journal of Architectural and Planning Research*, 23(3), pp.200-215.

ROUTINE MAINTENANCE AND SUSTAINABILITY OF EXISTING SOCIAL HOUSING

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ABSTRACT

Improving the sustainability of the housing stock is a major challenge facing the UK social housing sector. UK social housing accounts for approximately 18% of total UK housing and generates maintenance costs in the region of £1.25 billion per annum. The extent to which routine maintenance can be used as a vehicle to improve the overall sustainability (social, environmental and economic) of existing social housing is one focus of a 5 year EPSRC funded research programme. This paper reports the findings of a questionnaire survey examining current social housing maintenance practices and attitudes towards sustainability.

The research found that, whilst the stock condition survey is the favoured format for determining maintenance need and economics the basis for priority setting; neither systematically addresses wider sustainability issues; and, whilst cost is a major barrier to more sustainable solutions being adopted, landlords are able and have the desire to improve their practices.

KEYWORDS: social housing; sustainability; maintenance practice.

BACKGROUND TO UK SOCIAL HOUSING

According to the 2005 English House Condition Survey (DCLG, 2008) there are approximately 21.8 million homes in England of which approximately 3.9 million (18%) are within the social sector; 2.2 million owned by Local Authorities (LA) and 1.7 million owned by Registered Social Landlords (RSL). Further, demolition rates in the UK are currently very low - approximately 0.8% of housing replaced each year (DCLG, 2006a) and, given increased demand, by 2050 approximately 70% of the housing stock will comprise that already built today. Thus if the housing stock is to address the social, environmental and economic aspects of sustainability, the housing industry will have to work largely with today's stock.

There have been concerns' regarding the condition of social housing since the 1980's when a combination of low management and maintenance allowances, unwillingness to raise rents to match repair needs and restrictions preventing the cross subsidisation of Housing Revenue Accounts from general funds resulted in large repair backlogs (DGLC, 2000). By 1996 the repairs backlog had reached £19 billion for England alone (DCLG, 2008) which in turn prompted the UK Government's commitment to make housing decent by 2010 - The Decent Home Standard (DHS). The DHS was conceived as a minimum standard which triggers action if a range of decency standards are not met. A property is considered decent if it: satisfies Housing Health and Safety Rating System (HHSRS) as fit for purpose; is in a reasonable state of repair; has reasonably modern and appropriately located facilities; and has a reasonable degree of thermal comfort (SAP 2005 rating of 35 or more). In 1996 there were 9.1 million non-decent dwellings in the UK which had reduced to 6 million in 2005, of which 1.2 million dwellings were in the social rented sector. However, whilst the DHS goes some way to addressing the quality of UK housing, it is not a sustainability standard and as such is likely to have minimal impact on this aspect of the UK housing stock.

SUSTAINABLE DEVELOPMENT

A widely used and accepted definition of sustainable development is ‘development which meets the needs of the present without compromising the ability of future generations to meet their own needs’ (Brundtland, 1987) and over the last 20 years there has been a growing realisation that, in the UK people are not living within their means. In response, the UK Government, Scottish Executive, Welsh Assembly Government and the Northern Ireland Administration agreed a set of five principles (living within environmental limits**;** ensuring a strong, healthy & just society; achieving a sustainable economy; using sound science responsibly**;** and promoting good governance) as the basis for sustainable development. In the context of the built environment this has forced those responsible for developing and managing buildings to examine the impact that their buildings have on the environment and develop policy and strategies to reduce that impact over time. This is particularly pertinent to energy reduction where 27% of UK energy use is attributable to buildings of which 53% is as a result of space heating, 20% water heating, 6% lighting, 16% appliances and 5% cooking (DCLG, 2006b).

There are a number of existing and announced policies affecting domestic energy efficiency of UK buildings, including; the 1997 Kyoto protocol under which the EU set targets to reduce greenhouse gas emissions by 20% (compared to 1990 levels) by 2020; EU Energy Performance of Buildings Directive 2002 which requires all member states to achieve a minimum energy performance target for buildings; and the Climate Change Bill which proposes unilateral carbon dioxide reduction target of 26-32% by 2020 and 60% by 2050. However these targets cannot be met through new building development alone. Based on an analysis of demolition rates and assuming all new housing in the UK is carbon neutral, Shipworth (unpublished) estimates that only around a 5% reduction in CO_2 emissions will be achieved by 2050. Thus, if the UK is go get close to its stated target, it must address the carbon footprint of its existing housing stock. But, in the UK the retrofitting of energy efficiency and zero/low carbon technologies to the existing building stock is low and hindered by high upfront costs even though implementation of such technologies should result in significant life cycle cost savings (fuel bills) for occupiers (DCLG, 2006). Finally, whilst technological solutions offer the potential for improvements in the sustainability of existing buildings, people’s lifestyle and behaviour must also be addressed if the 2050 target is to be achieved. To this end: greater community engagement; deliberative forums to help people live more sustainable lifestyles; investigating ways in which stakeholders can influence decision making; new commitments to support education and training in sustainable development; and response to key environmental taxes are all challenges that those seeking to create future sustainable communities need to address (HMSO, 2005). Currently none of these issues regularly inform built asset management strategies.

CURRENT MAINTENANCE PRACTICES

The Stock Condition Survey (SCS) is central to the social housing maintenance decision making process (Fig. 1). The survey provides a snapshot of the physical condition of the housing stock at a particular point in time from which a stock condition profile model is developed that predicts maintenance demand and the associated budget requirements over a 25-30 year period (note: a rolling 12 month budget is also determined). The demand for maintenance action is predicted using data relating to the length of time remaining before a component fails/requires maintenance. Maintenance need is determined by considering the physical condition of components and compliance with the DHS (note: with the exception of the HHSRS the standard is not an absolute but relative to individual organisations). Budgetary constraints and specification standards (e.g. legislation) are applied to the demand profile and maintenance options and risk are assessed to ensure that the housing stock remains viable over the period until the next refurbishment stage. Finally, for cash flow purposes the demand model is 'smoothed' using algorithms and alternative maintenance strategies (e.g. responsive; planned maintenance etc) are assessed.

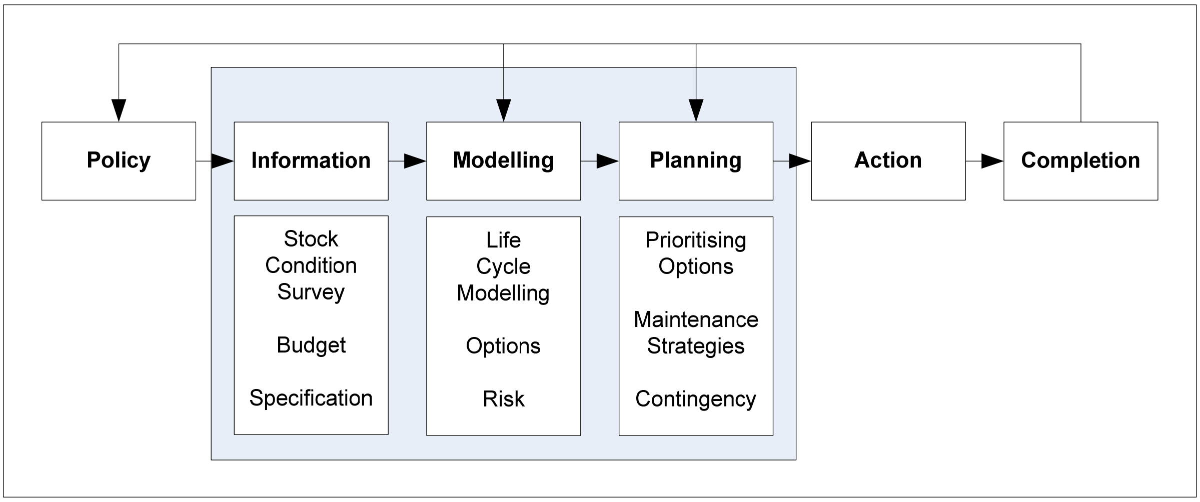

Figure 1. The Built Asset Maintenance Process Model (source: Wordsworth, 2001)

There are a number of well documented problems with the afore mentioned model (Sharp & Jones, 2007). Although it is assumed that organisational policies drive the maintenance planning process, in many instances policy objectives are unclear and an organisation's strategic objectives are not linked to its maintenance programmes. The effectiveness and efficiency of using the stock condition survey process as the basis for developing planned maintenance programmes has also attracted criticism. Chapman (1999) identified: poor specification of initial requirements; unclear aims and objectives and inappropriate frameworks; an inability to predict long term cost requirements; variations in levels of experience of those conducting surveys; unrealistic claims by consultants selling survey services; inappropriate or unusable data; poor links to organisational objectives; and a lack of fit of survey data to maintenance programmes as the key factors that contributed to high levels of dissatisfaction amongst social landlords. Dissatisfaction is further heightened by approaches to priority setting which are often simplistic, introducing subjective elements into the decision-making process which makes it difficult for maintenance managers to justify their decisions (Shen et al, 1998) to others. Finally the process model implies a feedback loop which in reality rarely occurs resulting in the same mistakes being made over and over again (Arditi & Nawakorawit, 1999). Given the above concerns there must be doubt about the ability of such a system to accommodate the wider range of criteria that need to be considered if the objectives of improving the sustainability of existing social housing is to be achieved through routine maintenance/refurbishment. These concerns formed the basis of a research project funded by the UK Engineering and Physical Sciences Research Council.

THE RESEARCH PROJECT

The project aimed to identify the issues/problems faced by Social Landlords as they attempt to improve the quality of their existing stock in a way that is environmentally, socially and economically sustainable. Through a postal questionnaire survey the project sought to identify the extent to which those responsible for UK social housing maintenance believed that their maintenance process, both planned and reactive, could be used as a means to improve the sustainable performance of their stock. Between October 2006 and March 2007 768 questionnaires were distributed to all parent RSLs (head of groups) all LAs who maintained responsibility for the maintenance of their housing stock and all Arms Length Management Organisations (ALMOs), throughout England and Wales of which 95 completed returns were received. This represents a return rate of 14% from organisations responsible for approximately 19% of the total UK social housing stock. Whilst the returns may be slightly biased towards larger social housing organisations the authors believe that they are representative of the English/Welsh social housing sector as a whole.

RESULTS FROM THE SURVEY

Housing Maintenance

For all three types of social landlord, whilst the primary housing maintenance decision making tool is the stock condition survey, there was some evidence that other measures (beyond those traditionally used) were being used to identify maintenance need. In particular there appeared to be a move to incorporate performance based tools such as SAP ratings into the decision-making process. There did not appear to be any trend between the size of the organisation, in terms of property portfolio, and the types of information collected, however smaller organisations (0-1000 properties) appear to carry out more annual building inspections, with the remaining concentrating on cyclical inspections of varying frequency (normally 4-5 years). For all organisations the major source of information for estimating maintenance budgets was property inspections followed by the previous years spend, or a combination of the two. In line with government targets there appeared to be a move towards planned preventative maintenance (PPM) compared to responsive maintenance (RM) with almost 70% of RSLs and 66% of LAs/ALMOs having a PPM:RM ratio of 60:40 or greater.

All three types of social landlord rated ‘priority need’ as the most important factor in determining maintenance actions with ‘budget constraints’ placed 2nd and ‘political criteria’ 3rd (and considered ‘not important’ by the majority of respondents). Approximately 80% of organisations were using historical data to identify maintenance trends although the exact nature of this information is still to be determined through interview.

Traditionally maintenance and refurbishment works have been distinguished by their funding mechanism, with maintenance generally funded through the revenue account and refurbishment works by capital grant. However the results from the survey would suggest that this differential is being eroded as RSLs and ALMOs receive more commercial freedom. Indeed, most organisations appeared to distinguish between maintenance and refurbishment works by the size (cost or scale) of the project.

Housing Quality – The DHS

From the survey all three types of social landlord had a high DHS achievement rate; with 82% of RSLs and 67.8% of LA/ALMO stock being classed as 'Decent'. These values are in line with the findings of the 2005 EHCS. Those RSL properties that failed the DHS were doing so mainly because of thermal comfort and the lack of modern and appropriate facilities. This again is in line with the findings of the EHCS (2005). Those LA/ALMO properties failing the DHS were doing so mainly due to repair and the lack of modern and appropriate facilities with failure due to thermal comfort only occurring in approximately 12% of dwellings. This finding is in contrast to the findings of the EHCS 2005. One possible explanation for the difference between the findings of this survey and the EHCS could be the impact of the HHSRS. Whilst this has been widely adopted by LA/ALMOs (71.4% of organisations had incorporated it into their SCS) and to a lesser extent by the RSL sector (59% had adopted it).

Whilst the DHS has impacted on the maintenance planning of the vast majority of respondents (which would be expected considering the Government's target that all social housing should be decent by 2010), its effectiveness as a standard for driving improvements in social housing received a mixed response. Positive comments made in response to open text questions included: "the DHS has reduced the pressure on revenue and has provided more funding for the housing stock"; "has raised the standard of works"; and "has enabled a more planned approach to delivering investment to address stock failure and plan and programme work in a more effective way that provides best value". Negative comments included: "the DHS criteria does not match tenant expectations or maintenance plans"; "leads to quantity rather than quality works"; and "is building centric and limited to a small number of elements/components". A similar divergence of views existed for the impact that the DHS has on sustainability with approximately 50% of RSL respondents and 67% of LA/ALMO respondents believing that the DHS will improve the sustainability of their housing stock, primarily because it has raised the status of maintenance and refurbishment amongst senior management, and the remainder believing it will have a negative impact primarily because of its failure to address wider social or environmental issues.

Sustainability Strategy

All respondents believed the sustainability debate was important to their work and most believed it had affected their maintenance practices to some degree.

Whilst most organisations rated their current practices as slightly or moderately sustainable, they also considered there was significant room for improvement. More consultation with neighbours; better understanding of sustainability issues; wider application of EcoHome principles (but not necessarily EcoHomesXB – see later); a better ratio of planned works to responsive repairs; the use of sustainable construction materials including recycled materials; the use of local contractors to minimise transport; and wider implementation of waste minimisation practices were some of the ways that respondents believed their current practices could be improved.

Only about half of the respondent organisations (mainly the larger ones) had a company wide sustainability policy and only about 40% of these measured the sustainability of their existing stock. Of those that did measure the sustainability of their stock very few used any recognised standard (note: toolkits such as EcoHomes XB were considered to: be too complicated; take too long to complete; require additional information to be collected which cannot otherwise be utilised; and to not add value to the decision making process.) with the majority developing their own ad-hoc measures to reflect their specific stock profile and circumstances. Where the sustainability of the stock is measured, 70% use the results to inform their maintenance strategies.

Respondents rated a range of factors which they believed should be included in a sustainable maintenance system. Of the 31 factors listed in the questionnaire, improvements to overall building performance, production of home user guides (note: Approximately 80% of respondents engage their tenants in energy awareness and other sustainability issues, primarily through awareness raising activities; active tenant forums and annual tenant training), increase proportion of works programmed through PPM, use of low environmental impact materials, the use of low toxicity paints, household security, the use of local labour, monitoring of best practice for air and water pollution, protection of existing eco features, and the use of renewable energy were the top 10 rated changes required to current maintenance practices.

As expected, cost was the overriding internal barrier to incorporating more sustainable solutions into maintenance planning (compared to bureaucracy, culture leadership and information) whilst a lack of incentive, and a lack of joined up legislation were the main external barriers (compared to commercial imperatives, government leadership, lack of technology and legislation). With regards to additional costs, the majority of RSLs believed that they were able to justify an increase of between 3-5% in initial costs to incorporate a more sustainable solution whilst 40% of LA/ALMOs believed they could justify an increase of between 6- 10%.

DISCUSSION OF RESULTS

The results from the questionnaire survey show that in general current maintenance practices do not fully address the social, environmental and economic aspects of sustainability. Even those organizations that have formally addressed the issues of sustainability do not routinely measure the performance of their stock against sustainability indicators or use the sustainability agenda to set targets or priorities. Indeed, in line with the UK Governments agenda, the DHS has been the primary focus for maintenance (and refurbishment) planning. This standard was not conceived, and is not perceived, to be a sustainability driver and, whilst it has generated more funding for stock improvement works, primarily by raising the status of maintenance and refurbishment at board level, it is viewed by many as a minimum standard which does not address the wider social and environmental issues that need to be addressed.

Current maintenance practices are perceived to be only slightly/moderately sustainable and offer significant opportunities for improvement. In particular there is a desire amongst maintenance managers for greater inclusion of sustainability principles, and in particular environmental and social performance measures of the ‘home in use’ into the maintenance process. Whilst there is some evidence that this is beginning to occur, particularly the use of SAP ratings, it is also clear that those toolkits specifically developed for assessing the sustainability of existing homes are having little impact. Indeed, it would appear that where sustainability principles have been integrated into the maintenance decision making process organisations have developed their own toolkits that more closely mirror local needs and priorities. This flexibility of approach would appear to be a critical criteria lacking from the current maintenance process model.

A SUSTAINABLE HOUSING MAINTENANCE MODEL

As a result of the questionnaire survey the authors have developed a new maintenance process model that they believe more clearly addresses the sustainability agenda (Fig. 2).

The proposed sustainable housing maintenance model is a generic model which can incorporate individual Landlord requirements. The model is based around the development of a series of indicators (tookits) that assess the physical, social, environmental and economic performance of a 'home in use' against government agendas and local priorities. If issues are identified then a series of analysis toolkits are used to establish the underlying cause(s) and a project brief is developed that describes the problem to be solved and specifies the required improvements to performance. A series of modelling toolkits then prioritise the actions required and assess the most appropriate strategy (PPM, RM Design Out, Operate to Failure etc) for action. Finally a series of performance indicators assess the impact of the interventions against the required improvements specified in the project brief and feeds this information back into the process for future reference. The model is effectively a multi-criteria performance based assessment of the home in use. The model is currently being trialled with a UK social housing provider.

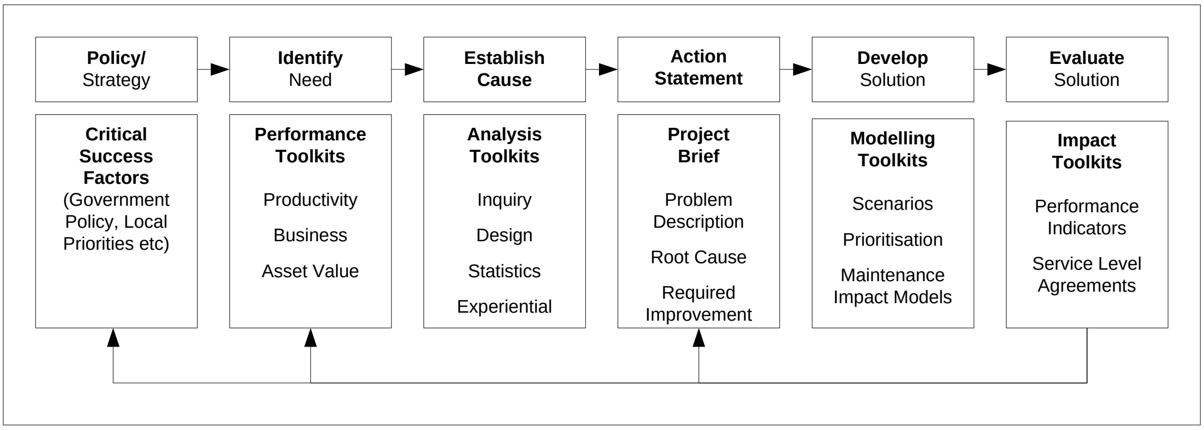

Figure 2. Performance Based Sustainable Housing Maintenance Model

CONCLUSION

The current approach to social housing maintenance does not fully address the social, environmental and economic aspects of sustainability and, whilst a wider range of criteria are being used by a small number of organisations to determine maintenance need and plan maintenance works, there use is disparate and not supported by established toolkits. Further, the vast majority of UK social housing maintenance managers believe their current maintenance practice can be improved to more fully embrace the sustainability agenda.

To ensure continued improved quality and sustainability of the existing built environment a new maintenance model is needed which is based on the performance of a building in use rather than on its condition per se. This will require new knowledge to be generated at each stage of the maintenance / operational process. Maintenance managers will need to move away from the use of a (predominantly) single, subjective criteria model to a multi-criteria model which includes a holistic examination of the root cause of the problems and the technical and business solutions required to ensure the business case for action is established.

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REFERENCES

Arditi, D. & Nawakorawit, M. (1999). "Issues in building maintenance: property managers' perspective", Journal of Architectural Engineering, ASCE, Vol. 5, No. 4, pp. 117-132.

Chapman, K. (1999). "Dissatisfaction with stock condition surveys in social housing", Structural Survey, Vol. 17 No. 4, pp. 211-215.

DCLG. (2000). "Housing Revenue Account" available at http://www.communities.gov.uk/housing/

DCLG. (2006a). "Housing Statistics" available at http://www.communities.gov.uk/housing/.

DCLG. (2006b). "Review of the Sustainability of Existing Buildings", DCLG Publications.

DCLG. (2008). "The English House Condition Survey", available at: http://www.communities.gov.uk/housing/

HMSO. (2005). "Securing the future: delivering UK sustainable development", HMSO.

Jones, K. & Sharp, M. (2007). "A new performance-based process model for built asset maintenance", Facilities, Vol 25, No 13/14, pp 525-535.

Shen, Q. Lo, K. & Wang, Q. (1998). "Priority setting in maintenance management of public buildings – a modified multi-attribute approach using analytic hierarchy process", Construction Management and Economics, Vol. 16, No. 6, pp. 693-702

The Brundtland Report. (1987). "Our Common Future", Oxford University Press, ISBN 019282080.

Wordsworth, P. (2001). "Lee's building maintenance management", Blackwell Science, UK.

UPDATE ON THE DEVELOPMENT OF A CUSTOMER PERFORMANCE MEASUREMENT SYSTEM (CPMS) FOR FACILITIES MANAGEMENT: ENABLING GENERIC MARKET BENCHMARKS

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ABSTRACT

Purpose: to enhance the level of performance measurement sophistication by filling the existing void of strategically applying customer satisfaction systems in facilities management (FM).
Methodology/ approach: a strategic management approach is implemented to develop a Customer Performance Measurement System (CPMS). The CPMS consists of four stages, combining quantitative benchmarking techniques with qualitative analysis in order to produce strategic objectives for business process improvement. This paper provides key findings from stage 1, enabling the production of generic customer satisfaction benchmarks within FM.
Findings: a lack of effective and accessible customer performance measurement research is evident within FM, in which the CPMS framework is a clear attempt to introduce a strategic management approach to improving FM customer performance.
Research implications: the CPMS is currently in the process of being piloted. This paper should firstly be interpreted as an introduction to the theory and process behind the CPMS, whilst secondly in providing a crucial update on the generic customer benchmark findings from stage 1.
Originality/value: the level of sophistication of customer performance measurement research within FM is limited. This paper aims to contribute to the enhancement of customer performance measurement in FM through the development of the CPMS.

KEYWORDS: performance measurement, customer satisfaction, benchmarking, strategic management.

INTRODUCTION

Performance measurement is the process of setting key drivers in order to assess, evaluate, and change (if applicable) core business objectives. It is integral to the effective implementation of continuous improvement and added value within business.

A key attribute of performance measurement is the customer. However within facilities management (FM), although customer performance studies are evident, accessible and applicable customer satisfaction performance knowledge within a strategic management context is limited. This has led to the development of a Customer Satisfaction Performance Measurement System (CPMS) in order to acknowledge the importance of applying customer performance measurement and enhancing the sophistication of strategic processes within FM.

CUSTOMER PERFORMANCE IN FM

Benchmarking

According to Camp (1989) 'benchmarking is the rational way of ensuring the organisation is satisfying customer requirements and will continue to do so as customer requirements change over time'. The emphasis needs to be on productively reacting to changing customer needs, whilst aspiring to 'superiority'. Camp (1989) contends that only an external benchmarking process will work in order to achieve customer satisfaction.

Wauters (2005) expresses that if benchmarking is applied correctly 'it will lead to effective value management of facilities service provision'. Massheder & Finch (1998a; 1998b) however surveyed a sample of user organisations in the UK and contested that benchmarking in FM is not understood and consequently misused by facilities managers. McDougall & Hinks (2000) have since commented on the state of benchmarking performance within FM, suggesting that shifts from cost-orientated motives to customer satisfaction is representative to the shift towards strategic FM.

Meeting customer expectations

According to Varcoe (1996) '"mass customisation" typifies the constant paradox with which organisations now have to grapple'. Robben (2004) highlights that in order to effectively deliver customer expectations; they must be aligned with the 'delivery mechanisms' of the organisation. Parasuraman's (2004) "GAPS model" exemplifies this contending that service quality fails when there is a gap between customers' service expectations and perceptions.

Tranfield & Akhlaghi (1995) acknowledge that modern organisations achieve high quality and high productivity levels at the same time by being customer focused. Organisations must therefore take the role of the informed client where FM's 'understand the needs of people in the workplace as producers and consumers' (Alexander, 2003).

Customer performance in FM

Studies on the involvement of the 'customer' in FM are certainly evident (Bandy, 2003; Amaratunga *et al*, 2004; Futcher *et al*, 2004, Walters, 1999; Loosemoore & Hsin, 2001). However specific research to the *application* of customer satisfaction measurement as a strategic performance tool within FM is insufficiently documented.

Bandy (2003) provides one of the most comprehensive approaches emphasising the need for customer satisfaction application within FM, introducing the 'Service Synergy Model', which encompasses the linkage between strategic management and customer performance through five key steps:

1. understanding customer needs
2. setting service standards
3. communicating through leadership
4. delivering the service
5. maintaining service culture

CPMS DEVELOPMENT

Customer performance should be a two-way process as the FM provider delivers a service to the customer, in which the customer then feeds back on their satisfaction with the service delivered. However the second element of this process is not fully achieved within FM as no sufficient systems are in place to enhance it. This has been termed as the organisation-customer interface gap (figure.1).

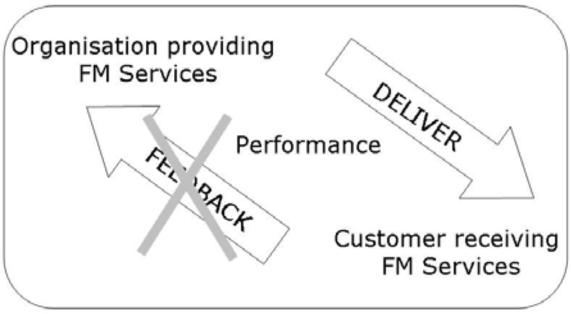

Figure 1: Organisation-Customer Interface Gap

The CPMS will create a continuous improvement process allowing both customers and FM providers to gain knowledge and accessibility to customer performance data, and help FM provider organisations prioritise and strategically apply customer performance measurement information. The purpose of the CPMS is twofold:

1. To allow customers receiving FM services to feedback on service delivery
2. To allow FM provider organisations opportunity to bridge the organisation-customer interface gap through knowledge transfer, by setting strategic objectives to improve customer service delivery.

Reflecting on the views of Amaratunga and Baldry (2002), the CPMS is essentially about performance *management*. Within the CPMS, external and internal benchmarks will explain 'what' has happened, a gap analysis procedure will explain 'where' it has happened, but the most important component, a strategic implementation process will explain 'why' and 'how' the organisation will go about improving service performance. Performance is never stationary, and changes must be managed. The CPMS is not a snapshot exercise, and must be undertaken on a systematic basis to fulfil maximum business potential. The CPMS framework consists of four key stages (figure.2):

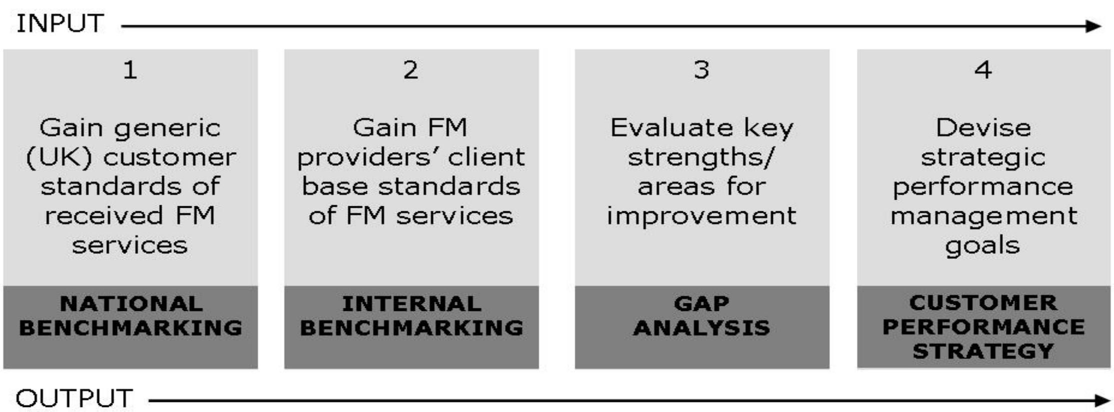

Figure 2: Customer Performance Measurement System (CPMS)

Stage 1: National Benchmarking
The purpose of this initial stage is to determine an external customer opinion via generic benchmarks within the FM industry. Key customer satisfaction attributes will be agreed across individual FM services and will only be targeted at organisations that receive and/or operate FM services in-house (i.e. no FM providers).

Stage 2: Internal Benchmarking
An internal benchmarking exercise will then take place within the individual FM provider organisation. This will require access to the FM providers' client base. The exercise will mimic the content of stage 1, providing a direct comparison to evaluate how individual FM providers are performing against the perceived national standards.

Stage 3: Gap analysis
Stages 3-4 require direct contact with the organisations' Facilities Manager, in order to develop solutions and determine strategic processes. The CPMS is now able to analyse the specific gaps/areas for improvement within the service delivery of the FM provider. Hence, we are effectively bridging the interface gap by establishing connection from the customer back to the organisation.

Stage 4: Customer Performance Strategy
The FM provider organisation is now in a position of the informed client. Strategic decisions can be made to devise new processes to add value and further enhance the organisations service quality.

CPMS STAGE 1: METHODOLOGY

The aim of the survey benchmarking exercise was to obtain customer feedback across individual FM services to assess their:

- Quality and efficiency
- Criticality to business operation
- Service provision (in-house/outsourced)

An online customer satisfaction survey was conducted targeting organisations that receive and/or operate in-house FM services (i.e. the customer as opposed to the provider). The survey was administered in July 2007 to all BIFM members in the UK and Ireland[1], obtaining a total of 230 responses[2]. Unfortunately a response rate could not be calculated due to the unavailability of statistics determining the proportion of BIFM members receiving and/or operating in-house services.

However, although response rates are useful they do not tell you how accurate, or confident, the survey data is in determining the views of the total population (i.e. including those who do not participate). This can be achieved by using a 95% confidence interval method, in which it is evident that the survey produced accurate findings.

[1] BIFM Scotland Region did not take part in the survey.
[2] The survey was disseminated on behalf of the BIFM through regional mailing lists. Hence, it was not possible to target specific sectors. A question was therefore included regarding what sector each customer was from. The results were 57% offices; 11% other; 10% mixture of sectors; 9% education; 5% healthcare; 5% manufacturing; 2% hospitality/leisure; 1% shopping centres.

Through a sample size of 230 within a total BIFM member population of 11,414 (BIFM, 2007), a 95% confidence interval of 6.4% was calculated. This means that if 50% of respondents answer "yes" to a yes/no question, we can be 95% certain that the views of the total population answering "yes" (including those who did not participate in the survey) will lie between 43.6% and 56.4%.

CPMS STAGE 1: KEY FINDINGS

Individual FM services

Table.1 summarises the generic benchmarks obtained from stage 1 of the CPMS. Generally, each service area is rated positively by customers. In each case very few customers (10% or less) rate the quality and efficiency of FM services as 'poor', with the vast majority rating them as 'good'. However through further analysis, we begin to identify intriguing variances.

Table 1: FM Customer Benchmarks – Summary Statistics

Services	Efficiency (%)			Criticality (%)			Provision (%)	
	G	A	P	NC	MC	VC	O	IH
Building Fabric	49	41	10	8	47	45	70	30
M&E Engineering	59	35	6	2	24	74	78	22
Waste Management	57	36	7	20	48	32	88	12
Grounds & Gardens	62	31	7	63	31	6	76	24
Cleaning	59	36	5	12	43	45	80	20
Catering	69	27	4	38	40	22	80	20
Mailroom	77	21	2	9	40	51	24	76
Security	71	26	3	3	32	65	72	28
Health & Safety	79	17	4	4	29	67	13	87
Reception	82	17	1	10	42	48	28	72
Helpdesk	70	24	6	11	42	47	31	69

Efficiency: G = Good; A = Acceptable; P = Poor
Criticality: NC = Not Critical; MC = Moderately Critical; VC = Very Critical
Provision: O = Outsourced; IH = In-house

Table.2 adopts a ranking system of each service area against the three identified assessment categories. The ranking system is based on the following criteria:

Quality and efficiency:	Ranked from highest to lowest satisfaction levels (ranges from 82% to 49%)
Criticality:	Ranked from most critical to least critical (ranges from 74% to 6%)
Service Provision:	Ranked by most outsourced to least outsourced (ranges from 88% to 13%).

Table 2: FM Customer Benchmarks – Service Ranking

Rank	Quality & efficiency (based on % rating 'good')	Criticality (based on % rating 'very critical')	Provision (based on % rating 'outsourced')
1	Reception	M&E Engineering	Waste Management
2	Health & Safety	Health & Safety	Cleaning
3	Mailroom	Security	Catering
4	Security	Mailroom	M&E Engineering
5	Helpdesk	Reception	Grounds & Gardens
6	Catering	Helpdesk	Security
7	Grounds & Gardens	Cleaning	Building Fabric
8	Cleaning	Building Fabric	Helpdesk
9	M&E Engineering	Waste Management	Reception
10	Waste Management	Catering	Mailroom
11	Building Fabric	Grounds & Gardens	Health & Safety

From these findings, we can interpret several relationships:

1. Services rated highest by quality and efficiency (e.g. reception, health & safety, mailroom), are rated lowest in terms of outsourcing (i.e. they are predominantly provided in-house).
2. Conversely, services rated low by quality and efficiency (e.g. waste management, M&E engineering, cleaning), are generally rated high in terms of outsourcing. The exception here is building fabric and catering.
3. Customers generally rate 'front-line' or 'soft' services as most critical, such as health and safety, mail room, reception, as opposed to more 'hard' services such as waste management and building fabric.
4. The exception from point 3 is M&E engineering rated as most critical, but interestingly rated as one of the least efficient, along with other hard services such as waste management and building fabric.

General themes

Customers generally rated the quality and efficiency of the FM team positively, with the majority rating the level of people involvement/ cultural fit (83%), training and competence (66%), and general attitude (77%) as 'good'.

An interesting finding however surrounds rating the level of innovation in service provision, with a distinctive 20% of customers rating as 'poor', with less than half (47%) rating it as 'good'. The remaining 33% rate the level of innovation as acceptable, identifying that this is a key area within FM service delivery that requires further attention.

Finally, customers were asked to provide their overall satisfaction with the services provided, in which 63% rated as 'good', 33% as 'acceptable' and only 4% as 'poor', identifying that overall, FM service delivery in the UK is healthy.

CPMS STAGE 1: DISCSUSIONS & IMPLICATIONS

The results produced intriguing findings in how customers' attach varying perceptions to certain services. Most notably, one can assume that customers tend to rate soft FM services higher in terms of quality and criticality. Two initial assumptions could be made from this. Firstly, customers simply attach greater importance and quality to services that are predominantly in the 'front-line' and are thus critical to the image and reputation of the business. Secondly, the trend is abnormally high as the vast majority of the soft services in question are provided in-house (i.e. by those who have completed the survey), implying the possibility of an element of bias. This is certainly an area that will require future consideration when replicating the CPMS.

General interpretations can be made surrounding the current state of customer satisfaction within FM. The overall outlook of customer satisfaction towards FM service delivery appears to be positive with 63% overall rating services as 'good'. Although this is a healthy benchmark, as this is the first standard set by the CPMS, a more sophisticated interpretation will be able to be made once the process has been repeated over time. The findings however note that less than half of customers feel that the level of innovation in service provision is 'good', with a fifth feeling innovation in FM is 'poor'. Through stages 2-4 of the CPMS, this will certainly be an area that will require further attention.

REFERENCES

Alexander, K (2003) A strategy for facilities management, *Facilities*, Vol. 21, No 11/12, pp. 269-274

Amaratunga, D & Baldry, D (2002) Moving from performance measurement to performance management, *Facilities*, Vol. 20, No. 5/6, pp. 217-223

Amaratunga, D, Baldry, D, Haigh, R (2004) Customer-related facilities management process and its measurement: understanding the needs of the customer, Proceedings of the CIB W70 Facilities Management & Maintenance: Hong Kong 2004 Symposium, Hong Kong Polytechnic University

Bandy, N.M (2003) Setting service standards: a structured approach to delivering outstanding customer service for the facility manager, *Journal of Facilities Management*, Vol. 1, No. 4, pp. 322-336

BIFM (2007) BIFM Annual Review 2007, accessed from www.bifm.org.uk (04/03/2008)

Camp, R.C (1989) *Benchmarking – The Search for Industry Best Practices that Lead to Superior Performance*, ASQC Quality Press, New York, NY

Futcher, K, So, M, Wong, B (2004) Stakeholder value in facilities management, Proceedings of the CIB W70 Facilities Management & Maintenance: Hong Kong 2004 Symposium, Hong Kong Polytechnic University

Loosemore, M & Hsin, Y.Y (2001) Customer-focused benchmarking for facilities management, *Facilities*, Vol. 19, No. 13/14, pp. 464-475

Massheder, K and Finch, E (1998a) Benchmarking methodologies applied to UK facilities management, *Facilities*, Vol. 16, No. 3/4, pp. 99-106

Massheder & Finch (1998b) Benchmarking metrics used in UK facilities management, *Facilities*, Vol. 16, No. 5/6, pp. 123-127

McDougall, G & Hink, J (2000) Identifying priority issues in facilities management benchmarking, *Facilities*, Vol. 18, No. 10/11/12, pp.427-434

Parasuraman, A (2004) Assessing and improving service performance for maximum impact: insights from a two-decade-long research journey, *Performance Measurement & Metrics*, Vol. 5, No. 2, pp. 45-52

Robben, R.W (2004) Quality measurement in a facilities environment, *Facilities Manager*, Vol. 20, No. 3, pp. 46-50

Tranfield, D & Akhlaghi, F (1995) Performance measures: relating facilities to business indicators, *Facilities*, Vol. 13, No. 3, pp. 6-14

Varcoe, B.J (1996) Business-driven facilities benchmarking, *Facilities*, Vol. 14, No. 3/4, pp. 42-48

Walters, M (1999) Performance measurement systems – a study of customer satisfaction, *Facilities*, Vol. 17, No. 3/4, pp. 97-104

Wauters, B (2005) The added value of facilities management: benchmarking work processes, *Facilities*, Vol. 23, No. 3/4, pp. 142-151

Williams, B (2000) *An Introduction to Benchmarking Facilities and Justifying the Investment in Facilities*, Building Economics Bureau, London

BENCHMARKING THE COSTS FOR OPERATING AND MAINTAINING ENGINEERING FACILITIES OF LUXURY HOTELS IN HONG KONG

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ABSTRACT

Tourism, a pillar of the service industries in Hong Kong, entails quality hotel accommodations to flourish. Among a wide range of hotel support services, operation and maintenance (O&M) of engineering facilities like lift, air-conditioning, lighting and fire services, *inter alia*, are typically executed or managed by an in-house engineering department. The expenditures of such department, including the costs for internal staff, routine repairs, capital projects and utilities consumption, are essential factors of production of O&M services. Whereas benchmarking can evaluate the cost-effectiveness of these factors, useful cost benchmarks remain to be scarce. A benchmarking study on 10 luxury hotels was completed recently. This paper reports the design of the study, the process of data collection and its difficulties, the major O&M cost elements and the factors influencing their magnitude. The benchmarks presented, including the dominant energy cost, are some useful findings whose coverage needs to be further expanded to facilitate more holistic benchmarking of hotel facilities.

KEYWORDS: Benchmarking, Facilities operation, Maintenance cost, Hotel

INTRODUCTION

Being one of the most popular tourist cities in Asia, Hong Kong welcomed 25.25 million visitors in 2006; among them 63% were overnight visitors. The corresponding revenue and expenditure, drawn from a survey on 612 hotels/guesthouses, were HK$17,394 million and HK$12,514 million respectively (HKTB, 2007a). An indispensable support service underpinning the growth of this sector is operation and maintenance (O&M) of the hotel facilities such as lift, air-conditioning, lighting, fire services and so on.

For the hotel industry in Hong Kong, some ballpark cost figures have been published (HKTB, 2007b) but metrics that can enable benchmarking specifically the costs for facilities O&M are inadequate. Among the major costs-in-use of buildings, energy consumption is one that has been widely studied (e.g. Deng & Burnett, 2002; Bohdanowicz & Martinac, 2007). Energy certification schemes (e.g. EPA, 2004; DEFRA, 2007) and benchmarking tools (e.g. EMSD, 2007; ESU, 2007) have also become abundant worldwide. In contrast, staff resources, which are a key cost centre, are seldom disclosed for reason of sensitivity. Reports on the costs for routine repair and maintenance works and capital projects executed for improving facilities performance are also rare.

Recently, an O&M cost benchmarking study on 10 luxury hotels in Hong Kong was completed. This paper reports the design of the study, its data collection process and the difficulties encountered, the demography of the samples, the major O&M costs and an analysis of the key factors affecting the cost benchmarks.

DATA COLLECTION

The process and the difficulties

Subsequent to the publication of Lai and Yik (2006), the authors were invited by a group of hotel practitioners to explain how an O&M benchmarking club may be established. On that occasion, a "coordinator" was selected among the practitioners to collect data of the hotels and the authors agreed to play the role of "facilitator" to analyse the data.

A data collection template was firstly designed by making reference to: a survey form used by the participants before for collecting O&M data; briefings given by a group of hotel engineers about how the hotels are operated; and sample O&M contracts of a typical hotel. The template was piloted, and the deficiencies and comments so gathered were incorporated into its second version. A meeting was held to further solicit the participants' comments on this version before it was refined for final distribution.

Difficulties of the benchmarking process began with designing the template. Since different hotel representatives had different ideas as to what items should be benchmarked, deliberations took place before coming to a consensus on a final list of the items.

Another difficulty was due to different charging or recording systems of O&M costs among the hotels. For instance, while each hotel would normally have its own chiller plant, the chilled water supply to one of the samples was fed from a central plant of a composite development. Thus, the maintenance cost for this hotel's chiller plant was nil in the first round of data collection. It was only clarified at a later meeting that a separate fee was paid, pro-rata to the amount of chilled water flow, to a third-party company which operated and maintained the central plant.

Different coverage of outsourced O&M works also gave rise to a difficulty. Some lift maintenance contracts, for example, specified the full responsibility of the contractors for all maintenance works in a comprehensive manner. But in some other hotels, the lift contractors were only required to, on a non-comprehensive basis, take care of the routine maintenance work arising from fair wear and tear; separate quotations would cover any repair or replacement work beyond the basic contract scope.

Apart from scope of work, variations in the extent of cost breakdown in contracts also added to the difficulty in data collection. For example, a contract was only indicated with a lump sum for all the lifts being maintained, without breakdowns for lifts of different capacities, speeds and so on.

As the required data spread over a variety of trades, the hotel representatives, who typically were the department heads, had to rely on their subordinates to fill in the template. Because this latter group of practitioners was not involved in the benchmarking meetings, a sample template completed with some typical data was prepared for their easy reference.

Due to the need to retrieve voluminous data from records, a period of one month was allowed for the participants to provide the data. Although the briefing and the voluntary analysis that the authors committed to provide had helped remove the knowledge and financial barriers (Lai and Yik, 2006), the lack of their desperate need to pursue the benchmarking exercise remained as a motivation barrier. The fear of divulging sensitive cost data of staff resources, O&M contracts and utilities consumptions was another information barrier encountered when collecting the data. These collectively prevented some of participants from providing their data in full.

The samples

Despite the difficulties, useful data of 10 luxury hotels over a period of one year were obtained. Three facets of data were collected. Data of the first kind include the grade, age, area, number of guestrooms and average occupancy of the hotels. The second kind of data covers the costs for repair and maintenance works, capital projects, in-house manpower and payroll, and the costs of maintenance contracts for facilities including lift, escalator, chiller, building management system (BMS), ventilation system, boiler/heat pump, generator, switchboard and fire protection system. The third kind of data is on utility costs, which comes from metering records and bills of electricity, diesel oil, towngas and water.

Table 1 summarises the demography of the hotels. Half of them were graded 5-star; the rest were 4-star. Aged between 16 and 34 years, the hotels had an aggregate gross floor area of 481,298 m^2 and 6,127 guestrooms in total.

Table 1. Demographic information of the hotels

	Mean	Minimum	Maximum
Star rating	-	4	5
Age of building (year)	22	16	34
Gross floor area (m^2)	48,130	30,835	65,024
Guestroom (nos.)	613	422	884
Occupancy rate (%)	86	71	94

O&M EXPENDITURES

Table 2 summarizes the major O&M expenditures of the hotels, which total to over HK$387 millions (HK$1 ≈ £0.063), although two hotels were unable to provide their capital project costs and one provided incomplete information about repair and maintenance (R&M) cost and staff cost.

Table 2. Yearly O&M expenditures

	Mean	Min.	Max.	Average %
Repair and maintenance cost (HK$)*	9,345,655	4,448,000	15,548,352	19
Capital projects cost (HK$)**	11,325,794	4,444,100	20,000,000	23
Energy and water cost (HK$)	22,827,322	9,974,811	32,777,276	45
O&M staff cost (HK$)*	6,497,481	4,266,385	8,845,669	13

Note: *based on 9 useful samples; **based on 8 useful samples.

The R&M cost covers two types of work. The first type is minor works executed on a routine basis; for instance, replacement of a burnt electric lamp. Maintenance works which take place less frequently, e.g. cleaning of potable water tanks, belong to the second type. This type of works was usually undertaken by contractors under regular contracts or ad-hoc quotations.

Capital projects refer to those large-scale improvement works carried out from time to time. Examples include conversion of an air-cooled chiller plant into a water-cooled system, modernization of lift installations, etc. Although the need for these projects fluctuates over time, the cost for their execution is not less than that for regular R&M works.

The greatest O&M cost element was energy and water cost – electricity (34%), towngas (5%), diesel oil (4%), and water (2%). The dominant energy source, electricity, was used to power building services, such as chillers, lifts and lights, and guestroom appliances like hair dryers and TVs. Towngas and diesel oil were primarily used for water and space heating, whose demand is relatively small given the mild winter of Hong Kong. The main end-uses of water include bathing, and food processing and refrigeration in kitchens and beverage outlets.

O&M works would not be properly performed without a team of capable staff. Among the samples, at least one full-time equivalent (FTE) of staff at director or chief engineer level was deployed for a hotel (Table 3). The majority of O&M staff were at operational level (e.g. technician, painter, etc.). The large variation of staff resources at this level was due to different extents of labor outsourcing, as can be seen from the wide-ranging yearly casual labor-days (i.e. number of daywork laborers multiplied by their employment days in a year).

Table 3. O&M staff resources

	Mean	Min.	Max.
Department head [e.g. Chief engineer]	2.3	1.0	3.5
Engineer [e.g. Duty engineer]	5.0	3.0	7.0
Supervisory staff [e.g. Foreman]	4.4	2.0	6.0
Operational staff [e.g. Technician]	16.9	11.0	23.0
Administrative staff [e.g. Secretary]	1.1	1.0	2.0
Yearly casual labor-days (Nos.)	335.3	0.0	1,250.0

Note: all units in FTE except yearly casual labor-days whose unit is number.

O&M COST BENCHMARKING

The main cost categories

Quality and scale of work are two basic factors that would affect the amount of O&M costs (Lai and Yik, 2006). To examine the effect of the former, the hotels were divided into two groups: 5-star and 4-star, and their O&M cost benchmarks (mean, minimum and maximum) are summarised in Table 4. Comparing the mean values of the costs for R&M, capital project, O&M staff, and energy and water draws no apparent conclusion as to which class of hotels would entail a higher level of O&M resources. Intriguingly, the 5-star hotels, whose facilities and service quality were expected to be higher, turned out to have a lower total O&M cost than that of the 4-star hotels, despite the difference was only HK\$124/m^2/year. Apart from the small number of samples that might impair the representation of this statistical result, the following factors could be some underlying influences.

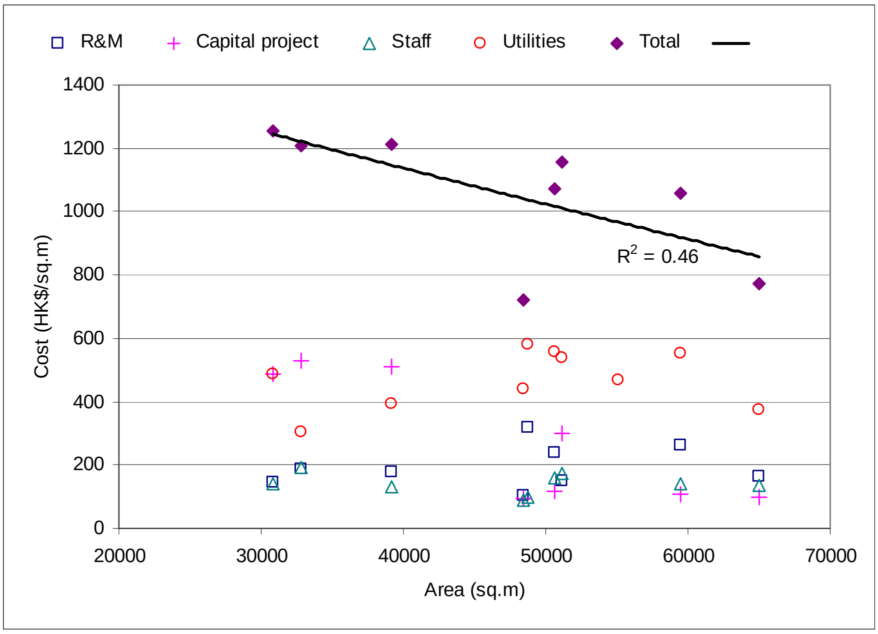
Whereas a hotel with a higher quality of facilities and services would have a higher star rating, the distinction between the 5-star and 4-star ratings is not crystal clear. Second, the difference in scale of the two hotel groups is an obvious factor. The average gross floor area of the 5-star hotels was 52,573m^2, which is 20.3% larger than that of the 4-star group, suggesting that the former group was more likely to enjoy a lower unit O&M cost by virtue of their larger size. Third, the average age of the 5-star hotels was 20, being 4 years younger than the 4-star group. Older hotels would require higher costs for operating and maintaining the deteriorating facilities, and vice versa. Fourth, the occupancy rate of the 4-star hotels, on average, was 88% while that of the 5-star group was 83%. This difference implies that the utilization rate of hotel facilities of the 4-star group and hence the corresponding O&M costs would be higher. The fifth factor which may lead to the difference in cost levels is no formal benchmarking was performed among the hotels before. In the absence of useful cost benchmarks in normalized form (e.g. in HK$/m^2), the practitioners often based on raw figures (in HK$) of historical budget or budget ceilings pre-determined by their senior management to seek funding for O&M works (Lai and Yik, 2007).

Table 4. Benchmarks of yearly O&M costs

	5-star hotels			4-star hotels		
	Mean	Min.	Max.	Mean	Min.	Max.
R&M cost (HK$/m^2)	208	105	318	182	144	237
Capital project cost (HK$/m^2)	165	92	299	348	97	527
O&M staff cost (HK$/m^2)	124	88	173	150	131	190
Energy & water cost (HK$/m^2)	514	438	578	423	304	557
Total O&M cost (HK$/m^2)	980	723	1,159	1,104	771	1,256

For a closer examination of the effect of scale, the cost items listed in Table 4 are plotted against the areas of hotel (Figure 1). The variations in the costs for R&M, O&M staff and utilities (energy and water) are not substantial. But the cost for capital project varies significantly (between HK$92/m^2 and HK$527/m^2) and it declines with larger hotels. In parallel, the total O&M cost exhibits a downward slope, yet at a much higher level – up to HK$1,256/m^2. An outlier is associated with a 5-star hotel, which was given an exceptionally low O&M funding (HK$723/m^2).

Figure 1. O&M costs against area of hotel



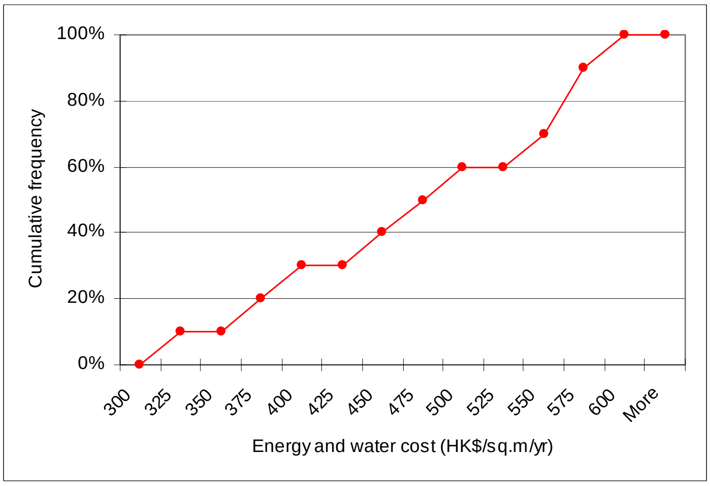
Energy and water

In view of the dominance of energy and water cost among the O&M expenditures (Table 2), its benchmarks including the mean, minimum and maximum values are examined in Table 4. Plotting the cumulative frequency of samples against the energy and water cost gives Figure 2, which is a useful benchmarking curve for the hotels. For example, hotels spending less than HK\$390/m^2 a year can be regarded as among the best 20% performers.

Table 4. Benchmarks of yearly energy and water consumptions/costs

	Mean	Min.	Max.	*SD*	*Cv*
Total energy & water cost (HK\$/m^2)	468.8	303.9	578.4	91.1	19
Energy cost (HK\$/m^2)	444.7	282.3	552.9	91.5	21
Water cost (HK\$/m^2)	24.0	19.1	31.3	4.2	17
Energy consumption (MJ/m^2)	1,717.5	1,283.9	2,179.0	289.5	17
Water consumption (m^3/m^2)	3.8	2.8	4.9	0.7	19

Figure 2. Benchmarking curve for energy and water cost



Note, however, that benchmarking the energy use based on energy cost may lead to unfair results. This is because the electricity supplies to the hotels were from two different power companies, which imposed different unit charges on electricity consumption. Besides, the water bills embraced not only the charge based on the actual amount of water consumed, but also sewage charge and trade effluent surcharge which vary with factors like purpose of water use and pollution level of the wastewater discharged. Benchmarking the water use, therefore, should refer to the amount of water consumption rather than the water bill.

From Table 4, the hotels on average consumed 1,717.5MJ of energy and 3.8m^3 of water per unit area (m^2) a year. Their coefficients of variation, *Cv* (defined as the ratio between standard deviation (*SD*) and mean, multiplied by 100), were 17 and 19 respectively, indicating the comparable variations of sample values between these two aspects.

Facilities maintenance contracts

Concurring with the findings of Lai et al. (2006), the O&M works for most of the engineering facilities were executed by a mix of in-house and external resources. In hotels where prompt responses to O&M needs (e.g. power outage) are paramount, only the works involving licensed personnel who are unavailable in-house or those of a scale beyond the in-house capacity would be outsourced.

Lifts (59%) and escalators (13%), whose maintenance works have to be undertaken by registered engineers, were found to account for the majority of the costs. The remaining 28% were incurred for maintenance contracts of chillers, fire services, BMS, ventilation systems, boilers, switchboards and generators. This much smaller aggregate percentage indicates a lower extent of outsourcing. In fact, the contents of these works are less demanding as compared to those of the lifts and escalators, although the laws also prescribe the statutory maintenance works of fire services, ventilation systems, boilers, switchboards and generators to be carried out by qualified personnel (Lai and Yik, 2004).

Table 3 summarises the cost benchmarks (normalised by unit area of hotel or by unit capacity of installation) of the various trades of maintenance contracts, with their mean, minimum, maximum, *SD* and *Cv* indicated. There are considerable variations among the benchmarks. The smallest *Cv*, associated with escalator, is as high as 31. The largest one, associated with fire services, is even up to 296. These results not only corroborate the difficulty in determining a cost-sensitive parameter for use in normalisation (Lai and Yik, 2005), but also support that the varied extent of outsourcing is a crucial factor intensifying such difficulty (Lai and Yik, 2006).

Table 3. Benchmarks of yearly costs of facilities maintenance contracts

	Mean	Min.	Max.	*SD*	*Cv*
Lift (HK$/m^2)	29.4	15.9	47.1	10.5	36
Lift (HK$/lift)	120,926.4	48,737.1	190,660.0	48,180.4	40
Escalator (HK$/m^2)	7.0	2.1	15.5	4.9	70
Escalator (HK$/escalator)	65,601.3	53,820.0	115,218.0	20,646.6	31
Chiller (HK$/m^2)	4.0	0.9	15.0	4.6	116
Chiller (HK$/TR)$^+$	66.0	15.0	179.3	59.0	89
BMS (HK$/m^2)	2.2	0.2	4.9	1.8	79
BMS (HK$/point)*	290.1	0.4	1,333.3	464.5	160
Ventilation (HK$/m^2)	1.8	0.8	3.0	0.6	34
Ventilation (HK$/fire damper)	49.3	23.2	90.0	20.6	42
Boiler & heat pump (HK$/m^2)	1.1	0.3	2.7	0.9	83
Boiler & heat pump (HK$/kW)	47.2	3.3	166.7	67.5	143
Generator (HK$/m^2)	0.3	0.1	0.7	0.2	60
Generator (HK$/kVA)	24.6	9.4	51.0	16.0	65
Switchboard (HK$/m^2)	0.8	0.3	1.8	0.6	68
Switchboard (HK$/kVA)	6.0	1.3	15.0	5.2	88
Fire services (HK$/m^2)	3.7	0.2	7.5	2.4	64
Fire services (HK$/kW)$^\#$	1,018.5	45.6	1,688.9	576.4	57
Fire services (HK$/point)^	5,403.2	9.4	48,000.0	15,973.9	296

$^+$per ton of refrigeration; *per BMS monitoring/control point; $^\#$per kW of fire pump motor; ^per fire monitoring/control point.

CONCLUSIONS

Notwithstanding that collecting the sensitive cost data was difficult, the study has unveiled the hotels' O&M expenditures, among which energy cost dominates. Generally, larger hotels can enjoy a lower unit cost. Quality rating, age, occupancy rate and budget level are potential factors affecting the costs for operating and maintaining the facilities. Further work is needed to investigate their effects clearer.

It has been demonstrated how a benchmarking curve can be constructed for use in benchmarking the utilities cost. Curves for benchmarking other O&M cost elements can be developed in a similar way.

Because of the variable extent of outsourcing, benchmarking facilities maintenance costs on a trade-by-trade basis requires measuring also the respective in-house costs. The findings presented are some useful O&M cost benchmarks of hotels. Benchmarks of the processes and values of O&M works (Lai and Yik, 2006) have yet to be established to enable more holistic benchmarking.

REFERENCES

Bohdanowicz, P. and Martinac, I. (2007), "Determinants and benchmarking of resource consumption in hotels – Case study of Hilton International and Scandic in Europe", Energy and Buildings, Vol. 39, pp. 82-95.

DEFRA (2007), UK Energy Efficiency Action Plan 2007, Department for Environment, Food and Rural Affairs, United Kingdom.

Deng, S. and Burnett, J. (2002), "Energy use and management in hotels in Hong Kong", International Journal of Hospitality Management, Vol. 21, pp. 371-380.

EPA (2004), Leaders in the hospitality industry tap the power of superior energy management, Environmental Protection Agency, United States.

EMSD (2007), Energy consumption indicators and benchmarks for commercial sector, Electrical and Mechanical Services Department, Hong Kong SAR, available at: http://www.esu.com.sg/smarttool.php

ESU (2007), Energy smart tool, Energy Sustainability Unit, Singapore, available at: http://www.hkiol.org/energy2/main.html

HKTB (2007a), Hong Kong Tourism Statistics in Brief 2006, Hong Kong Tourism Board.

HKTB (2007b), Summary of the Hong Kong Hotel Industry Review 2006, Hong Kong Tourism Board.

Lai, J.H.K., Yik, F.W.H. (2004), Law and building services maintenance in Hong Kong, Transactions, The Hong Kong Institution of Engineers, Vol. 11, No. 1, pp. 7-14.

Lai, J.H.K. and Yik, F.W.H. (2005), Benchmarking Operation and Maintenance Cost, Performance and Value for Commercial Buildings in Hong Kong, Proceedings of Joint (HKIE/CIBSE/ASHRAE) Symposium 2005: New Challenges in Building Services, Hong Kong SAR, 15 November, pp. 139-149.

Lai, J.H.K. and Yik, F.W.H. (2006), Developing Performance Indicators for Benchmarking Building Services Operation and Maintenance for Commercial Buildings, Proceedings of CIBW70 Trondheim International Symposium: Changing User Demands on Buildings, 12-14 June, pp. 283-294.

Lai, J.H.K., Yik, F.W.H. and Jones, P. (2006), Critical contractual issues of outsourced operation and maintenance service for commercial buildings, International Journal of Service Industry Management, Vol. 17, No. 4, pp. 320-343.

Lai, J.H.K. and Yik, F.W.H. (2007), A Survey of Operation and Maintenance Budgetary Practices for Commercial Buildings in Hong Kong – Preliminary Findings, CIB World Building Congress: Construction for Development, Cape Town, South Africa, May 14-17, pp. 742-754.

LOCATING SUBJECTIVE ASSESSMENTS IN LOCAL GOVERNMENT CORPORATE REAL ESTATE AND FACILITY MANAGEMENT

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ABSTRACT

Practices for managing operational real estate emphasise technical and managerial aspects. Consequently, operational property – corporate real estate (CRE) and facility management (FM) – struggles to adequately address subjective assessments of the real estate and its management. This can be attributed to inadequate conceptualisations of where such assessments fit into management processes. This is particularly so in local government where political dimensions exist as a consequence of subjective assessments.

From governance theory, this paper suggests a suitable model for locating subjective assessments relative to operational property's Technical and Managerial domains. Four types of performance effects that are subject to assessment are modelled. These effects are then located relative to local government CRE and FM's four contexts – as physical environments, management of those environments, organisational aspects and local government's social and political context – any of which could be assessed ant any one time. The assessment model includes stakeholders and forms and locations, relative to the organisation. The resultant suite of models defines and locates subjective assessments with greater clarity that has been the case previously.

Keywords: corporate real estate management, facility management, performance effects, subjective assessments

BACKGROUND

Managing operational property – corporate real estate (CRE) and facility management (FM)[1] – encompasses many Managerial and Technical activities; see Bon (1996), Kenley et al. (2000), and Varcoe (2000). Schön (1983) notes that professions operate from, and are defined on, a basis of technical-rational knowledge. This has expanded to include requirements for managerial knowledge, particularly when operating in organisations. Examples of CRE-FM Managerial work are outsourcing and the consequential arrangements for the organisational real estate function, and alignment of CRE-FM with organisational strategy, whereas facility projects or managing a facility throughout their life-cycle for service delivery constitutes Technical work. Such activities and practices constitute the 'Primary Work' or 'core technology' of professional CRE-FM practice. (Heywood (2007) has a more comprehensive argument for this distinction).

Demonstrating successful delivery of various CRE-FM activities could be thought to be sufficient to establish their effectiveness. This demonstration should bridge the gap between expectation and service delivery thought crucial by Barrett and Baldry (2003). Little literature has been identified addressing specific issues of bridging the expectation-evaluation gap. Hinks and McNay (1999) and Shaw and Haynes (2004) are notable exceptions.

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[1] This paper originated in a project where CRE was the preferred nomenclature, but two separate management domains are apparent – *Real estate* being a site (location and context) and building, and *Facility* being a building and its use or service delivery (Brackertz and Kenley, 2002). This paper abbreviates this as CRE-FM.

Considerable effort has been expended in demonstrating organisational performance. The adoption of management tools such as goals, aims, Key Performance Indicators, and even strategic management are all attempts to objectify business outcomes (Levy et al., 2003). General management theory has Neely (1998) and Kaplan and Norton (1996) as two examples of its attempts to define performance.

Authors addressing performance assessment for CRE-FM include: Preiser and Vischer (2005), Amaratunga (2000), Szigeti et al. (2005), Property Council of Australia and KPMG (2005), Brackertz and Kenley (2002), and Lindholm and Levainen (2006). This work is important because the fields do need to be able to demonstrate performance. Much of this work is underpinned by a premise that improving building performance improves human potential through creating appropriate environments. However, when the main inputs to the assessments are 'functional' and 'technical' qualities of real estate and its services, a Technical-Managerial paradigm exists with aspirations for demonstrating objective performance, assuming that both sides of the expectation-service delivery gap are objective, measurable and all that is required. Typically, these assessments employ positivist methodologies rather than ethnographic forms that may reveal more human and possibly subjective dimensions (Fleming, 2004).

This research originated in an observation that questioned whether objective measures are all that are necessary for convincing arguments about CRE-FM. Despite best efforts in providing objective information people appeared to decide about facilities on some other, 'perceptual', basis. This problematic phenomenon is subjectively based decision-making processes at work. That the observation was made in a local government context was more telling because potential civic protest and political action added further layers of subjective influence. The latter pose difficulties for professionals for whom the technical challenges are most important and who wish to achieve the best objectified and rational courses of action (Gibson, 1994).

Therefore, the creation and reliance on objective measures of CRE-FM performance struggles on at least three grounds. Firstly, what is performing is not clearly stated as CRE-FM operates in or has four responsibilities with four corresponding performance dimensions (Heywood et al., 2004;Valenziano and Kious, 2005). Second, the existence of subjective assessments in CRE-FM decision-making means that the property professionals' rational and technically sound arguments for real estate projects may not be convincing and may be usurped in decision-making, nor understood by the real estate's 'consumers'. Third, expectations of service delivery are internal, subjective, complex psychological phenomena.

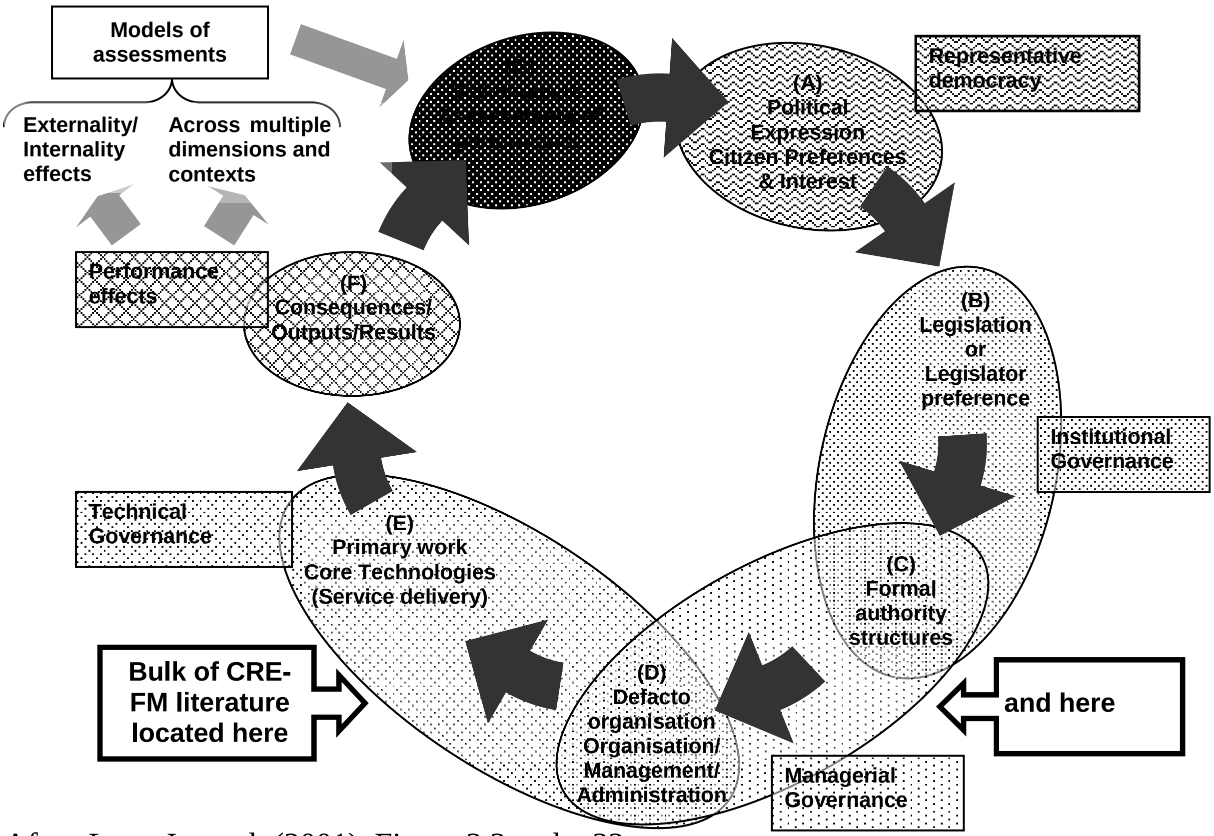
While it is apparent that CRE-FM operates across multiple responsibilities each with a dimension of performance, there seems little acknowledgement in the literature of which dimension in performance is applicable at anyone time. This is problematic because assessments of CRE-FM may be formed in any dimension, either singly or in concert with others. This is particularly so for subjective assessments. Therefore, a clearer framework in which to place CRE-FM professionals' work and assessments would be useful.

This paper presents an integrated suite of models as a framework for locating professionals' work, the effects of performing that work, and assessments of the effects relative to decision-making processes.

LOCATING SUBJECTIVE ASSESSMENTS RELATIVE TO PROFESSIONAL WORK

Professional work in organisational contexts, assessments of it and its decision-making scope are, essentially, issues of organisational governance. Lynn Jr, et al.'s (2001) governance framework is useful in linking professional work (both Managerial and Technical forms) a broader interpretation of that work's results, assessments of that work, and the cultural, political and rule-based norms (legislation) of organisations (Figure 1). Conceived for public administration, this model is also relevant to the private sector where choices about investment decisions, investor activism, and societal norms for organisations approximate 'Representative Democracy'. Organisational norms and other legislative rules for organisations create the 'institutional governance' for the private sector.

Figure 1. A model for locating subjective assessments.



After: Lynn Jr, et al. (2001), Figure 2.2 and p.32.

Importantly, this framework reconceptualises what technically-based professions, like CRE-FM achieve as 'performance effects'. These 'outputs, results and consequences' allows for different types of effects across multiple dimensions and contexts. This framework also allows for different models of assessment – the sought after objective ones – and also allows for subjective assessments of performance as a 'consequence' of that 'Primary Work'.

Conceptualising the effects of Managerial and Technical work in this way is useful where subjective assessments are concerned. First, CRE-FM may not directly provide service to the municipality. For example, a public park does, but a library has the building providing service to the municipal functions that it houses, which is, in turn, the municipal service delivery function. This somewhat, disconnects the effects of CRE-FM directly from its Primary Work, but this model accommodates this as 'consequences' – which may be more indirect. Second, the conceptualisation allows the effects to arise as a result of the management. For example, strategy (a management concept) has a communicative function (Deakin, 1999) which, as a result, may be interpreted for what it communicates about the decision-making organisation. This allows consequences to flow from management as well as the physical artefact. Third, the conceptualisation provides for a larger set of effects to be associated with CRE-FM, such as its financial, service delivery and political effects.

A matrix of performance effects in local government

These broader effects from CRE-FM are vectored *Externality* and *Internality* effects. *Externalities* draws from economic theory where they are welfare effects imposed on others by an entity's activities (Tietenberg, 2004), and urban planning where they relate to development proposals' impacts on neighbours (Dear et al., 1977). *Internalities* are partially informed by Environmental Psychology where an environment internally transacts with its occupants.

CRE-FM effects are at two levels. The first is the level of an individual facility where the effects are most easily identifiable. The second level is for the organisation that holds the facility in terms of that organisation's impact on its environment, relative to its business outcomes, and on itself. Together, they create a matrix of performance effects (Figure 2).

The *Organisational-Externality* quadrant of the matrix captures the organisational purpose in its doing business with the wider world. For example, real estate's location relative to consumers and appearance impacts on the capacity to do business and communicates things about the organisation – 'brand', as it is most commonly called.

Figure 2. The matrix applying CRE-FM performance effects (in local government)

CRE-FM effects (its consequences, outputs and results)			
	Externality	CRE-FM and its management: ● Facilitates doing business with the wider world; ● Impacts on service delivery to the municipality; ● Says things about the organisation (is communicative).	CRE-FM and its management impacts on its environment: ● Municipality; ● Physical, ● Social; ● Psychological; ● Economic.
	Internality	CRE-FM and its management impact on the organisation itself, for example: ● Design of the organisatlon that accommodates organisational functions, like CRE-FM; ● Workplace change	CRE-FM and its management impacts on: ● Service delivery from this facility; ● Users (Council staff/public); ● Usability;
		Organisation	**Facility**

Level of effect

Facility-Externality effects are frequently those of development applications where the effects of the physical presence of the facility are evaluated. Some of these effects are physical – for example, changed traffic flows and infrastructure requirements, and some of these effects are social in the impacts on neighbours. In local government, these *Facility-Externality* effects are particularly acute as the facility can have effects over-and-above its contribution to organisational service delivery. These effects include:

- Municipal quality-of-life (Michalos and Zumbo, 1999);
- Residents' cognitive and physical health (MacDougall et al., 1997); and
- The appearance of the community (Nasar, 2000).

In addition, management practices for facilities and projects influence or contribute to democratic practices. Called a ‘deliberative space’ by Forester (1999), these practices have impacts in regard to a range of social, cultural and political effects.

Given these varied contributions, local government CRE-FM straddles the, not always compatible, concepts of:

- Meeting organisational requirements; and
- Contributing to notions of community development and support.

It could be argued that the latter is self-evident, but the discourse of CRE and FM usually overlooks it.[2]

Organisational-Internality effects are those that impact on the organisation itself. This is most evident in issues of outsourcing and procurement where the effect is on the shape and structure of the organisation itself, and the form of its organisational functions. The effects are also evident in CRE-FM projects where the facility and the project are vehicles for, or in concert with, organisational change projects.

Facility-Internality effects are most evident in the accommodation, productive, or service delivery, aspects of the facility. Here service delivery within and producible as a result of the facility is a key effect. Impacts on users through environmental psychology are also an important internal facility effect with connotations for the facility’s appraisal and use. Usability of the facility is a key internal property, though this could also be construed at the organizational level.

EFFECTS ACROSS CRE-FM’S FOUR CONTEXTS IN LOCAL GOVERNMENT

Local government CRE-FM’s multiple responsibilities may be framed as four operating contexts (Figure 3):

1. As physical environments;
2. Management of those environments;
3. Organisational aspects (as CRE-FM is an organisational function); and
4. Local government's social and political context.

Items 1-3 correspond to the four responsibilities noted earlier, with the fourth being specific to the public sector, and connects to the ‘political expression’ and ‘citizen preferences’ from the governance framework. Modelling local government CRE-FM effects in those contexts clearly shows the effects of CRE-FM, their vector (external or internal) and the applicable operating context (Figure 3). This ties together the issues of the physical artefact, which is the most usual focus of the CRE-FM discipline, the artefact’s utility for organisational purposes, and facility management aspects in initially providing the artefact and throughout its life-cycle, and other effects of local government facilities.

ASSESSMENTS OF CRE-FM'S PERFORMANCE EFFECTS

Having more clearly identified the effects of CRE-FM, modelling their assessments may now be considered, though the assessment phenomenon is complicated given the multiplicity of effects and contexts. At least four aspects are identifiable (Figure 4), which include:

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[2] Some of these contributions, labelled as ‘Community FM’ were featured in a special 2006 issue of *Facilities* – Issue 7/8, published by Emerald Publishing

1. The different stakeholders involved, which may have had a professional education;
2. The gap between assessments pre- and post-experience of the effect;
3. Forms of assessment, which may be objective, or subjective; and
4. Assessments may be made internal, or external, to the organisation with the real estate.

Figure 3. Local government CRE-FM effects

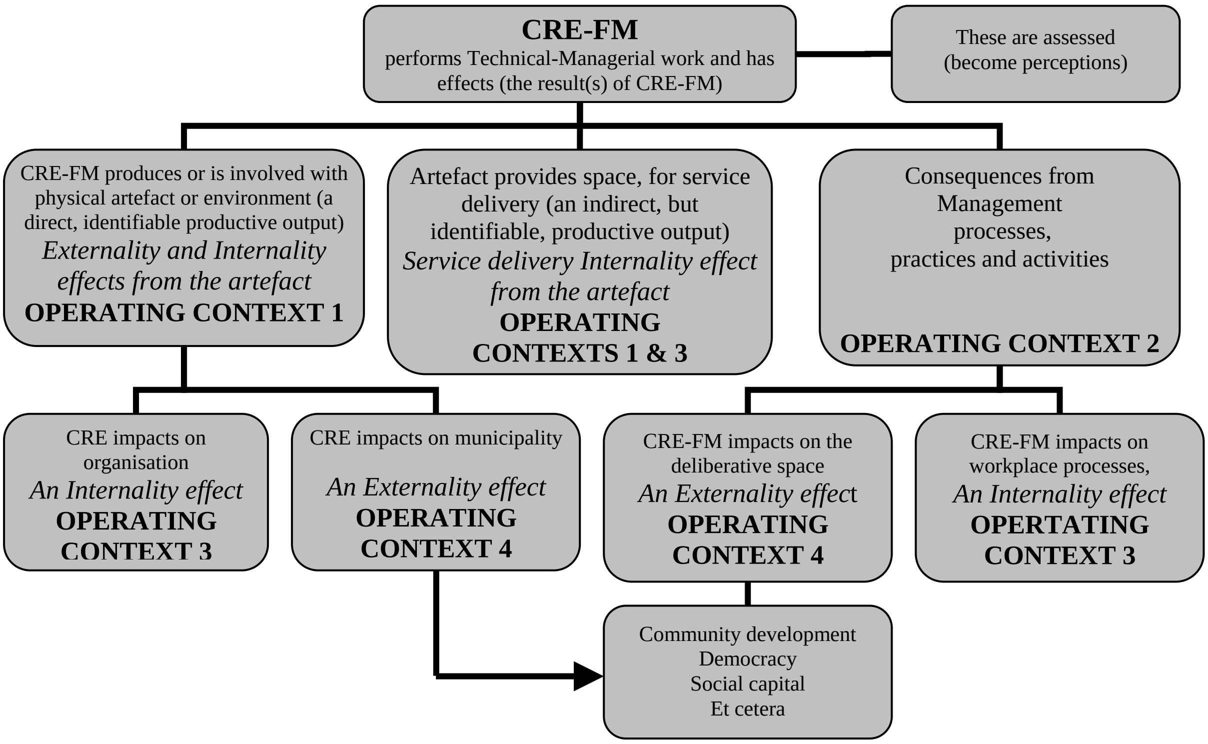
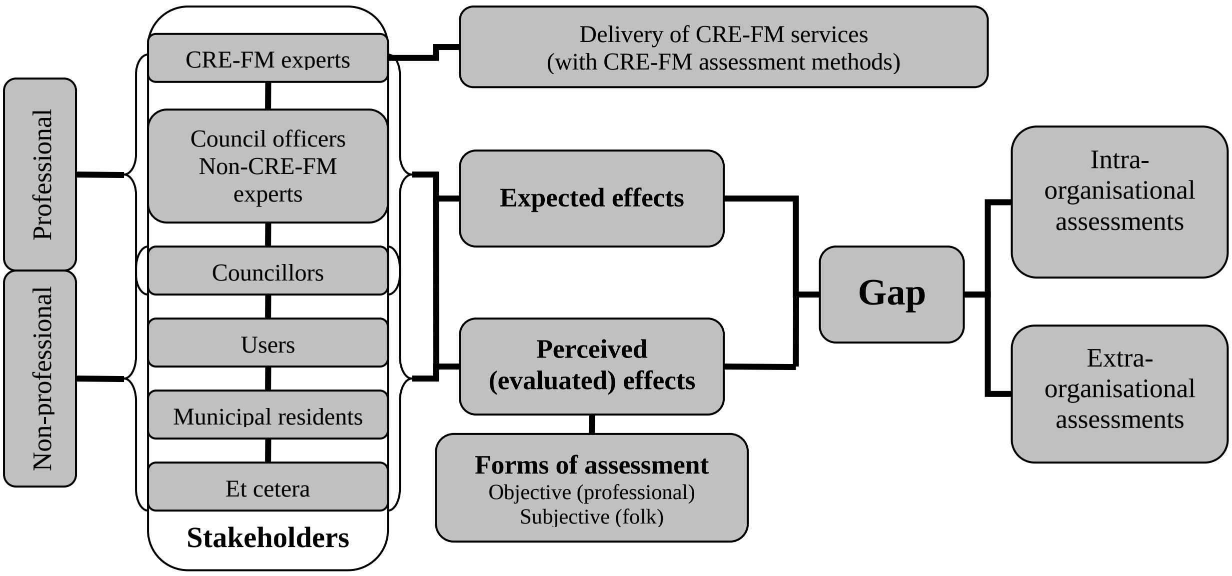


Figure 4. Assessments in local government CRE-FM



There are two broad perspectives for assessment potentials – professional and non-professional (Brown and Gifford, 2001). The professional perspective is underpinned by an assumption that its assessments will be technical-rationally formed through a professional education (Schön, 1983). The non-professional perspective may be categorised as one of ‘users’ or ‘stakeholders’ who could be either a non-professional or a professional operating out of their field.

It is implicit that the professional perspective comes with professional, technical and objective assessments that contrasts with subjective or ‘folk’ assessments of non-professionals (Anspach, 1991). While non-professionals may have to rely on non-technical assessments, professionals also employ subjective assessments of their own work (Linder and Peters, 1989).

People’s assessments of performance are usually contextual, even those claimed to be objective. In such circumstances, relying solely on objectified measures to demonstrate performance fails to completely satisfy assessors of that performance. Furthermore, objective performance measures count for little if they are evaluated through subjective lenses.

Assessments could be pre- or post-effects (expectations and evaluations, respectively). Barrett and Baldry (2003) frame the issue as a gap between assessments of CRE-FM service quality, but could apply to any CRE-FM effect. Differences between prior and post assessments may be determined by gap analysis (Hinks and McNay, 1999;Shaw and Haynes, 2004).

The fourth aspect of assessments is that assessments of effects of CRE and its management may be from inside the organisation (intra-organisational) or outside (extra-organisational).

DISCUSSION – IMPLICATIONS FROM THE MODELS

The intrusion of subjective assessments into the technical, professional world raises questions of the role, or purpose of that subjectivity. Dismissal as an irrational, distracting irrelevancy is one approach, yet subjectivity’s persistence and utility in making decisions raises questions of its legitimacy and its incorporation into CRE-FM professional practice.

It is suggested that part of the problem of grappling with performance and subjective assessments is the field’s poor definition and modelling of performance, its effects and forms of assessment. This inadequate addressing of assessments may be part of the fields’ lack of impact with senior management. To address this deficiency several models are required to fully define and model the various phenomena. The need for these models is the result of the under-theorisation of local government CRE-FM, and also the general field of CRE-FM.

The work of CRE-FM is located within the remit of organisational governance processes. This is provided by a framework, adapted from Lynn Jr, et al. (2001) to locate CRE-FM’s Technical-Managerial work as its core technology – defined by its literature – relative to what it produces – its performance effects. Conceptualising the effect of CRE-FM as consequences, results and outputs (treated as performance effects) expands understanding of the effect of CRE, facilities and their management and moves the field away from purely concentrating on the physical artefact and environment. It also allows for the inclusion of contributions to municipal life other than its technical and financial ones. This locates the professionals’ work relative to subjective (and other) assessments of them. This legitimises subjective assessments within CRE-FM’s professional domain. It also allows a more detailed modelling of effects as *Externalities* and *Internalities* from the facilities and the organisation.

The detail of the effects of that work, and their forms of assessment shows that the most obvious effect of CRE-FM is a building artefact within real estate or facility entities

(Operating Context 1). However, there are many other effects, which are evident in local government CRE-FM. These effects include those that the facility creates for its environment and its operating organisation. In local government, where operational property is the vehicle for delivering services to municipal residents (Operating Context 3) both the spaces themselves and the processes used in managing them contribute to community development, social capital and the like (Operating Context 4). These *Externality* and *Internality* effects have direction and magnitude (hence the vectorial description) with regard to the organisational intent or purpose for the facility.

Having the CRE-FM performance effects more clearly identified allows the, no less complex, assessments of them to be more properly modelled. Both objective and subjective forms of assessments, by a multiplicity of stakeholders, are now included in the assessment field. A basis for the perspectives of those stakeholders, each with varying degrees of potential for objective, technical assessments, is also shown, as this can be important for the form of assessment employed by stakeholders. Assessment modes – pre-effect as expectations and post-effect in a perceptually-based evaluations of real estate and facilities are clearly identified, with the gap between them also clearly shown. That these assessments can occur within the organisation (itself a hybrid-complex entity in local government consisting of bureaucratic and political operatives), within the municipality and outside the municipality adds credence to the conceptualisation of *Externality* and *Internality* effects.

With more complete modelling, more directed measures of performance that address all the legitimate methods of assessment is possible. Also, it is possible to develop and deploy management practices that more effectively target and produce the full range of performance effects from (local government) CRE-FM.

CONCLUSION

This paper notes that performance in CRE-FM is poorly defined, it being unclear in which of four possible domains of performance is the actual focus. This is particularly important where CRE-FM is concerned with subjective assessments, and also where organisational strategic purposes and the alignment with CRE-FM is important. Local government is a very good vehicle to examine this phenomenon given is potential for civic protest and expression of subjective assessments.

An integrated suite of models is developed that, together, provide a clearer and more comprehensive model of CRE-FM professional work and assessments within, and of it, than was previously the case. A model from governance theory locates professional work, its performance as effects, and models of assessments in organisational contexts. These effects are then conceptualised as *Externality* and *Internality* effects at two levels – the organisation and the facility. These are modelled with regard to the operating contexts on local government CRE-FM. Finally, there is a detailed model of assessments of performance effects that includes different types of stakeholders, forms of assessment and assessment locations relative to organisation itself.

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REFERENCES

Amaratunga, D. (2000) 'Assessment of facilities management performance', *Property Management*, 18, 4, pp. 258-266.

Anspach, R. R. (1991) 'Everyday methods for assessing organizational effectiveness', *Social Problems*, 38, 1, pp. 1-19.

Barrett, P. and Baldry, D. (2003) *Facilities management: Towards best practice*, 2nd, Blackwell Science, Oxford.

Bon, R. (1996) 'Corporate real estate management practices in Europe and North America: 1993-1996', *Facilities*, 15, 5/6, pp. 118-124.

Brackertz, N. and Kenley, R. (2002) 'Evaluating community facilities in local government: managing for service enablement', *Journal of Facility Management*, 1, 3, pp. 283-299.

Brown, G. and Gifford, R. (2001) 'Architects predict lay evaluations of large contemporary buildings: whose conceptual properties?' *Journal of Environmental Psychology*, 21, 1, March, pp. 93-99.

Deakin, M. (1999) 'The underlying issues, model and task ahead for local authority property management', *Proceedings of RICS Research Conference, The Cutting Edge 1999*, www.rics.org.uk/research/

Dear, M. J., Fincher, R. and Currie, L. (1977) 'Measuring the external effects of public programs', *Environment and Planning A*, 9, 3, pp. 137-147.

Fleming, D. (2004) 'Facilities management: a behavioural approach', *Facilities*, 22, 1/2, pp. 35-43.

Forester, J. (1999) *The deliberative practitioner: Encouraging participatory planning processes*, MIT Press, Cambridge, Massachusetts.

Gibson, V. (1994) 'Strategic property management - How can local authorities develop a property strategy', *Property Management*, 12, 3, pp. 9-14.

Heywood, C., Smith, J., Brawn, G. and Missingham, G. (2004) 'Innovation in Facilities Management practice using a performance approach', *Proceedings of cobra 2004*, September, Leeds.

Heywood, C. A. (2007) The role of affect in local government corporate real estate management, PhD Thesis, University of Melbourne.

Hinks, J. and McNay, P. (1999) 'The creation of a management-by-variance tool for facilities management performance assessment', *Facilities*, 17, 1/2, pp. 31-53.

Kaplan, R. S. and Norton, D. P. (1996) *Translating strategy into action: the Balanced Scorecard*, Harvard Business School Press, Boston.

Kenley, R., Brackertz, N., Fox, S., Heywood, C., Pham, N. and Pontikis, J. (2000) *Unleashing corporate property: Getting ahead of the pack*, Property Council of Australia and Victorian Department of Infrastructure, Melbourne.

Levy, D., Alvesson, M. and Willmott, H. (2003) 'Critical approaches to strategic management', In *Studying management critically*, (eds.), Alvesson, M. and Willmott, H., Sage Publications, London, pp. 92-110.

Linder, S. H. and Peters, B. G. (1989) 'Instruments of government: Perceptions and contexts', *Journal of Public Policy*, 9, 1, pp. 35-58.

Lindholm, A.-L. and Levainen, K. I. (2006) 'A framework for identifying measuring value added by corporate real estate', *Journal of Corporate Real Estate*, 8, 1, pp. 38-46.

Lynn Jr, L. E., Heinrich, C. J. and Hill, C. J. (2001) *Improving governance: A new logic for empirical research*, Georgetown University Press, Washington DC.

MacDougall, C., Cooke, R., Owen, N., Willson, K. and Bauman, A. (1997) 'Relating physical activity to health status, social connections and community facilities', *Australian and New Zealand Journal of Public Health*, 21, 6, pp. 631-637.

Michalos, A. C. and Zumbo, B. D. (1999) 'Public services and the quality of life', *Social Indicators Research*, 48, pp. 125-156.

Nasar, J. L. (2000) 'The evaluative image of places', In *Person-environment psychology: New directions and perspectives*, (eds.), Walsh, W. B., Craik, K. H. and Price, R. H., Lawrence Erlbaum Associates, Mahwah, New Jersey, pp. 117-168.

Neely, A. (1998) *Measuring business performance*, Profile Books, London.

Preiser, W. F. E. and Vischer, J. C. (eds), (2005) *Assessing building performance*, Elsevier, Oxford.

Property Council of Australia and KPMG (2005) *The new corporate real estate challenge: Performance measurement in practice*, Property Council of Australia, Melbourne.

Schön, D. A. (1983) 'From technical rationality to reflection-in-action', In *The reflective practitioner: How professionals think in action*, Basic Books, New York, pp. 21-69.

Shaw, D. and Haynes, B. (2004) 'An evaluation of customer perception of FM service delivery', *Facilities*, 22, 7/8, pp. 170-177.

Szigeti, F., Davis, G. and Hammond, D. (2005) 'Introducing the ASTM facilities evaluation methodology', In *Assessing building performance*, (eds.), Preiser, W. F. E. and Vischer, J. C., Elsevier, Oxford, pp. 104-117.

Tietenberg, T. (2004) *Environmental economics and policy*, 4th, Pearson Addison Wesley, Boston.

Valenziano, S. F. and Kious, L. G. (2005) 'Positioned for success: Designing the optimal corporate real estate organisation Part 1', *Journal of Corporate Real Estate*, 7, 2, pp. 129-144.

Varcoe, B. (2000) 'Implications for facility management of the changing business climate', *Facilities*, 18, 10/11/12, pp. 383-391.

ORGANISATION OF FACILITIES MANAGEMENT IN MUNICIPALITIES

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ABSTRACT

The local and regional authorities in Denmark were structurally reformed in 2007 leading to a major centralization. The concept of Facilities Management (FM) has been introduced in several cases as a new way of organizing the activities related to the buildings used by the municipalities. This development has been supported by a project managed by the Danish Facilities Management Association and with participation of representatives from many of the largest municipalities. This paper presents the project and the resulting recommendations as well as two case studies about FM in the municipalities of Copenhagen in Denmark and Malmö in Sweden. The case studies were part of a research project on FM Best Practice in the Nordic countries carried out by the Technical University of Denmark. The authors have worked together on both projects and have each managed one of the projects.

KEYWORDS: municipalities, organisation, action research, case studies

INTRODUCTION

The local and regional authorities in Denmark were structurally reformed in 2007 leading to a major centralization. As part of this process the organisation of municipalities with administrations being merged together during the fusions has been re-evaluated. The concept of Facilities Management (FM) has been introduced in several cases as a new way of organizing the activities related to the buildings used by the municipalities.

This development has been supported by a project in 2006-7 with participation of representatives from many of the largest municipalities. The project was initiated by the Danish Facilities Management Association (DFM) and was supported by the private foundation BoligfondenKuben. The project was managed by Poul Henrik Due, who at the time was responsible for DFM's secretariat. Per Anker Jensen was a member of a reference group for the project.

During the same period a research project concerning FM Best Practice was carried out by the Technical University of Denmark, which was supported by the same private foundation. The project involved 36 case studies from the Nordic countries and among those were case studies about FM in the municipality of Copenhagen, the capital of Denmark, and in the municipality of Malmö in Sweden. The project was managed by Per Anker Jensen and Poul Henrik Due was part of the project group.

The paper presents the Danish municipality project and the resulting recommendations as well as the case studies of the two municipalities from the FM Best Practice project. The paper starts with theory on organisation in the private and public sector in general and on FM in particular. After that the municipality project is presented followed by the two case studies. The final part of the paper is discussion and conclusion.

THEORY

The organisation of FM in municipalities has not been investigated much in academic research before now. Barrett and Baldry (2003) describe a number of case studies with examples of FM organisation and include two examples from the public sectors, but they concern hospitals and a university. FM in municipalities has recently obtained a stronger focus by the development of Community based FM and Urban FM, but the organisation of FM in municipalities has not been the main focus of the research (Alexander, 2006).

There exist a huge amount of theory on organisation and some of it deals with the differences between the private sector and the public sector. Boyd and Chinyio (2006) stress that a main difference derives from the fundamental purpose of the organisation. In private organisations the purpose is profit and the strategic decision-making is mostly done internally in the organisation. In public organisation the purpose is social operation and support and the strategic decision-making is done more externally as part of political processes.

The organisation in the public sector can by use of domain theory (Kouzes and Mico, 1970) be divided in the following three domains: Political, managerial and professional. These have different inner logics, working patterns and values which create an inner tension in the organisation. For private organisations it is common to see a vertical distinction in three stratas: Strategic, tactical and operational (e.g. Mintzberg, 1983). One of the main differences is a stronger vertical tension between the domains in public organisation compared to private organisation (Boyd and Chinyio, 2006).

Facilities Management has very much developed as a new profession in the private sector and the organisational thinking in FM is mostly based on a private sector model (Jensen, 2006). The distinction between strategic, tactical and operational strata is strongly integrated in the organisational thinking in FM. The new European standard on FM Terms and Definitions, approved in 2006, includes a model of FM in an annex, which holds this distinction as one of the constituting elements. In the annex the strata are called levels of interaction and the strategic level should achieve the objectives of the organisation in the long term. The tactical level should implement the strategic objectives in the organisation in the medium term and the operational level should create the required environment to the end users on a day-to-day basis (CEN, 2006).

The development in the public sector means that the distinction between the domains is changing. The direction of public activity is being moved towards a situation more like a private sector model with focus on delivering public services to customers who have rights in relation to defining the service and its quality. However, the delivery of the services still operates within strict budgets set by the political domain and there is a focus on value and efficiency. This development implies a derogation of the professional domain compared to the earlier public-administration model (Boyd and Chinyio, 2006).

THE MUNICIPALITY PROJECT

Background

The Danish government decided to implement a structural reform of the local and regional authorities from January 1, 2007. Until then there were 13 counties and 278 municipalities and both counties and municipalities had the authority to acquire taxes from their population.

With the reform all tax administration is centralized to the state administration. The number of municipalities was reduced to 97 and the counties were changed to 5 regions. The municipalities still have the authority to acquire taxes and have taken over some of the responsibilities from the counties, for instance in relation to roads and environment. The new regions are mainly responsible for hospitals and are financed by the state.

Before the reform was implemented, the Danish Building Client Association (BiD – Bygherreforeningen i Danmark) carried out a project together with representatives from 18 municipalities about the organisation of the building client functions in the municipalities. During this project it became clear that the municipalities were more engaged with real state operation and administration than with activities as building clients. Therefore, the project ended up dealing with the organisation of both areas as a more or less integrated function.

The main result of the project was the identification of the 4 models for organisation of this function in municipalities that are described below. The project did not provide any recommendations about the priority of the 4 models but only described them with examples and indications of possibilities and challenges. However, the project did conclude that new strategies and tools like FM show new solutions (BiD, 2006a and 2006b).

The municipal property unit model

In this model all the competences are placed together in an independent business unit under the municipal management. The unit acts as owner of all the property used by the municipality and rents out facilities to the different departments. This model was also called the Copenhagen model as the model is used in the municipality of Copenhagen. The model is explained in more details in the case study.

The business manager model

In this model all the competences are also placed together in a unit in the municipality administration, but the administration departments has the ownership of the buildings they use and the business manager unit acts as internal consultants to the different departments.

The administration departments' model

In this model the competences are distributed to the administration departments, who have the ownership of the buildings they use. This is the traditional model. Each department is managed by a civil servant but under political control by a committee with elected politicians. Therefore, this model gives the politicians the most direct influence on the management of the facilities.

The individual management model

In this model the responsibility for the facilities is decentralized to each individual institution and they can receive professional assistance from a central support function. This model was also called the Bornholm model, because at the time the island Bornholm used this model. This happened before the structural reform when the island was a county and the municipalities on the island voluntarily decided to merge to become only one municipality. Recently the municipality on Bornholm has changed the organisation to an administration departments' model and today no municipality in Denmark use this model.

The FM project

Following the project described above DFM and the private foundations, that had financed that project, decided to initiate a new project together with interested municipalities to investigate the possibilities and effects of implementing an organisation based on FM in municipalities. The project was organized with a project manager assisted by two experts, a work group with members from 16 municipalities and 1 region, and a reference group with representatives from various institutions, associations and organisations. The activities involved 3 seminars for all the participants and 7 meetings in the work group. The project can be seen as action research aiming at understanding and changing the reality in practice. The project started June 2006 and finished June 2007 with a project report and an extract of the strategic aspects aimed at decision-makers in municipalities - both written in Danish (Due, 2007 & Due and Stephensen, 2007). A popular brochure based on the project is also being produced.

The current state and potential for improvements in the municipalities

The municipalities own huge amounts of property and spend a lot of money on operation and maintenance. But at the same time there is a enormous backlog of maintenance and the standard of the buildings is generally not very good. Many municipalities do not have an overview over there property and other assets, because the responsibility is decentralized to the various administration departments and there are no common procedures for dealing with the facilities. The organization of the FM related activities are more often due to chance and history than based on deliberate strategic choices. Many employees in the municipalities have been given FM related tasks which they do not have the basic competencies for and very few have a detailed insight into the real state of handling of the FM related activities in the municipalities.

The economic value of the property of Danish municipalities is approx. € 200 billion and the expenditures on building operation and construction projects were about € 60 billion in 2006. Based on the experiences of DFM it was estimated that the possibility of annual cost saving is around € 1-2 billion by implementing professional FM in the Danish municipalities and at the same time improve the standard of buildings and the services.

The scope of FM in municipalities

The project analyzed the scope of FM based on the experiences from the participating municipalities. It was decided to define the scope as the internal support functions in relation to the facilities used by the municipalities. Outside this scope was the services related to the citizens in the municipality like operation of roads, water supply and drainage systems. These services were regarded as part of the core activities of the municipalities.

Furthermore, it was analyzed which of the FM activities should be regarded as strategic, tactical and operational. As examples of the results, the strategic activities can include definition of vision, mission, values and goals for the FM organisation, strategic planning based on a full overview of the property and other assets and formulation of strategies for communication and information. The tactical activities can include buying, selling, renting and renting out of property, planning and carrying out construction projects and preparation of guidelines, descriptions and frames. The operational activities can include operation of a call centre as well as building operation and the related services.

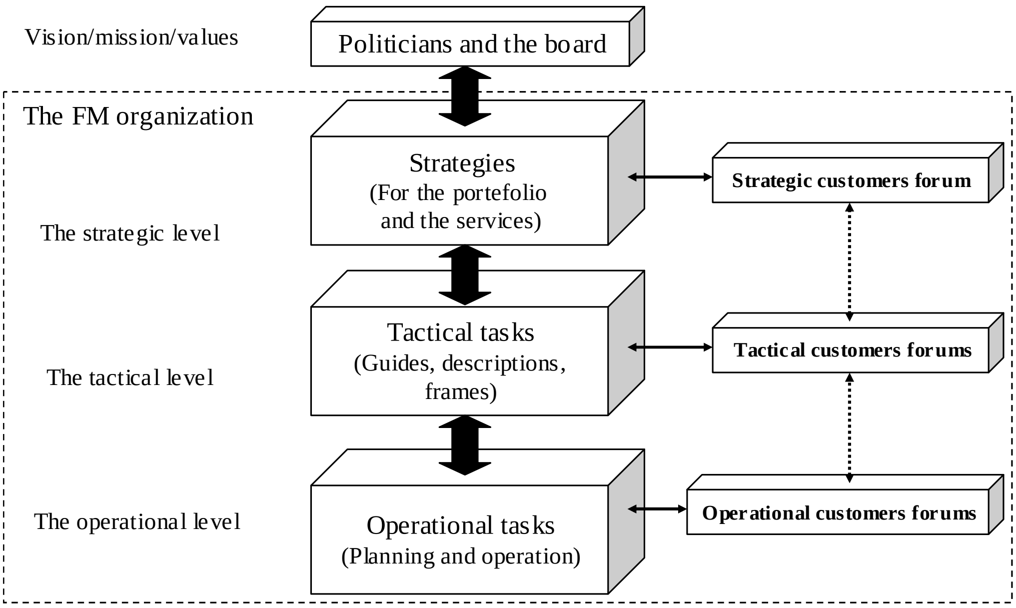
Requirements for an FM organisation

To be successful the project identified a number of requirements for the implementation of an FM organisation. It is necessary that the new organisation has a strategic awareness and support at top level in the municipality, which both involves the political leadership and the top management in the municipal organisation. The organisation should be proactive and optimize the municipal property portfolio in accordance with the political intentions for the development of the municipality, based on a holistic view, and with focus of the needs of the users on both short and long term.

The model for an FM organisation in municipalities

A main result of the project was the development of an ideal model for organisation of FM in a municipality. This model is shown in figure 1. Besides the distinction between the strategic, tactical and operational level, the most important element of the model is the inclusion of a customer forum on each of the three levels. The purpose of the customer forums is to ensure the alignment between the political intentions, the experienced reality by the citizens and the experienced service by the employees in the municipality, to create networks between the staff in the FM organisation and other parts of the municipal organisation and to get constantly updated knowledge about customers needs and feedback on the delivered service.

Figure 1. Model for FM organisation in municipalities (Due and Stephensen, 2007)



The project compared this ideal model with the four models identified in the former project. The result was that only the municipal property unit model could fully satisfy the requirements.

CASE STUDIES

The two case studies presented in the following are based on and further described in Danish in Jensen et al (2007).

Copenhagen Property

The property unit in the municipality in Copenhagen was established January 1, 2006 under the department of culture and leisure by merging 7 separate units placed in different departments and managed by an externally recruited property director. The property unit is responsible for all facilities used by the municipality. Beforehand each unit had its own goals and strategies with different priorities, planning methods, IT-systems, terminology and organisation. Nobody had a full overview over the amount of property and its condition.

The new unit started by defining mission, vision and goals. The mission is to create attractive physical frames for all the activities in the municipality on business like conditions. The vision is to be an active and professional partner in relation to property in the municipality. One of the big challenges is to change the focus of the staff from buildings to the customers. However, a main priority initially is to create the necessary overview over the portfolio and diminish a huge maintenance backlog. Implementation of IT-systems is important for creation of the overview. To improve performance of construction projects and maintenance the unit has established partnerships with private companies. The unit also offers consultancy in new ways of working and new layout of workplaces for the office departments in the municipality and has utilized the units own office space as a showcase for inspiration.

The unit is focused on a number of strategic goals. The long term development of the organisation is defined in a development ladder with five steps with the aim to change from being a caretaker with focus on building and expenses, to be a property owner with focus on customer and income, to become an active property owner with focus on dialogue with customers and optimization, to become the preferred collaboration partner creating added value for customers by developing the portfolio, and finally to become an innovator on a close cooperation with their customers and involved in developing the market and the industry. Balanced Score Card is used to document the fulfilment of the annual goals.

The Service Administration in Malmö

The municipality in Malmö established the Service Administration in 1996 with the responsibility for property, roads, parks, supply systems, vehicles, IT, school restaurants and a number of services. Since then the organisation has been through a long and impressive development to become an increasingly more professional and customer oriented service organisation. The mission of the unit is directed towards customers, staff, owners and a sustainable society, and the vision is to support the success of their customers. The customers are defined as the citizens of Malmö directly and indirectly as employees in the municipality.

The unit acts as owner of the property used by the municipality, but the administration departments have the right to rent spaces on the open market if they want to. However, the unit has not found it to be a problem to compete with the private market. As part of the municipality they have the advantage of meeting their customers as colleagues and the director of the unit has easy access to the heads of other departments in the municipality.

One of the successes of the unit has been implementation of a FM concept in the schools. The unit started a pilot project with one school. They separated the activities related to the core activities of teaching and the Service Administration took over the support activities related to create the best possible environment for the teaching. A reception at the school became the centre of the contact between the school and the service organisation. The main result was that the teachers got more time to prepare and teach. Their status was increased and recruiting new teachers became easier. Furthermore, the physical environment and the maintenance of the buildings was improved, sickness among teachers was reduces and a better service was provided for the same money. Based upon the experiences of the pilot project the concept was implemented in all schools in Malmö.

As part of the latest reorganisation in early 2007 the Service Administration has established a strategic management level to supplement the operational management level. The strategic level has a manager for each of the target groups in the mission. The customer coordinator at the strategic level has a liaison to each operational unit in the form of a customer responsible person with reference to the customer coordinator but is at the same time part of the operational management. The development strategist is responsible for a sustainable society and is managing a small development unit but to ensure the customer orientation the development projects has to be decided in a committee chaired by the customer coordinator.

DISCUSSION AND CONCLUSION

The municipality project provides a model for implementation of an FM organisation in municipalities. It is striking that the concept of FM with the distinction between strategic, tactical and operation levels creates a clear basis to prioritize between the four models for organisation of building client function and real estate administration in municipalities. The municipal property unit model is the only one of the four models described that fully satisfies the requirements for a FM concept.

The implementation of a FM organisation in the public sector can be seen as an attempt to transfer a private sector model to the public sector. This seems to be in line with the general development in the public sector in recent years. FM concerns support functions, which traditionally have not had much attention, neither in private nor in public organisations. Therefore, it is an area which has had a limited professional prestige and one of the purposes of implementing FM is to create a higher degree of professionalism in this area. The trend of derogation of the professional domain mainly relates to the core activities in the public sector and implementation of FM seems to express a different trend in the support functions.

The case studies show two examples of implementation of an FM organisation in municipalities. Both cases are examples of the municipal property unit model. The case of Copenhagen Property is limited to the facilities used by the municipal departments, while the Service Administration in Malmö has a broader scope and is not only focused on the municipal staff as customers but also the citizens in general. Copenhagen Property on the other hand has a stronger ambition to assist their customers in improving the office environments. Both units have a clear vision and a strategic plan for their organisational development towards a more profound customer orientation and innovation, but also a clear conscience of the need to develop organisations step by step.

The project and case studies are clear indications of the advantages a FM concept has to offer for municipalities. There are possibilities for cost savings but most of all there are opportunities to create better and more sustainable environments for both staff in municipalities and the citizens at large.

REFERENCES

Alexander, K. (ed.)(2006), Community Based Facilities Management. Special issue of Facilities, Vol. 24 issue 7/8. Emerald Group Publishing Limited.

Barrett, P. and Baldry, D. (2003), Facilities Management - Towards Best Practice. Second Edition. Blackwell Publishing. Oxford.

Boyd, D. and Chinyio, E. (2006), Understanding the Construction Client. Blackwell Publishing. Oxford.

BiD (2006a), Organisering af kommunale bygherre- og ejendomsforvaltningsopgaver (Organisation of municipal building client and real estate administration tasks). Report. Bygherreforeningen i Danmark and BoligfondenKuben.

BiD (2006b), Fire modeller – fire kommuner (Four models – four municipalities). Brochure. Danish Building Client Association and BoligfondenKuben.

CEN (2006), Facility Management – Part: Terms and definitions. EN15221-1.

Due, P.H. (2007), Herre i eget hus (Master in one's own house). Main report. Danish Facilities Management Association and BoligfondenKuben.

Due, P.H. and Stephensen, P. (2007), Herre i eget hus (Master in one's own house). Strategic aspects. Danish Facilities Management Association and BoligfondenKuben.

Jensen, P. A. (2006), Håndbog i Facilities Management (Handbook in Facilities Management). Second Edition. Danish Facilities Management Association.

Jensen, P.A., Nielsen, K. and Nielsen, S.B. (2007), Facilities Management Best Practice i de nordiske lande – 36 cases. (Facilities Management Best Practice in the Nordic countries – 36 cases). Internal report. BYG-DTU

Kouzes, J. M. and Mico, P.R. (1970), Domain theory: an introduction to organisational behaviour in human service organisations. Journal of Applied Behavioural Science, Vol. 15 issue 4, pp. 449-69.

Mintzberg, H. (1983, Structure in Fives: Designing Effective Organizations. Englewoods Cliffs, Prentice Hall.

A CONCEPTUAL FRAMEWORK FOR MEASURING FACILITY PERFORMANCE OF A CO-LOCATED HIGHER EDUCATION AND FURTHER EDUCATION CAMPUS

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ABSTRACT

The aim of this paper is to present the development of a facility performance measurement framework. The paper also attempts to provide a clear understanding of the role of facility management in higher and further education co-location type projects through identifying the criteria that determine long-term success of these projects. This will be achieved by investigating the cost and benefits of a co-location project using a case study of the development of the Scottish Borders Campus (SBC) in Galashiels.

The importance of this research lies in the growing competition among education institutions to provide improved facilities that cater for a variety of learning provision, and to do this in a cost effective manner. This initiative can be directly related to the policy of the Scottish Executive from 2004 to build a better Scotland through efficient and effective service provision.

KEYWORDS: Higher and Further education, performance measurement, co-location, shared services, KPIs, framework

INTRODUCTION

Higher education organisations attempt to increase efficiency to encounter escalating running costs and to meet end users growing demands for quality and value for money (Varcoe, 1995, cited by Amaratunga and Baldry, 2000). The opinion of Moohan (1993) was that HE estates have an effect on increasing the quality of education. Indeed, a research published by CABE (2005) provided evidence on the link between the functions and facilities of education buildings and the recruitment, retention and performance of both the staff and students of higher education institutions. On the other hand, Douglas (1996) was certain that change is inevitable especially when talking about the future of higher education estates that are not completely foreseeable. The speed of ‘buildings’ change, influenced mainly by technological and financial factors, is possibly to rise, and that in turn will increase the need to adapt more economic use of spaces of higher education buildings (ibid). It can be suggested that adopting sharing education facilities is one of the outcomes of these changes. This can take the form of co-locating educational operations at one particular site. However, this approach can be considered as an effective, efficient and strategic solution for enhancing education infrastructure in a particular location. Nonetheless, it brings significant financial, curricular, and structural advantages not achievable through occupation of separate estates. Nonetheless, the escalating need for such change in the education sector has become more evident (Duffy et al., 1993 cited by Douglas, 1996). As a result, effective techniques of measuring building performance will assist in adapting to those changes and implement new initiatives (Douglas, 1996). It can be argued that education institutions adopt more commercial methods to allocate resources than what they used to do in the past (Clarke, 1997). It is, for that reason, recommended that models of performance measurement can be more useful to enlighten resource allocation in education initiations and to form a guide to improvement of new resource-based methods for commercial competitive advantage (Preiser, 1995). In fact, governments worldwide consider evaluating the performance of further and higher education an issue of especial interest in the attempt to enhance educational provision effectiveness and maximise value of money (Belcher, 1997).

APPROACHES TO PERFORMANCE MEASUREMENT

Traditionally, the techniques that have been used to measure business performance relied mainly on monetary figures and accounting numbers. In the 1920s, the DuPont Company presented the return on investment 'ROI' measure, and the General Motors Corporation introduced original financial management ways in that era. Since then, several management accounting practices that are currently in use had been developed like discounted cash flow (DCF), residual income (RI), earned value analysis (EVA) and cash flow return on investment (CFROI) (Bassioni et al., 2004; Neely et al. 2000; Kaplan 1984; Chandler 1977). On the other hand, general dissatisfaction with performance measurement models that were based solely on financial approaches began in 1950s, and since 1970s, this dissatisfaction has explicitly become the subject of escalating criticism (Bassioni et al., 2004). Reasons for not meeting professionals' expectations have been explained in the work of many researchers. Skinner (1974) argued that traditional systems ignore strategic perspective while Hayes et al. (1982) reported that they promote short termism. Nevertheless, authors advocated that financially based practices do not improve performance rather than maximising shareholders gains (Johnson and Kaplan, 1987; Lynch and Cross, 1991) and lacking concentration (Kaplan and Norton, 1992). Neely et al. (2000) advocated that this dissatisfaction with performance measures was the trigger for the emergence of more "balanced" or "multi-dimensional" performance measurement systems. Indeed, to obtain a comprehensive perspective about how a business is performing, a broader evaluation that goes beyond the "traditional" backward looking and limited measures needs to be carried out, which involves considering the potential perspectives and aspirations of the company's corporate strategy, business processes, and customers' requirements (Zairi, 1996 and Olve et al., 1999). However, the newly developed systems have expanded to include non-financial measures that cover potential perspectives (Bourne et al. 2000). The same work of Bourne indicated examples like Keegan et al. (1989) who developed a balanced measurement matrix that included internal and external business criteria, and financial and non-financial metrics; others like Lynch and Cross (1991) introduced a pyramid of performance measures that is parallel to the order of an organisation's structure. Neely et al., (2000) pointed out that in the last decade of last century, the approaches to measuring business performance moved towards developing frameworks that involve "integrated measurement systems". They indicated that the balanced scorecard introduced by Kaplan and Norton in 1992 was one of the most notable examples. It can be argued that other performance frameworks have been developed since 1950s although they were quality based performance frameworks like the Deming Prize initiated in Japan in 1950, the Malcolm Baldrige National Quality Award that was established in 1987 and the European Foundation for Quality Management launched in 1989. However, the last three models include a set of criteria that encourages total quality management by focusing on personnel, processes, strategic planning, leadership, customer satisfaction as well as the end product.

CONCEPTS IN FACILITIES MANAGEMENT

The term "facilities management" or "FM" covers different disciplines and it is used to describe different activities. For this reason, there are many definitions of facilities management. The British Institute for Facilities Management (BIFM, 2008) defines facilities management as "the integration of multi-disciplinary activities within the built environment and the management of their impact upon people and the workplace". The work of Barrett and Baldry (2003) presented another definition of FM and revealed some of the types of activities mentioned in the BIFM definition; facilities management is an "integrated approach to maintaining, improving and adapting the buildings of an organisation in order to create an environment that strongly supports the primary objectives of that organisation". However, both definitions emphasised the significance of creating and managing a "positive" workplace environment within buildings that enhances the core business of an organisation. Indeed, these activities may cover allocating resources, building maintenance or refurbishment, technical assistance, space planning, ICT, security and cleaning. Duffy and Tanis (1993) and Becker and Steele (1995) (cited by Then, 2004) explained the interface between such kinds of activities and people by investigating the relationship between the workplace and the organisational change, the workplace and the personnel productivity, and explored how the design of physical spaces could be utilised to inform organisational change. Moreover, Nutt (2000) identified two levels of strategic objectives for FM; macro and micro levels. At the macro level, the purpose of FM is to provide an improved infrastructure and logistics to businesses of different types and across sector. At the micro level, the objective is to effectively manage the facility resources and services in such a way that supports the core business of an organisation and its employees. It seems that Becker (1990) has the same opinion of Nutt. In his work, Backer (cited by Then, 2004) put organisational effectiveness as a major objective. This is shown by his definition of FM "facility management is responsible for co-ordinating all efforts related to planning, designing and managing buildings and their systems, equipment and furniture to enhance the organisation's ability to compete successfully in a rapidly changing world". However, Nutt (2000) expanded with his comprehensive explanation of FM to conclude that the main role of facilities management is "resource management". Within this context, Nutt identified four basic "trails" consistent with the generic resources that form the key role of FM. These trails are the management of financial resources (business), human resources (people), physical resources (property) and the information and knowledge resources (knowledge). In conclusion, the different definitions of FM congregate in one opinion that facilities management as a concept expands to cover buildings aspects as well as human aspects of people using and occupying these buildings in addition to covering supporting activities to core business.

AIM AND OBJECTIVES

The main aim of the research is to develop a performance measurement framework that can be used to measure the success of co-location projects in the education sector. However, under the main aim, the research will try to identify the criteria that determine long-term performance success of supporting facilities through identifying the cost and benefits of co-location projects based on a benchmarking exercise.

METHODOLOGY

In order to develop the performance measurement framework that can be used to measure the success of co-location projects, a conceptual framework will be drown based on a comprehensive literature review to build on principals of performance measurement. Therefore, in the literature review, an exploration of best practices about performance measurement frameworks, investigation of the efficiency of the current frameworks and verification what a project performance measurement system has to be covered in terms of measures, objectives, type of data and methods of implementations. Then, the research will undergo a series of focus group workshops. By using this technique, professionals, whose opinions are very crucial in the fields of education, architecture, estate management, will be brought together in a number of organised and facilitated workshops to discuss the criteria that determine the success of co-location projects by identifying a set of key performance indicators (KPIs). This technique is imperative because it allows the participants to discuss on issue at a time from different point of views in a structured way. This will form the basis for further development of the framework at later stages.

Framework development

From the literature review, a conceptual performance measurement framework was developed which consisted of 82 indicators covering the whole-life aspects of a project. The framework was based on the final objectives a co-location project tries to attain throughout its various stages. Those objectives were derived from studying what construction projects in the education sector are trying to achieve in terms of cost, time, quality, safety, sustainability and potential educational and business benefits of such projects. The following step was to undertake a series of focus group workshops to refine the measures and to identify a manageable number of key performance indicators.

Key performance indicators (KPIs) focus group workshop

The next stage of building the performance measurement model embraced an in-depth focus type of group interview. Axelrod (1975) claimed that this technique is considered as a main data-gathering method used by researchers who are required to form certain type of strategies. This is particularly applicable in the current case as the opinion of Kagioglou et al. (2001) was that the metrics of a performance measurement system should relate to the strategic objectives of an organisation. This is applicable also on a project level as projects usually operate in the context of achieving organisational goals. Nonetheless, Greenbaum (1988) explained that the focus group session typically incorporates 8-10 people drawn together to one place to deal with questions that are of a great concern to the researcher(s). Hence, the focus group was undertaken with representatives of a cross section of professionals to reveal variables to be tested empirically at the second stage of the research project. Easterby-Smith et al., (1991) stated that the main responsibility relayed on the researcher to provide rationale about the workshop, create and promote a suitable environment for discussions. However, the workshop was organised by an independent facilitator who managed to keep the participants focused on the issues under consideration. Frey and Fontana (1993) described that the focus group usually takes the form of a structured interview, and as an ordinary interview the facilitator directs its process. The focus group consisted of eight individuals who were chosen to represent different project disciplines. Actually, the main idea behind implementing the focus group approach was to consider, examine and discuss criteria that are critical to the co-located type project success. Another reason was to provide different opinions from various backgrounds and from diverse personal experiences. The facilitated workshop was an opportunity for creating such an environment suitable for open arguments and steered discussions. During the workshop two main questions were under focus; the first one was to list the top five performance indicators that the participants think are most critical for the project from their own perspective. The justification for this question was to spotlight how the participants perceive success from different angles. This would provide the means to appreciate the group’s rational perception and understanding regarding different issues. However, focus group would also permit diversity of ideas to arise. As part of the exercise, the project success criteria are split into two main stages; the delivery stage which include project phases from inception through to project handover. The second is the post-delivery stage which starts thereafter till the end of the proposed age of the facility. Consequently, 82 indicators, developed from the literature, were divided and set up within the two main stages. Therefore, the participants were split into two groups. Each group was to deal with one stage of project success. The first group dealt with the project delivery stage and consisted of the director of HWU Borders campus services, the assistant director of HWU estates, HWU consultant and the Borders Campus project manager. The second group was formed from the HWU director of planning, the project architect and the Borders College assistant principle. The reason behind dividing the participants into two groups was to have their understanding and realisation of the project objectives, which were expressed in the first half of the workshop, converted into valuable ranking inputs according to their expertise and the participant's positions of responsibility. Thus, the second question was to rank the set of KPIs on a high, medium and low scale. New indicators were added (marked in red) to accommodate suggestions made by the participants during the workshop. The new generated list of key performance indicators will be used as measures for the Borders Campus Project. The outcome of the workshop revealed a refined framework (Figure 1). In this framework, the success of a co-location project is determined largely on maximising the value of public money, achieving successful transition to the stage where FE and HE can work collaboratively and within sustainable environment.

Workshop outcome

The outcome of that workshop was a milestone as the research took a new direction towards more operational and organisational issues. Another focus group workshop is needed to discuss, modify and validate the developed framework. However, the recent status of the framework is shown in Figure (1).

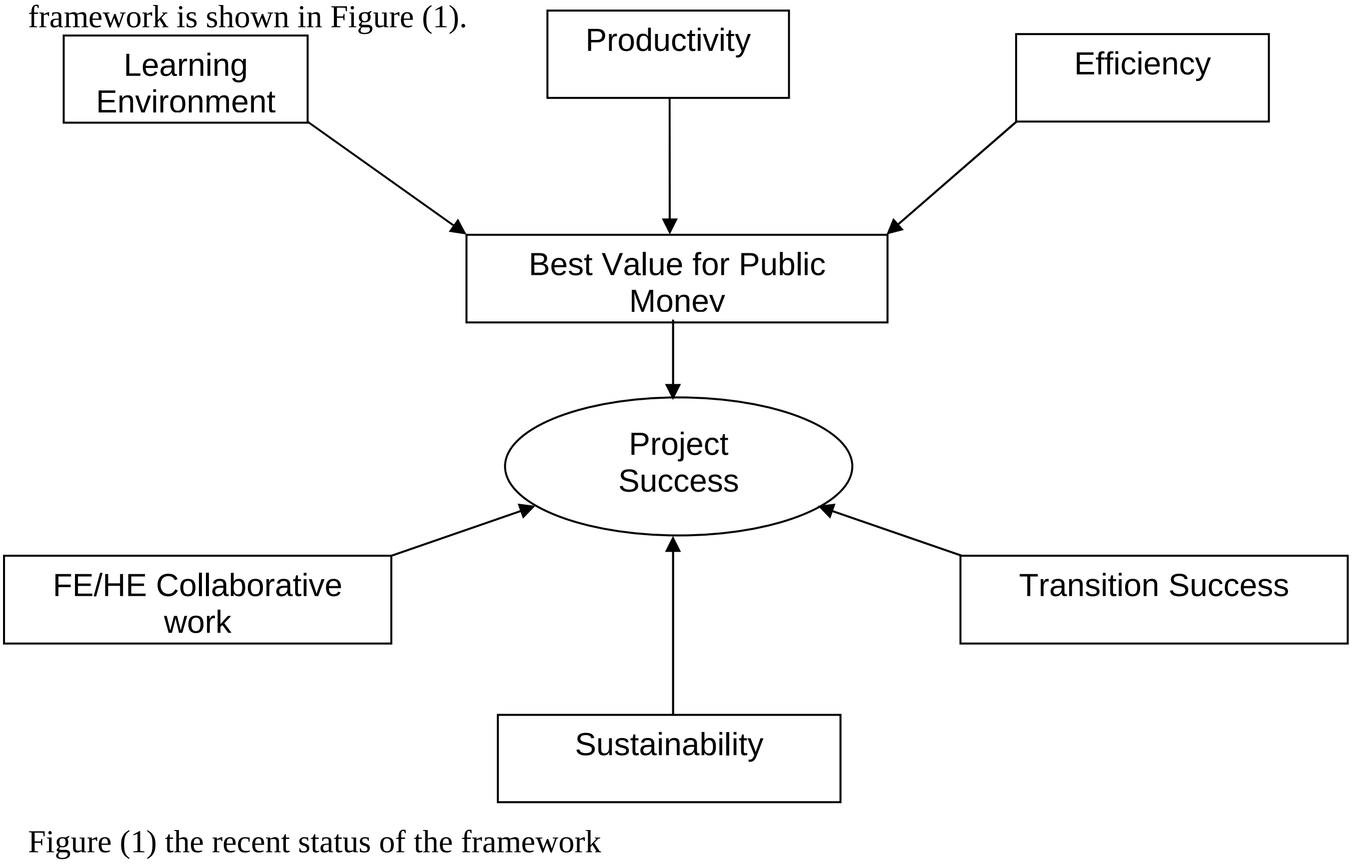

Figure (1) the recent status of the framework

Best value of public money

To maximise the value of public money spent on co-location projects, the building which is the physical environment has to shaped and structured to the highest possible quality offering suitable and efficient space, cost, service, energy, etc. This efficiency and effectiveness of cost together with delivering high educational provision indicates that sufficient resources are allocated properly and perhaps creates a culture of continuous educational and services improvements.

FE/HE Collaborative work

When FE/HE institutions work together, collaboration between them will create the opportunity to achieve gains if the experience of end-users integration, service integration, and shared space is successful. This area of the framework needs more investigation.

Sustainability

One of the main factors to achieve success in co-location projects is sustainability. Measures of sustainability include assessing the impact of the co-location project on biodiversity, materials recycling, CO2 emissions, waste and water consumption.

Transition success

This group includes effective design and construction measures. Some of these measures have been derived from the construction industry KPIs (Scottish Construction Industry, KPI Pack 2005). In addition, Transition success also includes achieving smooth integration and change management. This requires good leadership, communication and commitment throughout the co-location project stages. Another objective of this group is to have minimum negative impacts on the educational process.

Summary

It is hard to come up with an extensively approved answer for determining the project success although it has been the topic of many research studies. The consensus is to go beyond achieving the traditional project objectives in terms of cost, time and quality to more operational and organisational levels. This was highlighted in the study by adding more success criteria like achieving excellent integration of college and university staff and students, student recruitment and retention, good educational and social cohesion, successful FE/HE work collaboration and, ultimately, attaining the best value for public money. Nonetheless, the literature about this subject shows a general agreement about performance measurement frameworks based on time, cost and quality measures “hard measures”. In all the cases, there are very limited sources about “soft measures” especially the issue of “co-location projects” and the associated shared services and facilities in the education sector. All education institutions have essential support services, including procurement, HR, IT, and finance, legal and communications services. On the other hand, facilities include education assets and their maintenance, space usage, health, safety, environment and security. Nonetheless, sharing these services and facilities has the potential to generate substantial efficiency savings and cost reduction. Hence, it is very important to measure the performance of that type of project in a way that could identify weakness and strength points which in turn will help apply best practice in similar future projects. However, the next stage of the research is undertake a data collection exercise and based on the list of the developed key performance indicators of the co-location project a benchmarking exercise will be made to compare the performance of the co-location project with other institutions in Scotland.

REFERENCES

Amaratunga, D. and Baldry, D. (2000), “Assessment of facilities management performance in higher education properties”, Facilities, Vol. 18, No. 7/8, pp. 293-301.

Axelrod, M. (1975), “Markets get an eyeful when focus groups expose products, ideas, images, ad copy, etc. to consumers”, Marketing News, 8, 6-7.

Barrett, P. and Baldry, D. (2003), “Facilities Management”, Blackwell Publishing, Oxford, UK.

Bassioni, H.A., Price, A.D.F. and Hassan, T.M. (2004a), “Performance measurement in construction firms”, Journal of Management in Engineering, 20(2), 42–50.

Belcher, R.G. (1997), “Corporate objectives, facilities, measurement and use: a university model”, Proceedings of the RICS Cobra Conference, Portsmouth.

CABE (2005), “Design with Distinction: The Value of Good Building Design in Higher Education”, (www.cabe.org.uk)

Chandler, A. D. (1977), “The Visible Hand: The Managerial Revolution in American Business”. Harvard University Press, Cambridge, Mass.

Clarke, G. (1997), “Reassessing resource allocation strategies in higher education: methods for analysis”, International Journal of Educational, Vol. 11 No.6, pp.286-92.

Douglas, J. (1996), “Building performance and its relevance to facilities management”, Facilities, Vol. 14, No. 3/4, March/April, pp. 23-32.

Easter-Smith, M., Thorpe, R. and Lowe, A. (1991) “Management Research: An Introduction”, London, Sage.

Frey, J. H. and Fontana, A. (1993), “The Group Interview in Social Research”, in Morgan, D. L. (Ed) “Successful Focus Groups”, Sage Publications, California, USA.

Hayes, R.H. and Abernathy, W.J. (1980). “Managing Our Way to Decline”. Harvard Business Review, July-August, pp. 67-77.

http://www.bifm.org.uk/bifm/about/facilities (Accessed 15-03-08)

Johnson, H.T. and Kaplan, R.S. (1987). “Relevance Lost. The Rise and fall of management accounting”. Harvard Business School Press, Boston, MA.

Kagioglou, M., Cooper, R. and Aouad, G. (2001), “Performance management in construction: a conceptual framework”, Construction Management and Economics, 19, pp. 85-95.

Kaplan, R. S. (1984). “The evolution of management accounting”. Account. Rev., 59(3), pp. 390–418.

Kaplan, R. S. and Norton, D. P. (1992), “The balanced scorecard – measures that drive performance”, Harvard Business Review, January–February, 71–79.

Krueger, R. A. (1988), “Focus Groups: A Practical Guide for Applied Research”, Newbury Park, CA:Sage.

Lynch, R.L., Cross, K.F. (1991), “Measure Up! Yardsticks for Continuous Improvement”, Blackwell, Cambridge, MA.

Neely, A., et al. (2000), “Performance measurement system design: Developing and testing a process-based approach”. International Journal of Operations and Production Management, 20(10), pp. 1119–1145.

Nutt, B. (2000), “Four competing futures for facility management”. Facilities, 18 (3/4), pp. 124-132.

Olve, N., Roy, J. and Wetter, M. (1999), “Performance Drivers: A Practical Guide to Using the Balanced Scorecard”, Wiley, Chichester.

Preiser, W.F.E. (1994), “Facilities programming using design database systems: the post-occupancy evaluation project”, unpublished report, University of Cincinnati, Cincinnati, OH.

Skinner, W. (1974). “The focussed theory”. Harvard Business Review, May-June, pp. 113-21.

Then, D. (2004), “concepts in facilities management”, in Murray, M. and Langford, D. (Ed) “Architect’s Handbook of Construction Project Management”, RIBA Publications, London, UK

Zairi, M. (1996), “Benchmarking for Best Practice”, Butterworth-Heinemann, Oxford

TREES - TRAINING FOR RENOVATED ENERGY EFFICIENT SOCIAL HOUSING

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ABSTRACT

Numerous European research and demonstration projects concerned the improvement of thermal performance of buildings, but the dissemination of the results remains limited in the professional practice and education. The knowledge level is also very different among European countries. Much effort has been dedicated to new buildings, though much more energy is consumed in the existing building stock. This high energy consumption has dramatic consequences for low income families. Thus, a focus on energy efficient social houses will have very positive environmental and economic effects. Such a policy can also influence the rest of the building sector. The implementation of the European Directive on energy performance of buildings will impulse some changes that require innovation and skill.

European demonstration projects have shown that the energy consumption in social housing can be reduced by 30% through appropriate retrofitting. The knowledge level of the key actors, architects and facility managers, is a major barrier against such performance improvement. Some energy efficient and economical techniques and design methods are often ignored. Efficient technical solutions and demonstration projects in one country may be unknown in other parts of Europe. Collecting the best practice and disseminating it among European professionals will lead to better retrofitted houses.. Universities, research institutes and consultancy from France, Sweden, Norway, Holland, Germany and Hungary have collaborated and developed education packages for courses and seminars in the project called TREES (Training for Renovated Energy Efficient Social housing)

KEYWORDS: Education, Renovation, Retrofitting, Energy, Social housing

INTRODUCTION

The implementation of the European Directive on energy performance of buildings will impulse some changes that require innovation (energy certificates, audit and performance improvement). Research and demonstration projects carried out constitute a large knowledge base through which through this project can be more broadly disseminated among practitioners (architects, building owners and managers, social housing associations, consultants, contractors). It will also contribute to the promotion of EU labels (energy efficiency, eco-design), and particularly renewable energy systems (solar hot water, photovoltaic systems). At a more local level, the renovation of social housing is part of sustainable municipal policies and ought to be integrated in a local community planning. Reducing energy expenses for low income families contributes to the social inclusion objectives expressed in the Amsterdam treaty (articles 136 and 137).

The main objectives of the TREES project have been to improve the knowledge of decision makers on energy efficient technologies through education packages. Therefore, modular educational material that can be used in a flexible way within more global courses (e.g. continuing education of architects, building managers etc.), have been developed. This education material shows and demonstrate different techniques and tools for renovation projects. It also shows best practice examples using case studies from various country.

Development of educational material in courses for architects and social housing managers.

The main deliverable have been PPT presentations and explanatory texts, accessible on the internet, and structured in 3 main topics: techniques, tools, and case studies. Table 1, 2 and 3 give an overview of what techniques, tools and case studies have been in focus. The presentations and explanatory text are in English. Some of the countries will take initiative to make translations to the local language.

Table 1. Refurbishment techniques

Topics	Main focus and contents
Insulation and thermal bridges	Insulation materials and their characteristics. Insulation systems for low energy and passive house standard. Typical thermal bridges and their avoidance. Examples for thermal bridges and their visualization by 3D simulations.
Replacement of glazing	Heat losses and solar transmittance factors of various glazing types. Evaluation of the solar exposure of a façade. Choice of a glazing according to the climate, orientation and exposure. Heat gains and losses for different glazing types. Influence of glazing replacement on the heating energy consumption of a building.
Preheating of ventilation air	Various ways of preheating ventilation air through passive means, like glazed balconies, air collectors and ground tubes. Integration of preheating of ventilation air in energy efficient and passive house energy concepts for existing and new buildings. Main characteristics, energy and comfort aspects. Examples of projects with the application of preheating ventilation air.
Solar hot water	Feasibility and design guidelines including simple hot water load estimations. Design principles, system design alternatives, typical components and energy performance. Samples of building integration into various types of common building types.
Photovoltaic systems	Photovoltaic systems and components. Experience in the design and use and good practice in building integration.
Heating equipment	Replacement of boilers using cleaner energy sources (e.g. oil to gas or district heating). Improvement of control (thermostat), choice of technical solutions according to e.g. the size of the building. Examples

Table 2. Tools for use in the planning process

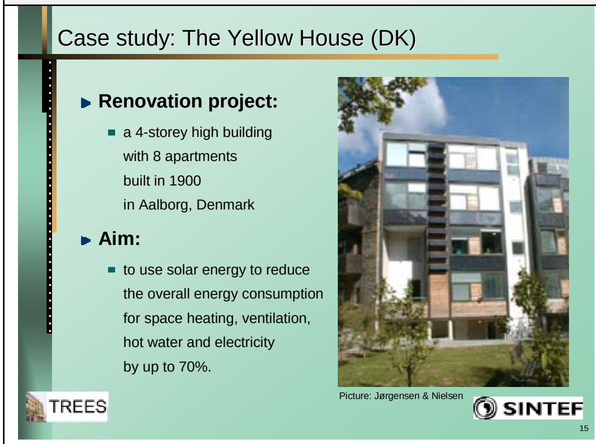
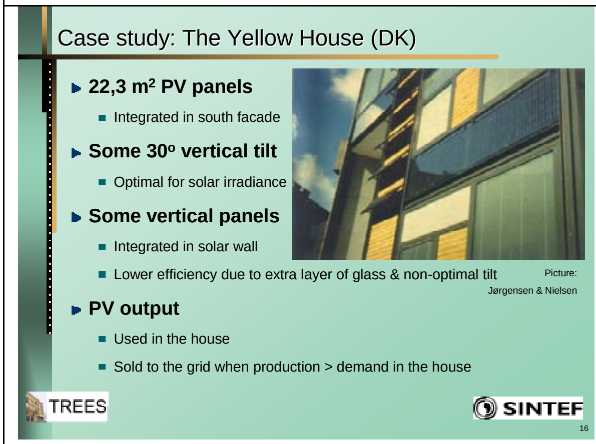
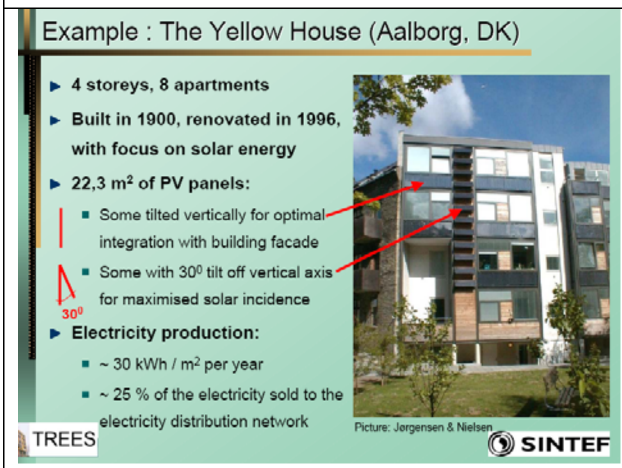
Monthly heating load calculation	Principles and models. List of tools and web sites. Reduction of the heating load obtained with various technical measures. Examples of application in the retrofit of social housing.
Thermal simulation	Principles and models. List of tools and web sites. Example of retrofit of social housing. Reduction of the heating load obtained with various technical measures.
Life cycle assessment	Presentation of the methods and tools. List of tools and web sites. Example application in the retrofit of social housing. Reduction of the environmental impacts obtained with various technical measures.
Sustainability assessment	Presentation of the generic methodology and relevant tools (e.g. Green building challenge) and examples applications.
Local community planning	Introduction to local community planning. Demonstration of the relationship between low energy demand, renewable energy applications and efficient technologies. Explanation of the link between urban planning, building density, and infrastructure. Examples of projects with successful local community planning.
Life cycle costing	Presentation of relevant tools (e.g. whole life costing and life cycle assessment). Examples

An example of how the educational material is presented.

There are six different thematic presentations of *Techniques* and six for *Tools*, written by experts at each topic.

Each PPT presentation consist of about 20 slides. Each slide has a supplementary text that explains the issue and give some background information. The lecturers will thus have the opportunity to learn enough about the issues to make the presentation even if they are not really experts in the topic. It is difficult to present a detailed introduction in this paper. But as an example, the combination between slides and supplementary text, is shown. (The example is from the presentation of using photovoltaic cells in a refurbishment concept.

Table 3. How the slides and supplementary text are combined.

From the slide presentation	From the supplementary text:
	*Slide 15:* The Yellow House is a four-storey high building with eight apartments. The house is situated in Aalborg in Denmark, and built in 1900. In 1996, the house was renovated and the building envelope renewed with focus on solar energy. The aim of the project was to use solar energy to reduce the overall energy consumption for space heating, ventilation, hot water and electricity by up to 70%. After its renovation, the performance of the house has been monitored extensively.
	*Slide 16:* The South facade of the house faces a back yard, which provides an opportunity for the use of solar energy. The South wall is used as a solar wall that preheats ventilation air for the house. In addition, it features a range of PV panels, the total area amounts to 22,3 m^2. Part of the PV panels are tilted 30^o vertically to optimise solar incidence. The other part of the PV panels are integrated in the vertical solar wall. In addition, an extra layer of glass in front of the PV panels is reducing their output even further. Yet, this layout was chosen as the one most fit for this house.
	*Summary slides:* 3 summary slides are made for each presentation show the main content and conclusions in the lecture.

Case studies and examples of good practice

Six cases, one from each country, were chosen to show how techniques and tools can be used in planning and priority making processes. Table 4 give a short description of the following cases;

Gardsten (Sweden), Montreuil (France), Husby Terasse/Stjørdal (Norway), Nuremberg (Germany), Dunaujvaros (Hungary), Kruitberg/Amsterdam (The Netherlands). The case studies have different approaches; refurbishment concepts, costs, measurement results, energy savings, etc.

The examples with short description of each case is detailed in Table 4.

Table 4. Cases and demonstration projects

Case	Short descriptions and results.
Gårdsten – Sweden 	Residential building area in Gårdsten, Gothenburg, has been renovated as part of an EC THERMIE project. The aim was to demonstrate a comprehensive integrated renovation concept comprising energy conservation measures and utilisation of solar energy, as well as improved architectural and social conditions, making typical blocks of flats from the 70's more attractive. The project got major prize for the Enhancement of the Social Structure 2006 in Gothenburg- Sweden.
Montreui - France 	This project was a part of the European demonstration project REGEN LINK and aims to demonstrate that the fulfilment of Agenda 21 objectives, particularly that the reduction of greenhouse gas emissions is also possible in regeneration and in the social housing sector. Under strict economical constraints, the concept of " lean regeneration ", i.e. the achievement of high energy performance by improving the building envelope using innovative but not too sophisticated technologies, has been studied and applied in 52 dwellings among a 536 units regeneration project.
Husby Terasse/ Stjørdal – Norway 	Husby Terasse consist of 110 apartments, erected in the middle of 1970. Like other domestic buildings in Norway from that decennium, energy efficiency was not given too much attention. Combined with failure in the window sealing system, and poor ventilation systems, the energy consumption was measured to approx. 255 kWh/m^2 year. In the beginning of year 2000 the owners decided to execute a major rehabilitation. Trough this upgrading the energy target was set to 120 kWh/m^2 year. The case describes the refurbishment process including evaluation and investment- and pay-back calculations

Nuremberg – Germany 	The three-storey multiple dwelling in Nuremberg (Bavaria), containing 6 flats, each with 149 m² living area, was built in 1929. In 2002, in the context of ECTarget 2-advancement, the refurbishment of the free-standing carriage-and-pair building was accomplished while it was inhabited. The thermal heat demand was calculated to 204 kWh/m² year before and 27 kWh/m²year after the refurbishment. The case describes also an Eco-efficiency-assessment, which considers the objects and materials used in the refurbishment process. The Eco-efficiency assessment tool calculates how much primary energy was necessary for the production.
Dunaujvaros – Hungary 	Buildings made with prefabricated technologies face significant problems in the building stock of Eastern-Europe in general. In Hungary 20 % of the dwellings belong to this category. The buildings represent a low quality standard regarding energy consumption, operating cost, thermal comfort and indoor climate. In a German-Austrian-Hungarian project called “Solanova building” , the flats were refurbished with passive house components. Monitoring and energy measurement have been done.
Kruitberg/ Amsterdam - Holland 	Kruitberg is a typical large-scale high-rise building in Amsterdam. The building was built during the 1960-70’s. This demonstration project includes the second phase of a large renewal operation and consists of 363 apartments out of a total of 9000, which was in need of renovation. This project is a comprehensive and cost-competitive sustainable renovation concept and process, which comprises energy conservation, utilization of renewable energy, improving comfort, and tenants involvement. A large number of similar renovation situations will occur in the coming years in other similar urban areas: the replication potential is large.

OWNERSHIP STRUCTURES AND CHALLENGES BY RETROFITTING AND REFURBISHMENT OF SOCIAL HOUSING

Social housing can be managed by public or private bodies. Especially in the eastern countries in Europe the ownership structure has been slowly changing. The dwellings are offered and sold to the residents that also become responsible for running and retrofitting of the houses. The decision-making process becomes then very complex, e.g. replacing an old window is an individual choice of each owner, whereas the heating equipment may be collective.

Lack of money, difficulties to get consensus for the level of retrofitting, and discussion about cost sharing and financial methods, are challenges in addition to the technical and practical aspects. Even if the target group of this project is constituted by professionals, the educational material can also benefit resident associations and professionals advising groups of co-owners.

Today, most social housing managers and architects do not pay much attention to energy performance because there are no requirements in the current regulations for existing buildings. In some countries regulation exists for existing large buildings (> 1000 m2) with major renovation (>25% of the construction cost). But in practice we can see the tendency of retrofitting is planned and executed in smaller steps to avoid the new stricter regulations that can cause higher investment costs.

ACKNOWLEDGEMENTS

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REFERENCES AND AVAILABLE MATERIALS

The full presentations from the project will in 2008 be available for downloading from the internet by contacting one of the partners in the project. Visit www.cep.ensmp.fr/trees/ There is also a long list of references related to each presentation, available on the same homepage

Some main literature and references:

Intelligent Energy Europe Programme, Project TREES, Deliverable 4 : Dissemination report page 19/25

PEUPORTIER, B.., *Assessment and design of a renovation project using life cycle analysis and Green Building Tool*, Sustainable Building 2002 Conference, Oslo, September 2002.

ZÖLD, A., SZALAY, ZS., CSOKNYAI, T., *Energy Performance and Major Renovation.* The 4th European Conference on Energy Performance and Indoor Climate in Buildings, Lyon, 20-23 November, 2006, pp. 267-273

CSOKNYAI, T., *Solanova project : solar supported, integrated and eco-efficient renovation for large residential buildings made with industrialized technology,* PLEA Conference, Beirut, 2005

ENERGY MANAGEMENT – A QUESTION OF ORGANISATION

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ABSTRACT

Energy management is one of the core businesses of a facility manager. A study of German speaking literature was done to analyze what is the significance of energy management in medium-sized and industrial businesses. Following aspects were investigated: motivation, methods and measures, obstacles, experiences and facility management. Facts are quite clearly. Energy management is very effective even with simple measures but companies management must be its driver. There is a growing awareness for energy consumption, but it is still not one of the most important matters. Although some projects were done there is still a lot to do handling energy management as a key issue.

INTRODUCTION

Against the background of growing CO2-concentration in the atmosphere mankind needs to rethink its use of energy. Most of the heat used for space heating is still generated by burning fossil fuels. A simple measure to reduce this consumption is to reduce the energy required for such heating and/or ensure more efficient use of fossil fuels.

Many facility managers are in charge of real estate and energy management is one of their core businesses. In recent years the consumption of energy and the costs involved have become increasingly important. Saving energy is not a new idea. This paper describes the results and consequences of energy saving measures, based on a study of the German speaking literature dealing with the significance of energy management in SMEs and industry.

In order to provide usable information, the literature of the last ten years was analysed, concentrating on some important aspects that will be considered in this paper. The main aspects the author was interested in are motivation, methods and measures, obstacles, experience and facility management.

Over 80 papers were found that describe energy management relevant topics in practice or theory. A more detailed classification was then made in accordance with the main aspects mentioned above. The resulting analysis shows that there are still some obstacles to resolve and there is a need for action to give energy management the emphasis it deserves.

Motivation (Streiff , 2007)

There are various reasons why measures to increase energy efficiency are planned and implemented. Figure 1 shows the most commonly-mentioned aspects for energy management in all the papers that were examined.

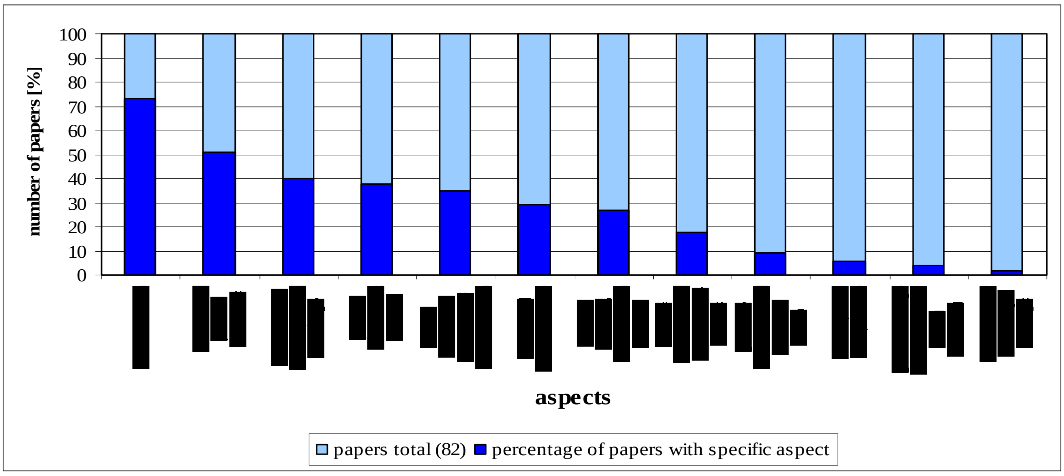

Figure 1: Most commonly-mentioned aspects for energy management (Streiff , 2007)

In three-quarters of all the reports and papers cost reduction is a major motivation for energy efficiency projects (see figure 2). This underlines the fact that it is cost saving is one of the most important priorities for management, whatever the business. Cost saving is a familiar priority for core business activities, but it is also becoming increasingly important for company facilities.

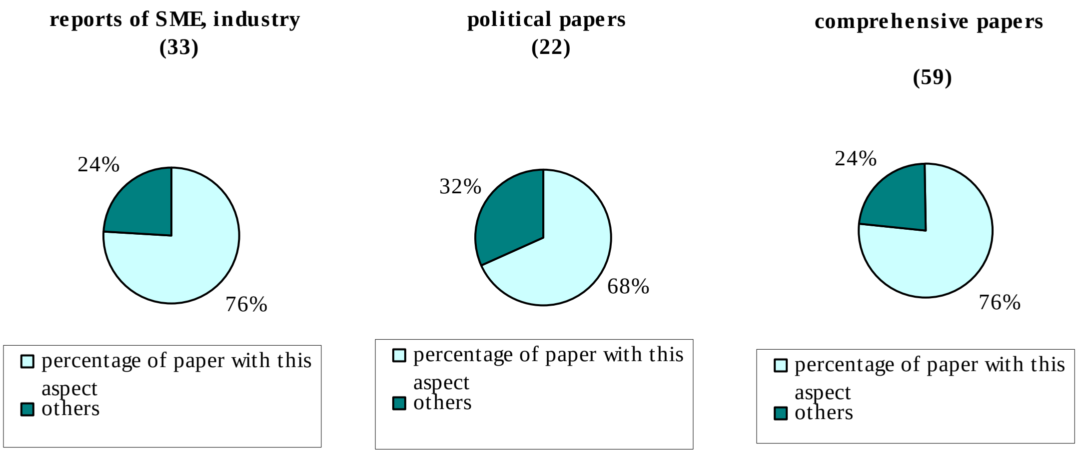

Figure 2: Mention of financial aspects (Streiff , 2007)

The second most important motivation for energy management is the existence of legal regulations or foreseeable political developments due to awareness of impending climate change (see Figure 3). In Switzerland, for example, different cantons have regulations in place for large-scale energy consumers that are forcing them to carry out an analysis of their energy consumption and to implement reasonable measures to reduce their energy use.

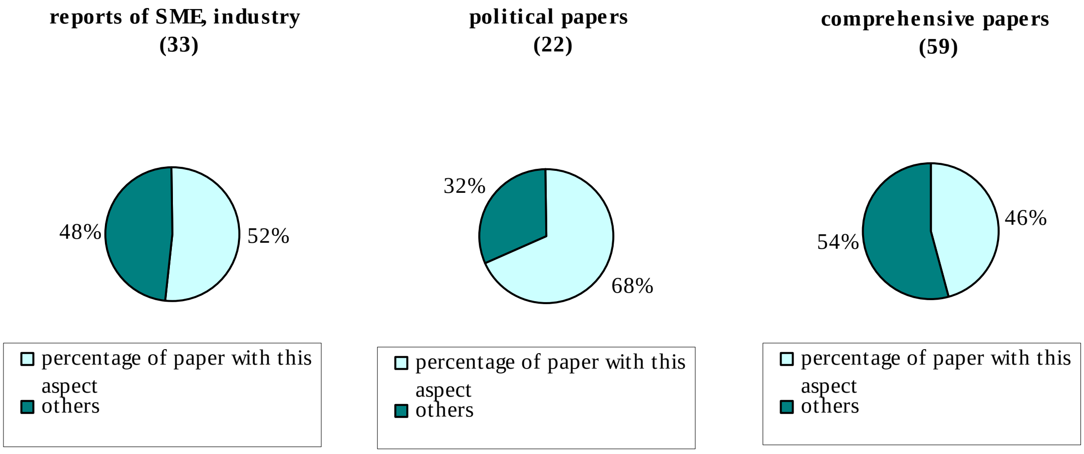

Figure 3: legal regulations as a motivation for energy management (Streiff , 2007)

Figure 4 shows a bundle of other motivations for companies to consider in the context of their energy management. Energy saving could lead to more favourable conditions for bank loans for investments in buildings. Another reason could be a reduction of dependence on energy imports.

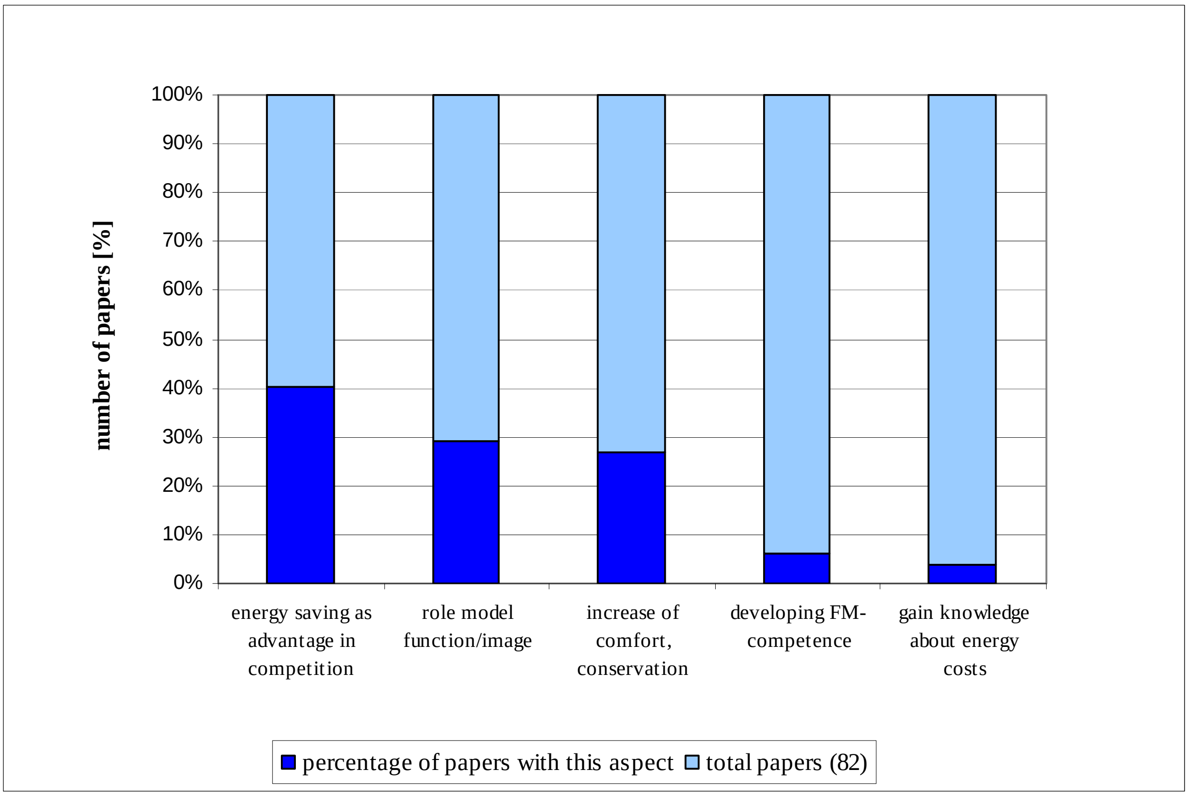

Figure 4: Entrepreneurial aspects as motivation (Streiff , 2007)

A company that acts as a role model and benefits from a good image because of sustainable energy use is usually considered modern and exemplary.

The development of FM competence in energy management is not a major aspect, which shows that facility management is still not very well known as a discipline.

METHODS AND MEASURES (STREIFF , 2007)

Before measures to increase energy efficiency can be taken, an analysis must be carried out in order to determine the areas to be addressed and the measures that are feasible under the current financial and structural conditions.

Such an analysis is proposed in most reports. It may comprise an analysis and evaluation of the existing documents on energy data, such as energy supply contracts, energy invoices and data regarding energy consumers. An inspection by an external consultant is also advisable.

The consultant has the role as a moderator. He examines the current state of recording and analysis of energy consumption data. Based on this evaluation he creates sets of figures and compares these over time to identify weak points and plan appropriate measures.

Common technical measures are waste heat utilisation, heat recovery, control adjustment, thermal insulation of buildings, replacement of old installations and use of renewable energy.

Beside these technical measures, it is equally important to carry out organisational measures. Energy management needs to be identified as part of facility management. This is usually not the case, especially if no facility management exists in a company. One person or department must be explicitly responsible for energy management and should have the necessary decision-making authority.

Nearly one-third (27%) of surveyed papers indicate that a mission or a goal to increase energy efficiency or energy saving should to be formulated. The goal will depend on the definition and the implementation of the project by a working group or management. This is a key part of the energy management strategy and will form the basis for decision on further measures. An energy saving vision should lead users in the company to become aware of their consumer behaviour and reduce consumption.

Quite often the users of a building are identified as a major impact on energy consumption. Users should therefore be involved in producing motivation and ideas, because energy saving measures, which require behavioural changes, must be broadly accepted. One good way of achieving improvements is a seminar for all employees.

Immediate measures are usually the most cost-effective ones. They are based on behavioural change and adapting equipment and the operating hours of installations. They are very obvious and feasible without major financial or staffing expenses.

The monitoring of measurements is the second major task. Controlling energy consumption and monitoring energy costs allows those responsible to determine the effectiveness of measures implemented and to propose necessary improvements. Costs and consumption controls should be noted at least once a year and monitored over a longer period.

OBSTACLES (STREIFF , 2007)

Although energy management is a very effective discipline there are still some obstacles to overcome. Figure 5 shows the most commonly-mentioned obstacles to energy management.

For many business the most frequent, and therefore the main obstacle appears to be the high cost of proposed measures. Even the initial analysis, which is usually the first step, may involve considerable expenditure. The estimated savings as a result of potentially efficient energy management are not high enough to overcome resistance to spending money. Lack of information about opportunities for better energy efficiency, together with a lack of knowledge on the part of the main persons involved, are key reasons why potential savings are not exploited. The fear of high costs is understandable, but unfortunate.

Often, an energy consultant would be necessary to fill in the gaps in knowledge. But as the costs of hiring an energy consultant are only one of the first components in a whole package of expensive measures, companies are reluctant to make this commitment.

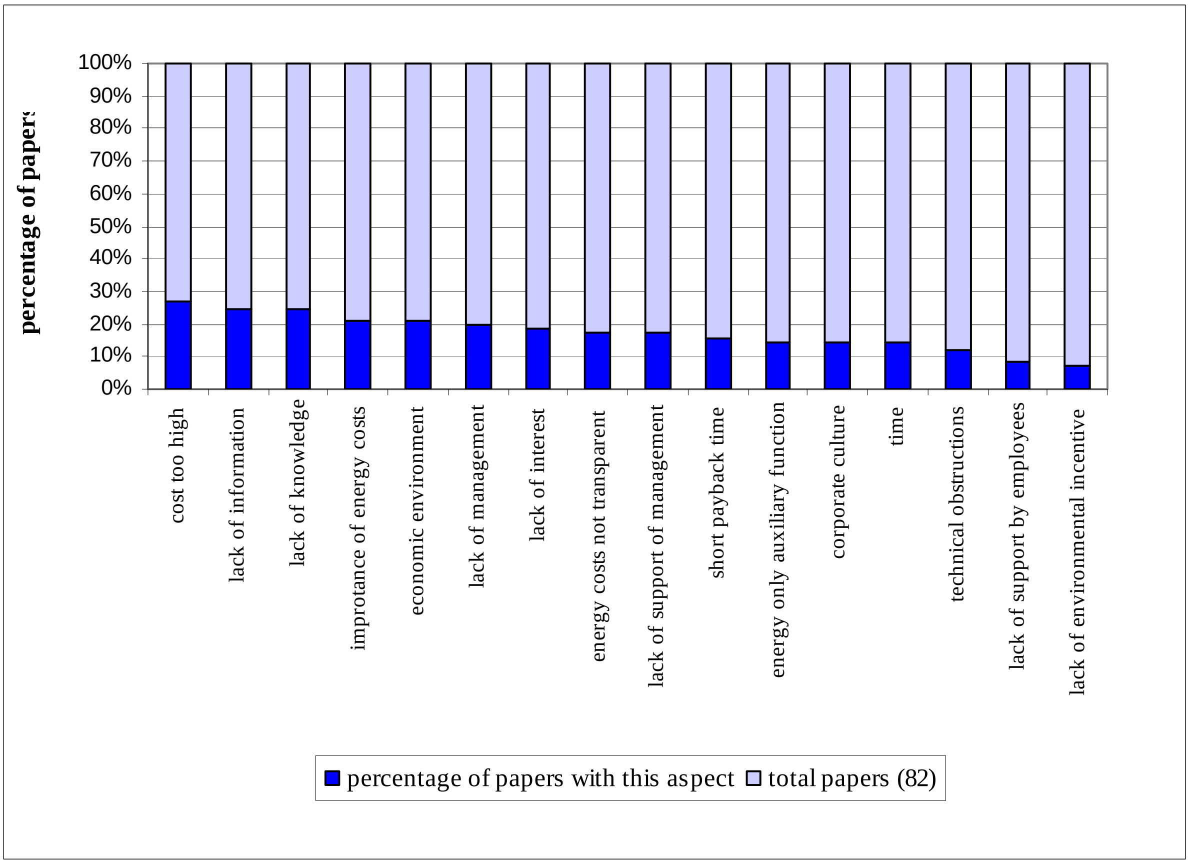

Figure 5: Most commonly-mentioned obstacles for energy management (Streiff , 2007)

Another explanation for the failure to implement energy management projects is the perceived lack of importance of energy consumption in daily business. Due to the fact that energy costs are low compared to total operating costs, there does not seem a need to take measures in this area: the cost-benefit comparison seems relatively unconvincing. Together with the main obstacle, the fear of high costs, this factor may ensure that energy management is hardly considered at all, and efforts to initiate a more detailed investigation will not be made.

The consequences of climate change will have no direct effect on a company's costs. This is why energy efficiency or energy management for companies is a purely economic consideration and the cost of investment in this sector must show either a financial effect or a substantial payback, or at least make a positive impact on the core business.

Massive price cuts for the purchase of electricity are not beneficial for energy-efficiency measures. Low energy prices provide little justification for investment, because the payback period is delayed.

Measures to increase energy efficiency can only be taken and implemented sustainably if management recognises and supports energy management. If directors have little or no interest in the subject, the result is a disincentive for such projects, because sometimes measures need to be enforced despite the doubts of employees and persons in managerial positions.

In many papers, staff's excessive energy demands are seen as a hindrance. On the other hand, insufficient or nonexistent energy management are not seen as an insurmountable obstacle, although there may well be areas in which energy management should definitely be applied. For example, the responsibility for lifecycle costs must be accepted and a lack of energy efficiency should be identified when real estate is to be constructed or altered.

Energy is often a vital need for industry and SMEs, but they see the provision of energy as more important than its efficiency. For this reason, and because of fears that savings could affect the quality of products and processes, projects to ensure more energy efficiency are not carried out. Energy management is often a secondary management function with low significance compared to other daily business concerns.

Experience (Streiff , 2007)

More than one third of the papers examined state that long-term benefits and savings can be expected as a result of active energy management.

There are also definite benefits to be gained from joint action. Exchange of experience in groups and a shared approach within newly forged networks can create positive experiences. Implementing energy management within a network is much faster and leads to more success. The formation of groups and even competition between them can encourage more energy efficiency.

Very often reliable benchmarks are missing due to the considerable diversity of companies, even within the same business.

For energy management and investments in improved energy efficiency to show a lasting effect, the involvement of users is necessary. This can be done in several ways. One is intensive information provision involving workshops and interviews, and another is the active participation of users in an energy management programme.

Facility management (Streiff , 2007)

Only a few papers refer specifically to a facility manager or facility management. Energy management is an additional function within facility management, and the person responsible is not usually described. But where facility management is mentioned, the benefits of the professionals involved in the company's management are clearly highlighted. This underscores the fact that facility management as a separate function has not yet been sufficiently established and is still inadequately positioned. The potential is there, but there is a lack of awareness that well-trained, competent professionals can carry out the work of facility management – and energy management as a vital part of their job – efficiently and to the economic advantage of the company.

Conclusions (Jäschke , 2007)

The demand for facility mangers that have the expertise necessary ability to make the right decisions in matters of energy management is definitely there. One important obstacle is that managers are not generally encouraged to be sensitive to environmental and energy concerns. In every case where their awareness has been raised and measures taken, energy management has been a success story.

Facility management is the discipline that can best be recommended to provide the energy management professionals required, but unfortunately facility managers are not prominent in the organizational structure of most companies. However, wherever a facility manager is given clear responsibility for energy saving, success generally follows.

While the cost savings awareness of executives and employees naturally operates in the traditional main business areas, the infrastructure of a company used by everyone (facilities, which make everything else possible) often goes almost completely unnoticed.

Broadly based training for facility managers in both technical and business knowledge and management must form the basis for a campaign designed to sensitise business to the need for energy management. The most efficient and effective influence will be generated when the facility manager is also in a position where facility-related expertise and the corresponding responsibility are 'bundled' in his position. Where strategic decisions with changes for the facilities are about to be taken, the facility manager must be in the team from the beginning.

If active energy management as a core competence of facility managers becomes a standard in companies, and is anchored in them through the necessary delegation of responsibility, this will open up energy-saving and cost-reduction potentials that are comparable with the results achieved by other company divisions.

Acknowledgement

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References

Petra Streiff (2007), "Energieeffizienz in KMU und der Industrie: Stellenwert, Management, Erfahrungen", unpublished

Jäschke, Stefan (2007), **"**Management von Energieeinsparpotenzialen – ein weiter Weg, Der FM als Energieeffizienz-Experte**"**, in Extra Energie und Automation in der Gebäudetechnik, AZ Fachverlage AG, Zeitschriften, 5001 Aarau, Heft 7, S. 122 – 124

CONSIDERING ALTERNATIVE ENERGY SYSTEMS IN THE FACILITY MANAGEMENT PROCESS

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ABSTRACT

EU Directive on Energy Performance of Buildings (EPBD) imposed obligatory feasibility studies of alternative energy systems (AES) for large buildings. Within EIE SENTRO project (http://www.sentro.eu/) an approach is developed to incorporate the introduction of feasibility studies and use of AES in the process of design of new buildings as well as renovation. The approach consists of a checklist to filter out most interesting AES at an early stage and of a handbook for a pre-design stage with a protocol to carry out feasibility studies. Technical, economic, environmental and organizational aspects are covered by the approach to assure that it is dealt with a complete package of barriers. The paper describes the background and tools. The application of the checklist for identification of appropriate AES is demonstrated on two case studies of building renovation planning. The benefits of the implementation of AES are shown by the Dutch residential buildings refurbishment case study.

KEYWORDS: alternative energy systems, feasibility studies

INTRODUCTION

Since January 4, 2006, all EU-countries are legally bound through the article 5 of Energy Performance of Buildings Directive (2002/91/EC) (EPBD) to include the requirements for feasibility studies of alternative energy systems (AES) within their national legislation. From an inventory carried out in March 2007 as part of the EIE SENTRO project (http://www.sentro.eu/) it appears that the associated feasibility studies will be implemented in very divergent ways in EU countries.

In order to support the EPBD transposition process, SENTRO project developed a protocol and tools for the implementation of feasibility studies of AES. The aim of the tools is to facilitate the AES evaluation process at an early design stage and to encourage the actual implementation of AES. Technical, economic, environmental and organizational aspects are covered by the approach to assure that it is dealt with a complete package of pros and cons for the particular AES in a specific building context.

Although the EU requirement itself covers new buildings with a total useful floor area over 1000 m^2, its implementation in the national regulation may extend the requirement also to renovation of existing buildings. Moreover, the checklist and handbook developed for facilitating the implementation of AES can be used to support the sustainable decision making in facility management process. AES like decentralized energy supply with solar thermal systems or photovoltaics, biomass energy systems, CHP at the building level, district or block heating and cooling, heat pumps, including geothermal energy systems, may, when technically feasible, significantly improve the economical and environmental performance of a facility.

The paper describes the status of protocols for investigation of AES feasibility in EU countries' legislation as well as in their building practice. Further on, a new approach for incorporation of feasibility studies of AES in design of new buildings and renovation is presented. The approach consists of a checklist to filter out most interesting AES at an early stage. The use of the checklist is illustrated by two case studies from the Netherlands and Slovenia, where the recommended AES are pointed out by ranking. To demonstrate the importance of aftercare and monitoring on the actual impacts of the implementation another case study on the Dutch residential buildings refurbishment is added.

STATUS IN EU-27

The inventory in EU-27 and Norway carried out in March 2007 as part of the EIE SENTRO project (Sijanec Zavrl, 2007) showed that the transposition of requirements for obligatory feasibility studies of AES (article 5 of EPBD) was completed on the legal level in 50% of countries, while only 35% of countries declared to have the secondary regulation ready for use. The most common barrier preventing the reliable comparison of AES with conventional solutions is the lack of professional tools for investigation of technical, economic, and environmental and organizational feasibility.

The analysis showed that the sooner in the building design process the feasibility study is done, the better the chances are for proving the feasibility of alternative energy systems. A building permit represents a milestone in the building design process. The investigation of envisaged solutions about positioning of feasibility study in the process of building design before the application for building permit showed, that 17 countries linked or planned to link the feasibility study to a building design needed for acquisition of the building permit. 4 countries do not connect feasibility studies with the building permit. In 7 of EU-27 and Norway countries the relation between a feasibility study and a building permit has not been defined yet.

The article 5 of EPBD, however, does not bring a clear definition of either a feasibility study or alternative energy systems and it also does not imply any requirements about actual implementation of an alternative energy system. A feasibility study can be standardized in order to reduce the administrative burden for a designer, to bring clear and understandable results for the client, and to facilitate the control of compliance with regulation. The inventory evaluated to what degree the content of feasibility studies of alternative energy systems is standardized on the national level. 20 countries have clearly indicated that they do not plan to standardize the content of a feasibility study. The other 8 countries intend to do so or they already have the tools that implicitly standardize the structure and content of the study. In spite of clearly indicated lack of tools for feasibility studies the progress protocols development and software support seems slow for the time being. In Ireland a comprehensive tool PASSES is in preparation, in Slovenia a VEM tool for feasibility studies of biomass systems vs. district heating systems, heat pumps and other common energy systems has been developed, in other countries, like the Netherlands and Austria detailed separate tools are available, covering different AES technologies and targets (technical, environmental, economical), respectively (Joosen et. al, 2007).

Moreover, the investigation of design processes in EU countries showed a clear need for a pre-evaluation checklist enabling the selection of AES for a detailed feasibility study in more detailed stages of design.

The final decision about actual implementation of AES in a building is left to investors and designers. Several general bottlenecks for implementation of AES are already known, like higher investment costs, lack of technical knowledge and confidence in new applications, insufficient knowledge about environmentally orientated subsidies and financing opportunities, lack of interest for life-cycle thinking, and lack of tools providing clear decision-making criteria.

The aim of SENTRO project was to develop an "optimal" approach in order to effectively incorporate the feasibility studies of alternative energy systems (art. 5 EPBD) in the common building practice and thus to support optimisation of the facility management process.

METHOD

Outline of feasibility study

The proposed method of a possible implementation of AES feasibility studies consists of a checklist for a brief pre-feasibility study and of a method for a more detailed feasibility study for the chosen AES. The aim of the checklist is to select at least two promising alternative energy systems for further investigations. This is done early in the building process (in the planning stage). Thereafter, a more detailed feasibility study will be performed for at least two chosen AES. A detailed feasibility is performed in the program stage of the building process.

Since the article 5 of EPBD requires an evaluation of a technical, environmental and economic feasibility of AES, the main feasibility study has been developed from these aspects. Besides these aspects also organisational aspects need to be considered and so in the suggested method the feasibility study is divided into four parts: technical, economical, organisational and environmental. First a technical evaluation is performed to see if it is possible to technically install the energy system. Here the right size of the alternative energy system is decided for and thereby space, construction and installation requirements. The energy system's performance parameters are used in order to calculate the expected yearly energy use in the building's operation phase. The results from the technical evaluation are used in order to make an economical and environmental evaluation. In the economical evaluation different scenarios of the development of energy prices and interests are calculated. The environmental evaluation is made for different mixes of electricity sources and for different scenarios of future energy sources, for example in a district heating system. The feasibility study also consists of an organisational evaluation of experts' knowledge both during the performance of the feasibility study (design team) as well as in the operation of alternative energy systems (employees or users). All the results from the economical, organisational and environmental evaluation are thereafter summarized in one common score.

Checklist for brief feasibility study

The objective of the SENTRO pre-evaluation checklist (Wahlström, 2007), intended for use early in the building process, is to make a fast identification of promising AES for further investigations. By using the checklist it should be possible to choose one alternative energy system for further investigations together with the conventional system or another alternative energy system. It is recommended that at least two promising energy systems are chosen for further investigations.

For each alternative energy system four evaluation parameters are considered. Each evaluation parameter is weighted with weighting parameters, which are set on the first page in the Excel spread sheet tool (Figure 1), default weighting value is 0.3 for technical, 0.2 for financial, 0.1 for organisational and 0.4 for environmental aspect, as the most important one. Once the weighting parameter is set, the same weighting will be used for all alternative energy systems. If the weighting parameters are set to 0.25 for all parameters it means that they all are equally important. The evaluation parameters are in their turn weighted between numbers of aspects that are relevant to consider in order to tackle the barriers for each specific alternative energy solution. Each aspect is evaluated with scores from 1 to 3; 1 means that it needs a high effort to realise success while 3 means that it only need a low effort.

SENTRO WP4 - CHECKLIST FOR FEASIBILITY STUDIES

		Score Technical parameters	Score Financial parameters	Score Organisational parameters	Score Environmental parameters	Probability for sucess in comparison of efforts
	Weighting to fill in, (0 - 1)	0,3	0,2	0,1	0,4	
	Decentralised energy supply					
A1	Solar thermal systems (hot water and/or heating)	56%	50%	83%	67%	62%
A2	Solar electricity systems (photovoltaics, PV)	100%	60%	75%	67%	76%
A3	Biomass energy systems (hot water and/or heating)	67%	78%	40%	50%	60%
	CHP and District or block heating or cooling					
A4	CHP (micro) at building level	89%	78%	50%	100%	87%
A5/A6	District or block heating	50%	44%	33%	33%	41%
A7	District or block cooling	33%	33%	33%	33%	33%
	Heat pumps					
A10	Geothermal energy systems (heat pumps for heating and/or cooling)	72%	67%	67%	100%	82%
A11	Heat pumps other than geothermal	0%	33%	75%	100%	0%

Figure 1. A summary page of the checklist with predefined weighting of technical, financial, organisational and environmental parameters (Walström, 2007); results refer to a pre-selection of AES in case of a checklist field trial in Kamnik schools, Slovenia.

The scores are based on rules of thumb. It may be necessary to change some of the parameters in order to adapt to local conditions. It is meant that the design team should only need to use one or two hours of discussion by filling the checklist in and thus get a relatively good overview of AES for further investigation in a detailed feasibility study (Figure 2). Therefore the design team should only set the scores based on previous experiences and no background investigations or calculations should be needed. In the worst case this may lead to constant abandoning of some systems, which the design team has a previous bad experience with. On the other hand, it is only compulsory to do the feasibility study, and not to actually use the suggested alternative energy system. In order to get real actions it might be more successful to concentrate on systems that the design team feels comfortable with.

Each evaluation parameter is followed by a number of aspects that should be assessed with scores from 1 to 3. For technical aspects the lowest score should describe the most difficult to realize the aspect. If it is impossible to realise a technical aspect the whole alternative system solution fails and further assessments should be done for other systems. In the same way technical aspects that will not cause any problem in implementation are not considered. The following example illustrates the criteria for evaluation of one of financial aspects, i.e. availability of subsidy schemes for PV systems: low effort demand to realise AES successfully, evaluated with 3 points, is chosen when subsidy of over 60% of investment is available; medium effort demand and corresponding 2 points are chosen if subsidy of over 30% is easy to get; while high effort demand to realize PV system and corresponding 1 point are selected when minor or no subsidy is available.

In the summary sheet (Figure 1) the scores for different aspects are presented, so that the design team can choose one or two AES that have high scores (preferably above 75%) and thereby promising qualities. Note that some of the systems are independent of each other and may therefore need separate assessments. For example, it is possible to use a solar thermal system together with district cooling.

A3	Biomass energy systems (hot water and/or heating)	Low effort demand to realise sucess = 3 points	Medium effort demand to realise sucess = 2 points	High effort demand to realise sucess = 1 point	SCORE to fill in, 1 to 3	SUBScore (%)
Technical parameters	sufficient space for fuel storage	available room for storage that are protected towards moisture	possible ta arrange for a two week storage that are protected towards moisture	no space for storage	1	
	accessibility of fuel storage	easy to access with a truck that can load fuel directly in the automatic feeder	need for manual move from truck to storage or from storage to the automatic feeder	difficult to access, need several manual loadings	3	
	efficiency (availability of technology on the market, with an good design)	yearly mean efficiencies over 75%	yearly mean efficiencies over 65%	yearly mean efficiencies less than 65%	3	
	fuel logistic system	fuel supply system available and well functionally	fuel supply system available	no fuel supply system in the neighbourhood	1	67%

Figure 2. Fragment of a checklist showing evaluation of biomass technical parameters by rules of thumb in a 1 to 3 points system (results for Kamnik field trial), (Walström, 2007).

CASE STUDIES

AES checklist field trial in multifunctional building in Breda

The municipality Breda, the Netherlands, is developing a multifunctional building with a gross floor area of 4316 m^2 in a residential area. The building encloses: two schools: Laurentius and Dr. Visser, a day care-centre: Kobergroep, and a sport facility. In 2007 the building process was in the pre-design phase, it is planned that the building will be finished in 2010. The municipality of Breda is also the owner of the building. The users of the schools and day care centre will pay for the energy costs; other third parties will rent the sport accommodation in the evening (rent includes energy costs). Municipality of Breda is active in the field of sustainable building and participates in the field trial of the SENTRO project.

Within the field trial three meetings are arranged. The aim is to have a serious consideration of AES at the beginning of the building process, ultimately towards decisions upon AES. During the first meeting as much as possible information is collected to make a first shift towards performable energy systems. In the second meeting the checklist developed within the SENTRO project is tested and evaluated. The selection of AES is further tuned towards three favourable options. During the field trial in Breda it turned out that a heat pump in combination with heat and cold storage, solar thermal systems and wood fired boiler are the most interesting AES options. The requirements for a detailed feasibility study of these favourable AES, including solution paths for possible financial and organisational obstacles will be discussed during the third meeting. Furthermore in the last meeting appointments for the upcoming period will be made. The selection scheme, including the results for the multifunctional building in Breda, is presented in Figure 3.

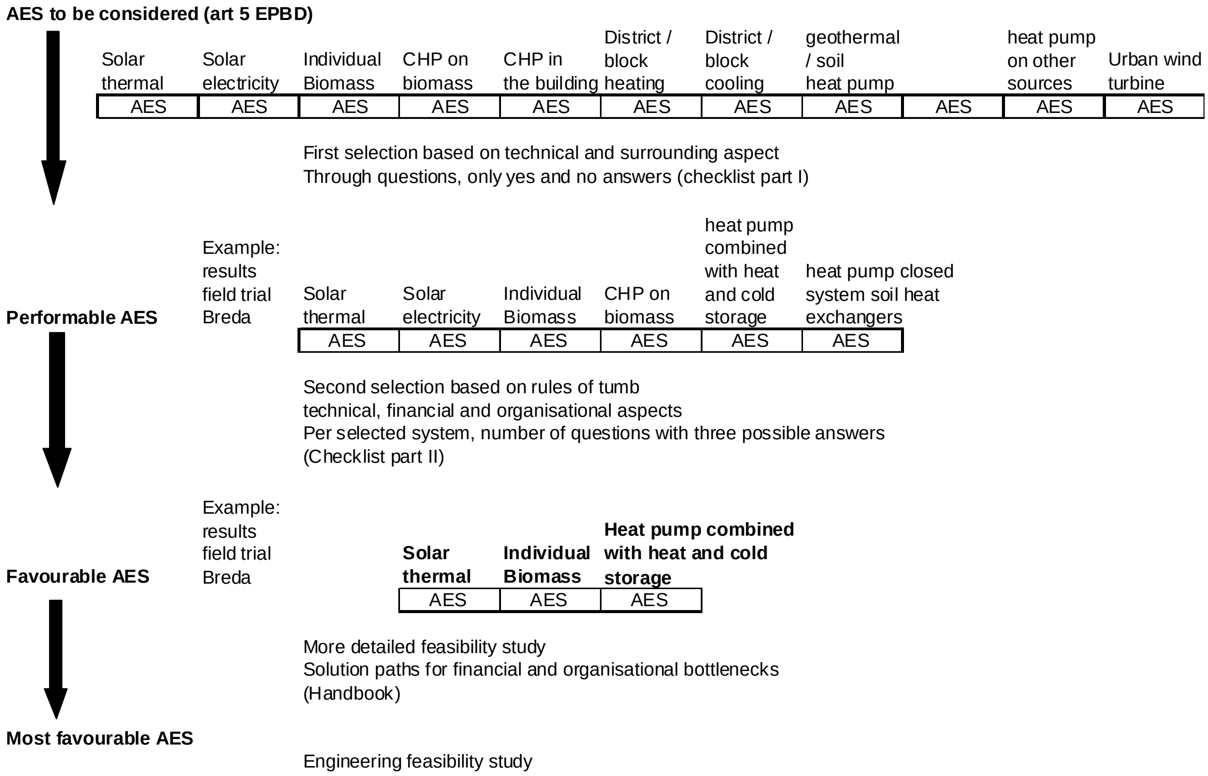

Figure 3. AES selection scheme in multifunctional building in Breda, The Netherlands.

The field trial demonstrated the score of 75% in case of geothermal heat pumps (closed and open systems), 72% for wood biomass boiler, 58% for solar thermal systems (hot water and/or heating), 49% for PV system and 42% for biomass combined heat production (CHP). Other AES like geothermal energy systems district or block heating and/or cooling and micro CHP at building level were found to have negligible potential for success.

AES checklist field trial in rebuilding of schools complex in Kamnik

The municipality of Kamnik, Slovenia, is planning a rebuilding of a school area, with two old existing elementary schools. The municipality is highly interested in sustainable solution since it is in a role of investor, and owner and it is also paying the operational and maintenance costs. As part of the planning stage a call for architectural competition for 9.616 m^2 of new and/or partly rebuilt school area was prepared. As the terms for evaluation of architectural solutions should consider also the economy of the proposed design in a whole life-cycle and environmental acceptability of the renovated schools the checklist was used to pre-select the AES with considerable prospects for realisation. The results are presented in Figures 1 and 2. They indicate the micro CHP and the heat pumps using geothermal energy the most promising systems and therefore worth of utmost consideration in further elaboration in design proposals.

AES in renovation of Prinsenflats in Rijswijk

The next case study illustrates the implementation and monitoring phase of AES project. Although the design tools indicate expected savings in energy use, costs and emissions, the reality may be different due to hidden technical problems. The case study shows the importance of monitoring of relative innovative AES to reach proper functioning and the calculated energy savings.

The housing-association Vidomes has an ambition to significantly reduce the annual energy-use of the Prinsenflats in Rijswijk through renovation. AES were considered in 5 high-rise buildings containing 506 apartments in total. A feasibility study showed annual savings of 55% within a payback time of 15 years. A European approach called SynPack was carried out. This approach aims at comparison of various packages of measures, which reinforce each other. Measures refer to maintenance, energy savings and/or use of renewable energy. The following five synergy measures were concerned at the renovation of the Prinsenflats: 1 - simultaneous improvement of the district area and renovation of the residential buildings, 2 - simultaneous improvement of the appearance and the energy efficiency of the residential buildings, 3 - replacement of individual open gas heaters by a collective heat pump boiler for hot water with ventilation air as a source, 4 - improved insulation, to make a lower supply temperature possible (as a consequence - improved use of condensing heat from exhausting air of the collective space heating boiler), 5 - tuned insulation measures and the existing construction possibilities.

The impact of the last three measures on the energy savings in practice has been closely monitored in one high-rise dwelling, called Johan-Friso, during one year (van de Bree, 2004). It turned out that the energy saving measures in the first year after the renovation led to a reduction of 51% of the primary energy consumption. Insulation measures are responsible for the majority of this reduction. The non-transparent parts have been upgraded to an average heat resistance of 3.0 m^2K/W. Transparent parts were provided with so-called highly efficient insulating glass (with a U-value of 1.2 W/m^2K). The ventilation has been secured by installing new registers in the window frames. The existing construction and the possibilities it offers were taken into consideration in designing the insulation, so that the insulation was optimised in a simple way.

Table 1. Impact of renovation of Prinsenflats with AES (van de Bree, 2004)

Impact	Energy consumption				Emission		Financial (index 2004)	
Indicator	Natural gas (m^3/a)	Electricity (kWh/a)	Primary energy (GJ/a)	%	CO_2 (ton/a)	%	Cost (Euro/a)	%
Before renovation	1.168.443	345.773	44.263	100	2.271	100	569.166	100
After renovation	511.112	407.850	21.730	49	1.142	50	292.722	51

The operating time and as a consequence the contribution of the heat-pump concept to the domestic hot water supply appeared to be below expectations. Besides a number of technical but solvable defects (in the first half year) the main reason was the supply-temperature of domestic hot water, which has been set at 65°C to prevent Legionella disease. This means that the heat-pump can only make a modest contribution (from 12°C to a maximum of 45°C), and auxiliary gas-fuelled boilers supply the rest. In spite of these problems 20-30% of the primary energy is saved compared to a less innovative concept, which offers an equal level of comfort. It appears that maintenance and control of functioning of an innovative system is essential to guarantee that the calculated energy savings are met or at least are as optimal as possible. A comparison of the annual energy-use as well as annual energy costs of the Prinsenflats before and after the renovation is presented in Table 1, based on an extrapolation of the monitored Johan-Friso building results.

CONCLUSION

The communication within a design team based on reliable facts is very important in the building process to achieve the set goals in time with a high quality building as a result. The proposed method for the implementation of feasibility studies of AES has been recognized based on a field trial in 7 EU countries as a very helpful tool for long-term planning of sustainable building and thus a promising support tool in facility management.

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REFERENCES

Joosen, S., Hansen, K. and Sijanec Zavrl, M. (2007), “Feasibility studies for alternative energy systems in large new buildings: state of the art, possible barriers and how to overcome them?”, in Attali, S. and Kenya Tillerson, K. (Eds.), eceee 2007 Summer Study, Saving energy – just do it!, 4 – 9 June, 2007, La Colle sur Loup, France, Conference proceedings, ABA Intercopy, ISBN 978-91-633-0899-4, pp. 903-909

Sijanec Zavrl, M. (2007), “Inventory of implementation of feasibility studies from EPBD Art. 5 in EU-27 (status 3/2007), SENTRO 1/2007/WP2, September, 2007”, available at: http://www.sentro.eu/

van de Bree, A. G. (2004), Monitoring residential building Johan-Friso Rijswijk, June 2004, assignment of Christelijke Woonstichting Vidomes, with financial support of the European Commission

Wahlström, Å. (2007), “Handbook for performing feasibility studies of alternative energy systems, SENTRO 3/2007/WP4, December, 2007”, available at: http://www.sentro.eu/

EXTREME WEATHER EVENTS AND BUSINESS CONTINUITY PLANNING

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ABSTRACT

There is now a broad scientific consensus that the global climate is changing in ways that are likely to have a profound impact on human society and the natural environment over the coming decades. The challenge for Facilities Mangers is to ensure that business continuity plans acknowledge the potential for such events and have contingencies in place to ensure that their organisation can recover from an extreme weather event in a timely fashion. This paper will review current literature/theories pertinent to extreme weather events and business continuity planning; will consider issues of risk; identify the key drivers that need to be considered by Facilities Managers in preparing contingency/disaster recover plans; and identify gaps in knowledge (understanding and toolkits) that need to be addressed. The paper will also briefly outline a 3 year research project underway in the UK to address the issues.

KEYWORDS: climate change; extreme weather events; business continuity planning; disaster recovery planning.

INTRODUCTION

A changing climate is one business driver that organisations have to consider as part of their strategic business planning. In developing business plans that address the market barriers; competitive advantage; and business opportunities that climate change may bring, they have to examine the impact that future weather events may have on their ability to deliver business outputs to key customers. Disruption to production (both physical and knowledge based) and distribution networks (physical infrastructure and communication networks), and the ability of organisations to cope with them has forced Facilities Managers (FMs) to examine their current approaches to business continuity planning (contingency planning and disaster recovery) in the light of the challenges that a changing climate may present. This paper will review these challenges and consider whether current approaches to contingency/disaster recovery planning provide a sound base for strategic facilities management decision making.

CLIMATE CHANGE - EXTREME WEATHER EVENTS

There is now a broad scientific consensus that the global climate is changing in ways that over the coming decades are likely to have a profound impact on human society and the natural environment. In the UK there is evidence that extreme weather events (EWEs) are increasing in frequency and severity (Ekstrom et al, 2005) with, over the last decade, the UK seeing significant increases in heavy rainfall (Fowler, 2003) resulting in both localised urban flooding and more widespread fluvial flooding. Indeed, in 2000 flood events resulted in £500M worth of insurance claims in the UK (RMS, 2000), and in 2004 managing flooding cost the UK £2.2 billion (OST, 2004). In addition to flooding the incidence of heat waves

(Good et al, 2006) and water resource drought (Blenkinsop & Fowler, 2008) are also projected to increase, particularly in the south of the UK, as climate models predict wetter winters and drier summers (Hulme et al, 2002) together with increases in temperature and thus evaporative losses throughout the year. Finally, strong storms in Europe have induced, during the last decades, severe human losses and extensive damage to properties. The great storm of October 15, 1987 caused €5M damage and killed 34 people in the UK and France. The Lothar and Martin storms in December 1999 caused €13.5M damage in Europe, killing 125 people (wikipedia, 2008). All of these provide challenges to FMs as they seek to quantify the risks and develop contingency/disaster recover plans to prepare for them.

VULNERABILITY, RESILIENCE AND ADAPTIVE CAPACITY

Vulnerability, resilience and adaptive capacity are concepts from the biophysical and social realms that are increasingly being applied to the understanding of the complex relationships between community's, the built environment, and the drivers that may affect change. Whilst there is considerable debate over the precise definitions of the terminology (Gallopin, 2006), in the context of this paper: vulnerability will be considered as the risk of a system to perturbations by external forces or hazards (EWEs) that are beyond the normal range of variability under which the system operates; resilience, as the ability of the system to cope with such forces or hazards and return to its normal operating status once the perturbations have been removed; and adaptive capacity, as the ability for a system to change to meet the new conditions bought about by perturbations that fundamentally change the system. This paper will consider these drivers in the context of business contingency/disaster recover planning.

EWEs - VULNERABILITY, RESILIENCE AND ADAPTIVE CAPACITY

Assessing the impact of EWEs on vulnerability, resilience and adaptive capacity at the national, regional and sectoral level has identified a range of contextual (e.g. physical, economic, climate scenarios etc) environments that are likely to exist in the future and has highlighted the weaknesses in existing knowledge sets and the decision-making processes required to ensure 'operation as normal'. Whilst a community's resilience to EWEs, is known to be largely determined by the strategic decisions taken before, during and after an event, many of the policies, guidance, codes and regulations, currently in place in the UK tend to be complex and difficult to apply consistently (Spence, 2004) and as such many individuals and businesses are unsure of where responsibilities lie (following an EWE) and where assistance (to recover) can be obtained (Crichton, 2006).

Assessing the impacts of EWEs at a local level is less well developed. Whilst it is generally accepted that a community's resilience and adaptive capacity is a complex association of behavioural characteristics between: households; businesses (particularly small and medium sized enterprises - SMEs); and local decision makers (politicians), the precise nature of these relationships is less well understood (Smit & Wandel, 2006). What is generally agreed is the need for each community to identify its own determinants of vulnerability and adaptive capacity rather than rely on generic assessments and 'preferred solutions' and to understand the sensitivities of these determinants to the wider political, social, economic and technological forces (Smit & Wandel, 2006).

The specific dynamics underpinning the ability of business organisations to adapt to climate change have been studied by Berkhout et al (2004). In essence Berkhout et al argued that organisations respond to signals about the impacts (actual or perceived) that an activity (EWEs) may have on their operations in the context of their own, and their competitors performance (vulnerability). If a threat/opportunity is perceived they apply existing solutions to address any impacts and, if successful, they continue as normal (resilience). Only if their interventions are unsuccessful do they invest effort to find 'new' solutions to the problems and seek evidence to measure their success (through feedback) (adaptive capacity). Based on this theory Berkhout et al developed a 4 stage decision-making framework based around:

- risk and opportunity analysis;
- strategy setting;
- implementation; and
- integration.

However, when evaluating the model against climate change scenarios Berkhout et al found that:

- organisation's found it difficult to recognise and interpret climate change stimuli;
- because of the weaknesses and ambiguities in climate change stimuli trial and error experimentation with existing operating procedures were unlikely to yield satisfactory results;
- organisation's found it difficult to assess the advantages and disadvantages of alternate adaptation strategies; and
- organisation's found it difficult to directly measure feedback on the impact that the adaptation has had on organisational value.

Similar findings to the above have been identified by other authors who found that: a lack of forward planning; lack of capital for recovery; ineffectual interactions with national agencies; infra-structure problems (Runyan, 2006); individual attitudes and organisational culture (Petts, 1998); access to expertise; and perceived exposure to risk (Yoshida & Deyle (2005) all contribute to a general inertia amongst organisations to consider continuity planning for EWEs and this must raise questions as to whether current approaches to business contingency/disaster recovery planning can really deliver increased resilience and enhanced adaptive capacity in response to vulnerabilities induced by climate change.

CONTINGENCY PLANNING FOR EXTREME EVENTS - SMEs

Probably the most significant study of SMEs reactions to EWEs was presented by Crichton (2006). Crichton found that whilst SMEs are considered the backbone of the UK economy, in terms of diversity, innovation and social cohesion, they are also the most vulnerable section of the UK economy to climate change impacts. Drawing on evidence from insurance claims, backed up by telephone interviews, Crichton found that (as a consequence of EWEs):

- the average cost of business disruption had risen by 60% between 2001 and 2005 to an average of £35,000 per claim and was set to rise at an even steeper rate in the years to come;
- the average interruption period had risen from 8 months in 1996 to 14 months in 2005;
- 70% of those SMEs currently in high flood risk areas were unconcerned of the potential impacts on there business, with 69% of SMEs having no form of business continuity plan in place;

- 90% of SMEs were under insured (when measured against insurance industry expectations) with less than 33% having business interruption cover to pay wages whilst the business is out of operation.

Conversely Crichton found that, whilst 75% of SMEs did not connect climate change with a threat to their business, many were beginning to take actions to address specific threats posed by EWEs. Fifty one percent were reviewing their insurance cover; 50% were encouraging home or flexible working; 43% were reviewing weather related risks; 32% were seeking advice from government bodies; and 25% were considering relocation. However, what was unclear from Crichton's work was whether these actions were ad-hoc responses to single stimuli (e.g. reactions to situations that had occurred, or had occurred to close competitors) or a general reaction to the wider climate change debate. Given the small number of SMEs with formal business continuity plans, the former is probably more likely than the latter, and indicative of a reactive rather than proactive approach to the issues. Whilst such a position might be understandable, it is unlikely that it will provide the basis for improved resilience or the enhancement of adaptive capacity in the short to medium term.

COPING WITH EWEs – THE CHALLENGE TO ORGANISATIONS

Business continuity planning in the face of extreme events is not a new phenomenon. Indeed business contingency planning and the development of specific disaster recovery plans forms part of the day to day work of those with strategic responsibility for an organisation's support facilities. The process of developing a plan normally involves (Savage, 2002):

- the development of business risk and impact models;
- documenting activities prior to an event;
- identifying activities for the disaster recovery phase;
- identifying activities for the business recovery phase;
- testing and auditing the business recovery phase;
- training of staff;
- updating the plan.

However, whilst most of the above address disruptions caused to an organisation or its physical assets by a single focussed event (e.g. power loss, fire etc), they do not generally consider the implications of wide scale disruption to service. Such a situation not only causes problems for individual organisations but also for the supply chain on which they may rely on for their day-to-day operations and/or recovery following an event. Indeed it is these types of events (e.g. fluvial and localised flooding; prolonged periods of extremely hot weather; severe storms and tornadoes etc) that EWEs are likely to produce (in the UK). This must raise the question as to whether plans developed to cope with localised disruption to business can prepare an organisation for the more wide scale disruption associated with EWEs.

Assessing Organisational Vulnerabilities To EWEs

In essence an organisation's vulnerability to EWEs is the risk that it will fail to recover from the event. However, very little information exists to support the risk assessment process. Measuring the exposure of an organisation to an EWE requires not only an idea of what type of events may occur in the future (which we have got in part through the work of the IPCC and UKCIP) but the likely severity of the event(s) and the probability that it/they will occur.

At present this information is unavailable in the UK (although it should form part of the UKCIP 2008 Climate Change Scenarios).

Given that an assessment of the likelihood of an EWE can be made, an organisation then has to assess the potential impact of an event on their market. In making this assessment an organisation will need to consider the extent to which:

- regular customers may be affected by the same EWE;
  - will they be affected for longer or less time than your organisation?
  - is your organisation part of their recovery process?
  - if they loose their market how will it affect your organisation?
- those not affected by the EWE will switch to alternative suppliers
  - how long does your organisation have before a customer switches?
  - if customers do switch how easy will it be to win them back?
- an EWE that does not have a direct physical effect on your organisation (e.g. major flooding has occurred but your organisations premises are not directly affected) may cause disruption to your supply/distribution chains.
  - do your critical suppliers have robust plans in place for their recovery?
  - does your organisations have alternate suppliers?
  - how robust is your distribution network (physical and digital)?

In addition to the general market drivers outlined above, an organisation will also need to assess the potential vulnerability of its physical and humans assets. Whilst many of the physical issues are well known (e.g. structural damage to buildings; operational damage to building sub-systems; damage to fixtures and fittings etc) from other disruptive events (e.g. fire) others are less clear. Again, the problem is one of scope. An EWE is likely to affect a large geographical area and as such many organisations will be in a similar position (i.e. seeking to get back to full operation as quickly as possible) and the supply chain on which everyone relies may well be over stretched (or indeed trying to recover from the event itself). As such, even when the immediate problems associated with the EWE have passed, an organisation may find itself waiting in line for the services it requires to get back to full operation. With regards to an organisation's human assets: disruption to local infra-structure, both physical (e.g. transport) and social (e.g. schools) may pose problems for employees attending their place of work; whilst exposure to prolonged heat stress (in particular lack of sleep) may have a general impact on employee productivity and cause unacceptable levels of mistakes amongst knowledge workers.

Assessing/Enhancing Organisational Resilience

An organisation's resilience is its ability to continue working during, and recover following, an EWE. As discussed earlier resilience is very specific to the particular circumstances (both physical and business) that an organisation faces and as such making generalisations about the factors that affect it is difficult. However, in assessing resilience an organisation may need to consider: the strength of relationships with key customers and suppliers, and particularly the procedures in place to manage expectations during the period of disruption; alternative working practices and the infra-structure that may be needed to support them; critical points in the supply and distribution chains and the extent to which these can be mitigated by redundancy (in suppliers and systems); the contingency plans of key suppliers and distribution systems, particularly digital networks outside the organisation's direct control; and the timescale for recover, including quick access to those organisation's critical to this process.

Building Adaptive Capacity (Climate Proofing)

In its broadest sense adaptive capacity is the ability of a system to respond to changed circumstances: in the context of an organisation it is the ability to change its existing practices to meet the challenges/opportunities posed by climate change. In assessing adaptive capacity (in the context of EWEs) an organisation needs to consider what actions it can take prior to an event (in addition to assessing vulnerability and resilience) to ensure that it can continue to operate through the event and take advantage of market opportunities following the event. In particular organisations need to examine the trade-offs between: protection of their physical assets against increased construction/maintenance costs; redundancy in systems (e.g. off-site storage of data, multiple office locations etc) against increased operating costs; the purchase of mitigation measures (e.g. sand bags, portable air conditioning units etc) against the storage costs; the relocation of key building systems and services in existing buildings (e.g. power distribution moved above flood level) and refurbishment with resilient fixtures and fittings against relocation out of an affected area; and devolved rather than centralised working spaces. These pose new challenges to FMs.

THE CHALLENGE TO FACILITIES MANAGERS

Integrating climate change scenarios, and particularly EWEs, into contingency/disaster recovery planning is a new challenge facing many FMs. Whilst some larger organisations have begun to develop integrated business continuity plans many SMEs fail to see the importance of these to their organisation. They are generally unconvinced about the whole area of business continuity planning; see no compelling reason, or return on investment incentives, to engage in business continuity planning; believe that 'an event won't happen to them'; and are unprepared to admit vulnerabilities that a competitor may seize on (Wilson, 2007). However, against this background the UK Government (BCI, 2007) and insurance industry are trying to raise awareness of EWEs and have developed a range of toolkits and business guides (AXA, 2007a; AXA 2007b) to help SMEs develop business continuity plans. However, whilst these guides provide general advice on what is needed, they do not explain how to assess the specific risks to an organisation of climate change and EWEs. This is left ostensibly to the senior management within the SME organisation. In general such people are too busy dealing with the day-to-day problems associated with running the business to find the time to seriously engage in meaningful continuity planning for events that may never happen. This I believe is where FM consultants could play an important role.

The biggest challenge to those trying to develop business continuity plans for EWEs is quantifying the risks of an event occurring and the potential impact that such an event may have on the support services an organisation requires in order to perform their primary function. In 2008 the UK climate Impact Programme will release a new set of climate change scenarios that will provide a probabilistic estimate of the likelihood of an EWE occurring anywhere within the UK (based on a 25km square grid) along with a weather generator that will provide future daily and hourly weather predictions for any 5km square grid (UKCIP, 2008). This should allow FMs to develop specific climate change and EWE scenarios for organisations which coupled an assessment of how such events may affect the physical and business infra-structure will allow them to assess their risk exposure and plan mitigation and intervention strategies. The development of the scenarios; the impacts that they may have on the physical and business infra-structure; and the integration of these in business continuity planning forms one part of a major new study into community resilience underway in the UK. The study uses an action research approach to develop a range of toolkits which will be evaluated in the field and modified in the light of feedback from the SME community. The study should produce a greater understanding of business resilience and a range of business toolkits that allow FMs to assess the potential impacts of EWEs on their, or their clients, business.

CONCLUSIONS

Whilst contingency and disaster recovery planning are not new to FMs, the author would argue that current approaches are too narrow in scope to be effective in the light of EWEs. What is needed is a broader view of EWEs and of the types of contingency that are effective in ensuring 'business as usual' both during and following an event. Robust mechanisms for the quantifiable assessment of the likelihood of an event; business focussed toolkits that assess the potential impact of such an event on an organisation and its supply/distribution chains; contingency plans that consider the soft human resources response to EWEs as well as the hard physical infra-structure; continuity plans that support temporary working solutions, either through re-location or mitigation measures; and climate proofing that takes a holistic view of the EWE and market position are all required if SMEs are to improved their resilience and adaptive capacity. The author would ague that the majority of the above are currently missing from the contingency/disaster recovery plans of most SMEs in the UK. As such they will become increasing vulnerable to EWEs with many failing to recover following an event. This in turn will have a major impact on community resilience.

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REFERENCES

AXA (2007a) 'Business continuity guide', available at http://ww.thebci.org.

AXA (2007b) ' Business 4 Tomorrow', available at http://ww.thebci.org.

BCI (2007) 'Expecting the unexpected – Business continuity in an uncertain world', available at http://ww.thebci.org.

Berkhout, F. Hertin, J. & Arnell, N. (2004) 'Business and climate change: measuring and enhancing adaptive capacity', Technical Report 11, Tyndell Centre for Climate Research.

Blenkinsop S. & Fowler H.J. ‘Changes in drought frequency and severity over the British Isles projected by the PRUDENCE regional climate models’, Journal of Hydrology, in press.

Crichton, D. (2006) ‘Climate change and its effects on small businesses in the UK’, AXA Insurance PLC, ISBN 978-0-9554108-0-2.

Ekström M., Fowler H.J., Kilsby C.G. & Jones P.D. (2005) ‘New estimates of future changes in extreme rainfall across the UK using regional climate model integrations. 2. Future estimates and use in impact studies’, Journal of Hydrology, Vol 300, pp234-251.

Fowler H.J. & Kilsby C.G. (2003) ‘A regional frequency analysis of United Kingdom extreme rainfall from 1961 to 2000’, International Journal of Climatology, Vol 23, No 11, pp 1313-1334.

Gallopin, G. C. (2006) ‘Linkages between vulnerability, resilience and adaptive capacity’, Global Environmental Change, Vol 16 pp 293-303.

Good P., Barring L., Giannakopoulos C., Holt T. & Palutikof J. (2006) ‘Non-linear regional relationships between climate extremes and annual mean temperatures in model projections for 1961-2099 over Europe’, Climate Research, Vol 3, No 1, pp19-34.

Hulme M., Jenkins G.J., Lu X., Turnpenny J.R., Mitchell T.D., Jones R.G., Lowe J., Murphy J.M., Hassell D., Boorman P., McDonald R. & Hill S. (2002) ‘Climate change scenarios for the United Kingdom: The UKCIP02 Scientific Report’, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, UK, 120pp.

OST (2004) ‘Foresight: Future Flooding: Executive Summary’, available at http://www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/Reports_and_Publications/Executive_Summary/executive_summary.pdf.

Petts, J. (1998) ‘Environmental responsiveness, individuals and organisational learning’ Journal of Environmental Planning & Management, Vol 41, No 6, pp 711-730.

RMS (2000). ‘U.K. Floods, Nov 2000: Preliminary report of U.K. flood damage from increased rainfall in November 2000’, available at

Runyan, R. C. (2006) ‘Small businesses in the face of crisis: Identifying barriers to recovery from a natural disaster’ Journal of Contingencies and Crisis Management, Vol 14, No 1. pp 12-26.

Savage, M. (2002) ‘Business continuity planning’, Work Study, Vol 51, No 5, pp-254-261.

Smit, B & Wandel, J (2006) ‘Adaptation, adaptive capacity and vulnerability’, Global Environmental Change, Vol 16, pp-282-292.

Spence, R. (2004) Risk and regulation: can improved government action reduce the impacts of natural disasters? Building Research & Information, 32(5), 391-402.

UKCIP (2008) ‘What to expect from UKCIP 08’ available at http://www.ukcip.org.uk.

Wikipedia (2007) ‘Windstorm’, available at http://en.wikipedia.org/wiki/European_windstorm

Wilson, B. (2007) ‘The myths of business continuity and disaster recovery’, available at http://www.continuitycentral.com/feature0139.htm.

Yoshida, K. & Deyle, R. E. (2005) ‘Determinants of small business hazard mitigation’, Natural hazards Review, ASCE, February 2005, pp1-12

CONTAMINATED LAND LEGISLATION: EUROPEAN ANOMALIES AS THEY AFFECT FACILITIES MANAGEMENT AND CLEAN-UP

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ABSTRACT

Remediation and reclamation of contaminated land presents a growing opportunity for facilities managers seeking to increase opportunities and options for land use. Many potentially valuable land sites are despoiled by the blight of contamination: this despite their often attractive location for redevelopment. For many facilities managers, such contaminated land may form a major part of their portfolio. This is particularly true of organisations that have inherited an industrial or manufacturing legacy. Other obvious examples include defence estates and power generation. Given the pressures for land in urban locations, the option of reclaiming previously discarded land appears to be increasingly attractive. This paper considers the varying legislative obstacles and incentives that apply in different parts of the European Union, focusing on the UK and Germany.

KEYWORDS: contaminated land, reclamation, European legislation

INTRODUCTION

Much of current environmental law has emerged from the late Twentieth Century. Such laws are widely believed to be responsible for stifling the redevelopment of many sites as a result of their broad financial and legal liabilities. Such concerns affect numerous parties including current owners, potential buyers, financers and facilities managers. The process of complying with laws can be time consuming, with requirements for impact assessment, standard-setting and licensing. The effect is that facilities managers are often reluctant to redevelop a site or carry out their desired organisational activity on the site. This applies particularly to what Kirkwood (2001) calls ‘manufactured sites’: that is, ‘a class of site found in old manufacturing towns and cities whose present condition is a result of manufacturing and industrial processes or disposal of waste’. However, there are a number of government and private innovations that are enabling the dismantling of such archaic legislation in the light of new techniques and technologies. These include changes to the established environmental laws, tax incentives and insurance options. This papers aims to investigate the varying legislative obstacles and incentives to deal with contaminated sites in different parts of the European Union. This analysis focused on two case studies, in the UK and Germany, and highlights the different approaches in dealing with the remediation and reclamation processes ruled mainly by the local authorities and national legislation.

During the 19th Century it was popular to refine town gas from coal: one of the most widely used phosphor fuels during the time of the Industrial Revolution. Today these former gaswork sites are one of the main concerns of Environmental Agencies worldwide. According to Hatherway (2002), sites of former gasworks contain a vast range of contamination from normal construction and demolition waste like brickwork and concrete to ash, clinker and slag resulting from solid steam of the pyrolysis. In addition, cyanides, mercury, sulphur and other heavy metals are likely to be present. Moreover, it is also likely to contain ammonia (NH_3), residual tar, tar sludge and hazardous gases.

The two case studies were provided by BilfingerBerger AG, which runs operations in both the UK and Germany, allowing the authors to examine both project data/information and to discuss with the engineers and managers responsible for the design and site operations. The initial documents concerning 'risk assessment' and the 'rehabilitation plan' were analysed and were shown to have a major influence on the design and setup.

Remediation methods

There are a wide range of remediation technologies available to deal with this particular source of contamination. Friman (1992) cites thermal treatment, bioremediation, soil washing and stabilisation/solidification as appropriate to address typical gasworks contamination. According to Cainey and Hobson (1998) the most widely used approach to 'clean-up' contaminated soil is excavation and off-site disposal. Bayer and Finker (2006) suggest that groundwater treatment (or pump and treat method) is a conventional and effective technique to clean-up the underground water.

European Legislation

Each EU member state has a duty to comply with environmental legislation, although interpretations may vary between them. According to Pirotte (2004), the European Union only provides a basic framework: one that aims to ensure *minimal protection*. This enables each member state to maintain or to establish a more stringent and detailed legislation as required. The most important treaty in this respect is the Directive 2004/35/CE of the European Parliament and of the Council on *'environmental liability with regard to the prevention and remedying of environmental damage'*. The title itself indicates the main aims of the Directive, prevention of environmental damage and remediation of such damage. The Official Journal of the European Union (OJEU) proposes that prevention and remedying of environmental damage as its key concern. Environmental damage, according to Pirotte (2004), refers to *'damage to protected species and habitats, damage affecting water and damage affecting soil'*. Therefore flora and fauna, water and soil can be seen as the protective goods which are, as observed by Pirotte (2004), identified respectively in the 'Water-Framework' Directive 2000/60/CEE, the 'Birds' Directive 74/409/CEE and the 'Habitats' Directive 92/43/CEE. The OJEU advocates the furtherance of the 'polluter pays' principle in line with promoting the principle of 'sustainable development' as most important in achieving the goal of prevention and remediation of these protective goods.

The preventive action is then specified in Article 5 as '*environmental damage [that] has not yet occurred but there is an imminent threat of such damage occurring, the operator shall, without delay, takes the necessary preventive measure'*. In the following Article 6 the remedial actions are specified as *'all practicable steps to immediately control, contain, remove or otherwise manage the relevant contaminants in order to prevent further environmental damage'* (OJEU, 2004).

When it comes to the removal of contaminated soil it is necessary to consider the directives regarding waste 91/156/CEE and regarding hazardous waste and substances 91/689/CEE in relation to transport or disposal. The remediation of an environmental damage in the

Directive 2004/35CE is divided into three sections ‘Primary Remediation’, ‘Complementary Remediation’ and ‘Compensatory Remediation’. Primary remediation describes a full restoration of the damage into its baseline conditions and is seen as the most desirable option. The complementary measure replaces natural resources in similar conditions and the compensatory approach seeks to provide areas in substitution for a damaged site.

‘*For the purpose of assessing damage to land as defined in this directive. the use of risk assessment procedures to determine to what extent human health is likely to be adversely affected is desirable’* (OJEU, 2004, p.2).

Legislation in the United Kingdom

In the UK, all environmental issues are regulated by the Environmental Protection Act 1990 (EPA 1990) which is divided into several parts. The parts potentially involved in remediation are Part 1, the ‘Pollution Prevention and Control’ regulations (PPC), Part 2 the ‘Waste Management and Licensing’ regulations and Part 7 the ‘Water Resource Act’. However, the most important part for remediation works is Part 2a, ‘Contaminated Land’, which was added in 1995. Herein, the government objectives are to ‘identify and remove unacceptable risk to human beings and the environment in line with bringing damaged land back into beneficial use’. Cost burdens regarding any remediation effort shall be considered ‘proportionate, manageable and economically suitable’ (UK, 2006). Therefore any area restoration has to follow the *suitable to use* approach. This approach focuses on risks with a risk assessment on a site-to-site decision. The risk assessment should investigate the suitability for any current use, or the future use set out in the re-development plans. This approach should help to limit requirements of remediation to reinforce redevelopment of damaged sites. Part 2a delegates the responsibility for identifying contaminated land to the local authorities. A site must have a so called ‘significant pollutant link’ to be declared contaminated land. Such a link consists of a *pollutant*, a *receptor*, and a *pathway exposing the receptor to the contaminant*. In absence of one of these three parts ‘no linkage’ is established and therefore no risk existent.

According to Part 2a Annex 3 Table A, the receptor is either a human being, any ecological system or living organism forming a part of such a system. Agricultural properties including timber and properties in form of buildings are also identified to be potential receptors. However, the ‘pollutant link’ becomes ‘significant’, according to annex 3 table B, if either a significant harm or a significant possibility to harm can be identified. Such harm is defined as health effects like intake, body contact or explosion and fire. Ecological system effects, animal and crop effects and building effects can also be effects affecting health. Furthermore, the significance can be identified by pollution or likely pollution of controlled waters which causes involvement of Part 7 of the EPA 1990.

The Part 2a of the EPA 1990 sets out a framework for the local authorities for dealing with contaminated land. This framework needs to be initiated by the gathering of information from the local authority itself, other regulatory bodies or via information or complaint by a member of the public.

After a *source – pathway – receptor* link is identified, the next step is the determination of whether the land is contaminated. This is enacted through official notification, which can either be delivered by a remediation notice or statement. The statement is based on mutual agreement whereas the notice is founded on legal enforcement. Both forms have to contain information on the ownership of a site or an appropriate responsible person, a description of the contamination and the remediation process which is thought to be appropriate. The choice of the remediation process is generally with the appropriate person but needs to be approved by the local authority. The standard of remediation and therefore the remediation goal, according to Part 2a Annex3, has to ensure that the identified linkage is no longer a '*significant pollutant linkage*'. This can be achieved '*by removing or treating the pollutant, breaking or removing the pathway or protecting or removing the receptor'* (UK, 2006). Effects of significant harm, which already occurred, have to be remediated. The technique used needs to be practical and suitable for the particular site and contaminant, effective in achieving the stated goals and durable in the long term. The success of the work carried out needs to be monitored over an agreed period of time, which has also to be agreed with the local authority.

Part 2a also sets out the regimes of the Environmental Agency (EA) for England and Wales and the Scottish Environmental Protection Agency (SEPA) for Scotland. The duties of these regimes are to provide advice for the local authorities, publish periodic reports and carry out the remediation of 'special sites'. The attribute 'special site' is assigned, according to annex 4, in case of water pollution affecting drinking water, surface water classification criteria and major aquifers. Industrial cases such as waste acid tar lagoons, oil refineries and cases affecting Part1 (PPC) are also the duty of these agencies as well as defence cases and contamination caused by military use. Cost burdens regarding remediation have to be allocated in line with the *polluter pays* principle. According to the Finance Act 1996, exemption of landfill tax can be applied in case contaminated material is being removed.

Legislation in Germany

In Germany, the environmental law is based on an interlinked legislation framework. According to Storm (2006), the 'Circular Economy / Waste Disposal Act' (Krw- /AbfG), and 'Federal Emission Control Act' (BImschG) at the top of the legislative framework deal with promotion of a circular economy and recycling and air emissions in general. The 'Water Management Act' (WHG) and the 'Federal Soil Protection Act' (BBodSchG) deal with natural resources in more detail.

The government's objectives within this legal framework are to declare *protective goods*, which are the natural resources soil, water and air. Additionally to each part of this framework the government established several directives for legal execution in the day-by-day business. These directives contain instructions for execution as well as guideline values for ensuring the protection of the protective goods.

In terms of remediation of contaminated land, however, the 'Federal Soil Protection Act' (1998) and the 'Federal Soil Protection Directive' (1999) are the most important. Herein the functions of soil are described and declared to be protective. These functions are natural functions; function as archive of natural and cultural history and also functions for utilisation. According to the Federal Soil Protection Act the alteration of one of these functions is then an *adverse soil alteration*. The alteration is established by exceeding the guideline values set out in annex A of the Federal Soil Protection Directive. Where *adverse soil alteration* to soil functions already occurred, the responsible person or the legal owner including all its legal successors have to remediate such harmful change or to prevent any further damage that springs from their property to an economical suitable extent. For remediation purposes the Federal Soil Protection Act distinguishes two ways of dealing with adverse soil alterations. The principles of *averting of a danger* and *prevention* claim to combine both the protective goods approach and the declared duties of the legal owner.

The principle of averting a danger is further subdivided into precautionary arrangements during an ongoing production process and the duty of remediation. The polluter of soil or water is responsible for remediation by applying one of the following arrangements in the given desirable hierarchy. ‘Decontamination’ which means removal or reduction of the contaminant, is the most appropriate option. ‘Safeguards’ and ‘treatment’ which changes the physical, chemical or biological consistency of the contaminant into a less harmful substance might also be suitable. The principle of prevention focuses on the guideline values set out in annex 2 of the Federal Soil Protection Directive. The planned future use of a site as well as the neighbouring use is taken into consideration especially in terms of the economical extent of a remediation project.

Therefore the directive sets out pre-defined pathways with assigned guideline values for residential, commercial or industrial use. The most important pathway due to direct exposure of human beings to a contaminant is the pathway ‘soil – human’. Pathways exposing contaminated soil to other protective goods such as water and air have to be considered as well. The pathways ‘soil – groundwater’ and ‘soil – soil atmosphere’ have to be assessed also with respect to the Water Management Act and the Federal Emission Control Act as stated earlier. For each pathway ‘test values’ and ‘activity values’ are published in annex 2 of the Federal Soil Protection Directive. Exceeding the test values, however, will cause an assessment with respect to the planned use, whereas exceeding an activity value will directly bridge over to the principle of averting a danger. Each of the pathways has to be assessed on a site-to-site basis.

In order to confirm the suspicion of contamination and assessment of the pathways the local authority can request a detailed analysis and the preparation of a rehabilitation plan (Sanierungsplan) according to §13 BBodSchG (Federal Soil Protection Act). This rehabilitation plan must be written by an accredited person, who is normally an independent consultant engineer. The rehabilitation plan needs to be approved by the local authority. After such approval the rehabilitation plan becomes legally binding for all parties involved in the redevelopment of the contaminated site.

The core elements of a rehabilitation plan are firstly a summary of the risk assessment and testing results, the planned future use, former or historical uses, as well as the current use of the site. The remediation goal including necessary decontamination measures, safeguards, protection measures and if necessary restrictions of usage have to be detailed described in written form and also in form of drawings. The rehabilitation plan should also contain a draft master schedule for all necessary works. In the case of soil being contaminated, the soil has to be removed to a landfill, the Circular Economy / Waste Disposal Act which rules processes involving all kinds of waste has the main influence. It follows a hierarchy of principles for dealing with waste, which is prevention before utilisation before disposal. For reusing less contaminated soil as secondary building material the “Federal Working Group Waste” (LAGA) posted technical guidelines for backfill. This guideline, TR LAGA M20, contains guideline values as well as requirements for backfill of any material. The final disposal then is ruled by the Landfill Directive (DepV) and subordinated statements (TA Siedlungsabfall and TA Abfall).

ANALYSIS AND COMPARISON OF THE CASE STUDIES

A comparison between any two projects which originate from different cultural systems is problematic because projects are naturally characterised by a certain degree of uniqueness. In order to compare the approaches for dealing with contamination, two projects with a high level of similarities in the initial condition were chosen. The main similarities were in the range of contamination present on each site. Prior to each remediation activity a risk assessment was carried out. The comparison between both risk assessments is presented here, to aid the understanding of the influence of the legal framework at the design stage, before a comparison of the remediation methods is shown. General project success criteria, such as effectiveness, time and cost, were applied to support the comparison of different processes. Important criteria for a remediation, such as the environmental impact of a certain methodology and its monitoring needs were also investigated and discussed in this sub-section.

Similarities between the initial situations

The 'Gaswerke Krefeld-Hüls' started its production in 1897 while the 'North London Gasworks' started in 1845, thus both facilities were founded around the same time; as a consequence similar facilities and buildings were found. The two manufactured gas plants were initially built to refine artificial gas from coal to supply a big neighbouring industrial and residential area. Both plants were subject of several upgrades during their life cycle. Thus the addition of facilities to refine gas from oil and facilities for purifying by-products (e.g. benzene and ammoniac) was an important feature, developed during the years of use. Hatheway (2002) identified core components (e.g. retorts, scrubbers, condensers, washers, purification boxes, tar chambers and gasholders) for the manufacturing process which were also found in the historic structure of the two sites. Due to the production process, both sites were divided into special hot spot areas along the former location of the production, treatment and storage facilities, like retort house, clarification and purification, tar pits, and tar wells. In addition areas with common construction and demolition waste were present on both sites. Furthermore secondary contamination so called plumes, originated from the hot spot areas, were also a point of attention for the remediation.

The projects in London as well as the project in Krefeld were affected by a similar range of contamination in the hot spot areas. The site investigations in both countries obtained elevated concentrations of poly aromatic hydrocarbons (PAH) while both investigations were carried out with respect to the priority list of organic contaminants set by the United States Environmental Protection Agency (USEPA). Naphthalene and Benzo(a)pyrene were selected as indicators for the whole range of PAH due to their bulk density. In addition volatile organic compounds like BTEX and phenols were reported in both laboratory analysis. Cyanides and ammonium were found, which were also common by-products of artificial gas production. The geological and hydrogeological conditions were reported to be similar in terms of the underlying aquifer followed by a protective less permeable clay layer in both projects.

Remediation process

In both case studies, the 'North London Gasworks' and the 'Gaswerke Krefeld-Hüls', a discussion on several remediation processes were considered prior to the final choice. The value of a particular process in a certain situation is described by Kelly et al. (2006) as a relationship between function, cost and quality. It can not be doubted that also the aspect of time influences the decision making process as time is directly connected to cost. Time savings would have a positive influence on costs whereas a time overrun would have a negative impact on the costs. It is therefore reasonable to argue that every technical decision regarding a particular remediation process is a trade-off between time, cost and performance.

Effectiveness: The rehabilitation plan for the site in Krefeld discussed the options of either an extensive soil exchange or capping by an impermeable layer. All other options were cancelled due to the restrictions given by the location in a drinking water protection zone. The latter led to the need for a highly efficient technology without any by product which would remain on site. The capping opportunity was rejected due to the presence of the extremely sensitive neighbourhood (e.g. kindergarten, primary school). In the tender document of the UK case study, three options were discussed. The free-product recovery combined with groundwater treatment was chosen; because an effective technology was required which particularly addressed the risk to the aquifer beneath the site. The site history of the UK case study showed a foregone soil exchange in 1998 prior to the free-phase product recovery in 2003. Thus a question in terms of the effectiveness of a soil exchange is raised. The effectiveness of source removal of the PAH contamination, carried out in Krefeld, might be doubted in terms of the desired outcome of removal of the identified risk to the groundwater. The technique chosen in the UK case study focused on the significant pollutant link identified in the groundwater aquifer.

Cost: The remediation opportunities for the German case study were discussed regarding the cost aspect, but were found not to have a significant monetary effect within the limited range of processes available to meet the tight pre-defined boundaries. Therefore cost was not the main influencing factor on the decision. The fact that the dual phase extraction, which was also discussed for the UK case study was seen to be most appropriate but too expensive draws the attention directly upon cost as a decision making factor. The cost burdens of a remediation project are nearly always additional for any redevelopment project. Therefore both lawmakers took into account that the clean-up requirements need to depend on the planned future use as well. The impact of costs in terms of former manufactured gas plants is often particularly difficult because it involves mostly historical contamination. Therefore new owners or developers need to deal with their available budgets to address a problem they did not cause themselves. Thus the budgets for a remediation project play an important role in the decision but the cost, as mentioned above, is also strongly connected to effectiveness and a given time frame to achieve the remediation goal.

Time scale: The single product recovery, first discussed in the tender offer for the UK case study, was indicated to possibly have slow recovery rates which would lead to an extensive time overrun. The time scale in the German case study again was of secondary order for the decision. Optimisation was achieved just by carrying out certain work simultaneous. Summarising the focus in the UK case study was set more on time and cost and less on effectiveness, due to the location in a mixed industrial area, while the trade-off focus in the German case study was set on effectiveness, due to protection of drinking water and neighbourhood.

***Environmental Impact**:* In the UK case study, the environmental impact of the free-product recovery combined with an on-site groundwater treatment was lower but still the contaminant was also not treated, only removed. The removal of only the product and not the entire soil matrix lowers the environmental impact due to a volume reduction. The hazardous tar sludge remains untreated and also the volatile compounds removed by means of the air stripper were not treated just attenuated and transferred to the medium air.

Monitoring needs: During the construction phase the monitoring needs for the methodology applied in Krefeld were high because the contaminants were simply excavated and not treated or reduced in their harmfulness. The monitoring needs after the successful remediation was carried out, were limited to a certain period of groundwater monitoring to prove the success of the remediation works. Monitoring needs of a landfill site, where the contaminated soil material was finally stored, may be increased due to the presence of particularly dangerous organic waste mixture. The monitoring needs north of London during the construction phase was significantly reduced and involved air quality measurements along the site boundaries and sampling and testing of the treated water discharge.

FINAL CONSIDERATIONS

The legal frameworks were based on differing approaches to risk assessment which influenced the choice of the remediation process. Both systems indicated advantages as well as disadvantages. The main differences were found in terms of the risk assessment and the flexibility for creative contractor involvement at the design stage of a remediation project. Based on these differences, a discussion about risk and uncertainty versus standardisation was raised. A decision about the quality of either system is very difficult as it tends to involve personal judgement and many different factors that can vary from case to case. Both legal systems have certain limitations, for example limitation of creativity and functionality in Germany and high degree of uncertainty and the potential for malpractice in the UK. The analysis of the case study material also indicated the importance of common project success criteria such as time, cost, and quality which were connected in a trade-off relationship. In terms of the cost burden of a remediation project, the future use of the site highly affected the requirements of the remediation goal. These criteria, aligned with the legal requirements strongly influenced the decision for the different approaches to deal with a similar set of remediation problems.

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REFERENCES

Bayer, P.; Finkel, M. (2006), ‘Life cycle assessment of active and passive groundwater remediation technologies’, In: Journal of Contaminant Hydrology, Vol.: 83, pp.: 171 – 199.

Cairney, T.; Hobson, D.M. (1998), ‘Contaminated Land: Problems and Solutions’, E&FN Spon, London.

Friman, L. (1992), ‘Sanierung eines ehemaligen Gaswerksgeländes in Nienburg / Weser’, In: GOSSOW, V. ED., Altlastensanierung, genehmigungsrechtliche, bautechnische und haftungsrechtliche Aspekte Bauverlag GmbH Wiesbaden und Berlin.

Germany: Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (1998), Bundes-Bodenschutzgesetz-BBodSchG (Federal Soil Protection Act).

Germany: Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (1999), Bundes-Bodenschutz-und Altlastenverordnung- BBodSchV (Federal Soil Protection Directive).

Hatheway, A. W. (2002) ‘Geoenvironmental protocol for site and waste characterisation of former manufactured gas plants; worldwide remediation challenge in semi volatile organic wastes’, In: Engineering Geology, Vol. 64, pp. 317-338.

Hatheway, A. W. (2002), ‘Geoenvironmental protocol for site and waste characterisation of former manufactured gas plants; worldwide remediation challenge in semi volatile organic wastes’, In: Engineering Geology, Vol. 64, pp. 317-338.

Kelly, J.; Male, S.; Graham, D. (2006), ‘Value Management for Construction Projects’, Blackwell publishing, Oxford, 2nd Edition.

Kirkwood, N. (2001), Manufactured sites: re-thinking the post-industrial landscape, Spon Press.

Official Journal of The European Union (2004), ‘Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to prevention and remedying of environmental damage’, Available at: http://europa.eu.int/eurlex/pri/en/oj/dat/2004/l_143/l_14320040430en00560075.pdf

Pirotte, C. (2004), ‘A Brief Overview of Directive 2004/35/CE on ‘Environmental Liability’, Available at: https://www.eaglelaw.com/papers/brussels2004_en-06.pdf

Storm, P.C. (2006), ‘Umweltrecht – Einführung’, 8th edition Erich Schmidt Verlag & Co: Berlin.

United Kingdom: Department of Environment Food and Rural Affairs (2006), ‘Contaminated Land’, Environmental Protection Act 1990: Part 2a.

THE ROLE OF THE BEHAVIOURAL ENVIRONMENT IN ENHANCING OFFICE PRODUCTIVITY

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ABSTRACT

The aim of this paper is to demonstrate the role that the behavioural environment plays in office productivity. The author reviews the literature from the occupier perspective. This approach enables a greater appreciation of the social context of offices. The review establishes the need to link work process with the office environment. The balance between the positive interactions in the office and negative distractions are explored. The review of the literature reveals that by adopting the occupier perspective potential tensions can be identified between individual, private and team based collaborative work areas. These tensions can have an impact on the office occupier's productivity. This paper establishes that the "people-centred" approach to office evaluation is most appropriate for office workers with varying job tasks and allows the end user or occupier perspective to be established. This paper proposes that to ensure office environments are designed for optimum productivity, consideration needs to be given to the role of the behavioural environment. Office environments need to be designed to enhance collaboration, whilst at the same time ensure individual private work is not compromised. An agenda for further behavioural environment research is developed.

KEYWORDS: Office productivity, Office evaluation, Office layout, Behavioural Environment

INTRODUCTION

This paper will aim to develop the concept of a behavioural environment with regard to the office environment. It will demonstrate that the behavioural environment is an integrated dimension of office productivity. The term "office occupier" will be used in this paper and is defined as a person who works in an office environment. Fundamentally, this paper aims to explore how the office environment can affect the office occupiers' behaviour and the social environment created by office colleagues.

CONCENTRATION VERSUS COMMUNICATION

The possible behavioural tensions within office environments were investigated by Brenner & Cornell (1994). They specifically evaluated office environments that had been designed to enhance privacy and collaboration. The environments evaluated consisted of a small enclosed area called a "personal harbour workspace", and a group area called "common space". The personal harbour gave its occupants the opportunity to withdraw physically and obtain territorial privacy. The commons area consisted of group space, which were configured according to work process and technology needs (Brenner & Cornell, 1994). The environments created conformed to the "commons" and "caves" metaphor (Hurst, 1995; Steele, 1981). The meaning of the metaphor is that when people are in the "common" areas they are available to interact with other group members, and when they wish to be on their own they can withdraw to the "caves", thereby signalling they want their privacy.

Brenner & Cornell (1994) investigated the willingness of the team members to trade off the need for privacy with the need for collaboration with other team members. They reported that the need for privacy diminished over the time of the experiment, and concluded that this was as a consequence of the team becoming more cohesive. Also whilst the door on the personal harbours was not used as often as expected, it was deemed to be important by the office occupiers, as it provided them with an element of control over their environment, an issue also identified by Leaman & Bordass (2000). The door was used to restrict their level of interaction with the other team members, and ultimately to regulate their level of privacy (Marquardt, *et al*, 2002).

Becker & Steele (1995) reiterate the benefits of their organisational ecology concept, by claiming that it can transform physical workplace environments to support the organisation's business processes. It could be argued that the connection between the workplace and the organisation is central to the development of strategic facilities management. Becker & Steele (1995) propose that to ensure that the work environment supports the organisation's objectives, then consideration needs to be given to the work processes undertaken, and the culture the organisation wants to portray with its physical workspace.

Strategic facilities management can be developed further when emphasis is placed on the role the physical environment can play in representing organisational culture. The ultimate proposal, presented by Becker & Steele (1995), is that the physical environment can be used strategically to facilitate a change in organisational culture.

> *"The planning and design of the workplace can, however, be used – or serve – as a deliberate catalyst for organizational change including the culture of the organization."(Becker & Steele, 1995, p58)*

Ultimately, Becker & Steele (1995) present an argument for using space to change organisational culture, which means that the physical environment will influence, and change, the patterns of behaviour in the physical environment.

INTERACTION VERSUS DISTRACTION

If office environments are to act as conduits for knowledge creation and transfer, then the debate widens to include the notion that work environments can be designed to support creativity (Stokols, Clitheroe & Zmuidzinaz, 2002). Stokols *et al* (2002) propose a theoretical framework for evaluating the effects of both the physical environment, termed "environmental distractions", and the social environment, termed "social climate", on the perceived creativity of occupants in the workplace.

In an attempt to create design criteria to allow the coexistence of both individual and team work, Olson (2002) created, and evaluated, a database of individual projects from multiple US-based clients between 1994 and 2000. The database contained 13,000 responses, which had been gathered by questionnaire. Olson (2002) attempts to establish the workplace qualities that have the most effect on the occupier’s individual performance, team performance and job satisfaction. The workplace quality which has the strongest effect on its occupants is the ability to do distraction-free solo work (Olson, 2002). The second workplace quality to affect occupiers is support for impromptu interactions. Clearly, the tension in office environments between privacy and collaboration is brought to the surface (Haynes, 2005).

Olson (2002) argues that other people's conversations are the main interference with distraction-free working. Also, office occupiers that are in open-plan, or shared offices, are more frequently distracted by other people's conversations than people who work in private offices. He suggests that on average office occupants spend 25% of their time making noise, such as having conversations near other people's individual workspaces. Therefore, one individual can simultaneously affect eight other office workers in a high density open-plan environment (Olson, 2002).

Whilst acknowledging the disadvantages of people having conversations in the workplace, Olson (2002) also establishes the advantages of impromptu interactions. Results from the total data set show that 87% of respondents believe that they learn through informal interaction such as casual conversations and impromptu problem-solving sessions. However, he suggests that the scores for informal learning from both private offices and open-plan offices are very similar, and therefore concludes that the idea that people in open-plan environments can learn more by overhearing other people's conversations may need to be questioned.

In contrast to Olson's (2002) findings, Sims (2000) presents findings from a case study evaluation that deliberately designed space around teams, with the intention of increasing team communication and shared learning. It was called 'creative eavesdropping', and it was claimed that by adopting such a team-centred approach, cycle times were reduced by 25%. In addition the space required for the teams reduced by 43% (Sims, 2000). A limitation of this research is that whilst headline figures are presented, the research data are not provided.

Olson (2002) proposes:

> *"Quiet, individual work and frequent, informal interactions are the two most time-consuming workplace activities and are the two with the greatest effects on performance and satisfaction." (Olson, 2002, p46)*

Finally, Olson (2002) suggests the answer to the potential tension between interaction and distraction is to create office environments that offer a high degree of enclosure, such as private offices. Whilst this proposal may address one side of the equation, the issue of distraction-free work, Olson (2002) does not appear to offer a solution for the other side of the equation that environments should allow of informal interaction.

The issue of distraction in the workplace is specifically addressed by Mawson (2002). He argues that anything that takes attention away from the task in hand, is effectively a distraction, and therefore impacts on the performance of the individual. Mawson (2002) develops the argument by suggesting that when individuals are focused on an individual task they are in a flow state, and when they are distracted they are brought out of that flow state. The concept of workflow can be traced to DeMarco & Leister (1987). They propose that there is a time requirement for an individual to reach a deep level of concentration, termed "ramp-up". If distracted then the individual's flow of concentration would be broken, therefore requiring further ramp-up time to reach the same level of concentration previously attained. Mawson (2002) argues that over the period of a day, the cumulative effect of all the distractions leads to a disruptive and less productive day. Cornell (2004) also supports the concept of workflow highlighting that:

> *"The optimal experience of flow is achieved when nearly all resources are concentrated on one task." (Cornell, 2004)*

Cornell (2004) proposes that to achieve optimal flow state, distractions need to be kept to a minimum. The concept of workflow, as presented by Mawson (2002) and Cornell (2004), appears to suggest that productive work is only achieved when individuals work alone. The main conclusion drawn is that the office environment needs to be a distraction free work environment. This stance does not acknowledge different personality types, and assumes one work process, i.e. individual. The major limitation of this conclusion is that it does not acknowledge the benefits that can be obtained from different work processes, i.e. team and collaborative work (Haynes, 2005).

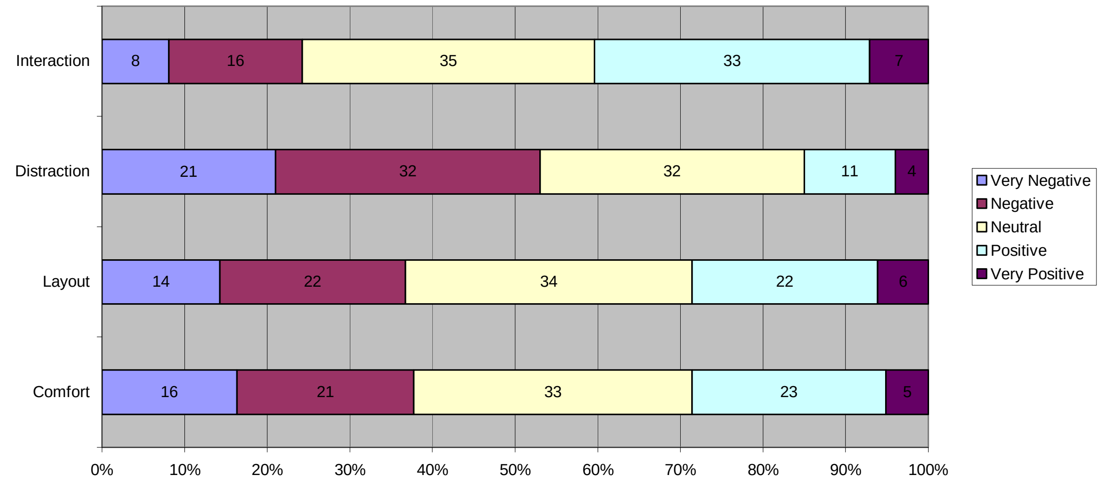
Factor analysis was the main statistical technique used by Haynes (2007a) to develop an understanding of the underlying concepts of office productivity. The application of factor analysis allowed 27 evaluative variables to be reduced to four distinct components. The results of the analysis can be seen in Table 1.

Table: 1 Four components of office productivity and associated reliability.

Factor	Name	Attributes	Cronbach's alpha
All			0.95
1	Comfort	Ventilation, heating, natural lighting, artificial lighting, décor, cleanliness, overall comfort, physical security,	0.89
2	Office layout	Informal meeting areas, formal meeting areas, quiet areas, privacy, personal storage, general storage, work area - desk and circulation space	0.89
3	Interaction	Social interaction, work interaction, creative physical environment, overall atmosphere, position relative to colleagues, position relative to equipment, overall office layout and refreshments	0.88
4	Distraction	Interruptions, crowding, noise	0.8

The components Comfort and Office Layout represent the physical environment, and the components Interaction and Distraction represent the behavioural environment (Haynes, 2007a).

The four components of office productivity were subsequently used to form a scale against which the results could be measured. (See Figure 1).



	Comfort	Layout	Distraction	Interaction
Very Positive	5	6	4	7
Positive	23	22	11	33
Neutral	33	34	32	35
Negative	21	22	32	16
Very Negative	16	14	21	8

Percentage Repsonse

Figure 1 Results for four factors of office productivity

The results shown in Figure 1 identify the total positive results for office layout to be 28% and the total positive results for comfort to be 28%. It appears that the basic requirements of layout and comfort are not being addressed, which means that opportunities for productivity improvement exist by addressing the physical environment. These findings generally support the office productivity literature that has linked the physical environment to office occupiers' productivity (Whitley *et al*, 1996; Oseland, 1999 and 2004; Leaman and Bordass, 2000).

The behavioural components of interaction and distraction appear to be having the most effect on perceived productivity. The results indicate that it is the interaction component that is perceived to be having the most total positive effect (40%) on productivity, which supports the proposition that office environments are partly knowledge exchange centres (Becker & Steele, 1995). This result demonstrates that office occupiers value interaction at both a work level and a social level (Heerwagen *et al* (2004). The behavioural component distraction is the component that has the most total negative effect (53%) on perceived productivity (Mawson, 2002; Olson, 2002). In contrast to Olson (2002) and Mawson (2002), research undertaken by Haynes (2007a) measures distraction using a multi-item scale, thereby providing a richer understanding to the distraction concept.

Clearly the distraction component and the interaction components are related: one person’s interaction is another person’s distraction. The interaction and distraction components contribute to the debate because they establish an understanding of the behavioural environment within an office environment. The challenge for managers responsible for managing office environments is to maximize the interaction component, whilst at the same time attempting to minimize the distraction component. The solution to this paradox will be a combination of office work processes, office layouts, office protocols and organizational culture (Peterson & Beard, 2004).

OCCUPIER PERSPECTIVE

Understanding how people react to the built environment is at the centre of Environment-Behaviour Studies (EBS). To develop the debate there is a requirement to establish the occupier perspective. Rapoport (1990) identifies the importance of "meaning" to the users of the built environment. Rapoport goes as far to differentiate the users' meaning from the designers' meaning.

> *"One of the hallmarks of man-environment research is the realization that designers and users are very different in their reactions to environments, their preferences, and so on, partly because their schemata vary. It is thus users' meaning that is important not architects' or critics'; it is the meaning of every day environments, not famous buildings – historical or modern" (Rapoport, 1990, p15-16)*

In an attempt to address the differing needs of office occupiers Fleming (2004) proposes a conceptual framework. He proposes that assessment of work environments should include the occupier perspective. Subsequently, he develops an argument for behavioural assessment of work environments to complement the physical assessments.

> *"The mechanistic, quantitative nature of building performance paradigms fails to take into account the effect of occupiers' perceptions of their environments. Facility managers currently see buildings as containers of products and not containers of people. Products are measured against technical performance specifications rather than the idiosyncratic thoughts and perceptions of the building occupants." (Fleming, 2004, p35)*

This approach contributes to the debate by proposing a conceptual framework that establishes that traditional property performance has largely concentrated on the alpha press measures, such as observations by detached non-participants (Fleming, 2004). It develops the argument by proposing that a greater understanding of the behavioural environment can be obtained by the use of beta press measures; the occupier perspective.

Support for Fleming's (2004) call for a paradigm shift with regards to evaluation of office environments is found with Duffy (2000) and Haynes (2007b). Duffy (2000) proposes that office environments have changed relatively little over the last 20 years. Duffy (2000) attributes the lack of development to a preoccupation with hierarchical cultures, Taylorist mentalities and a cost reduction emphasis. Haynes (2007b) argues that traditional office research has tended to adopt a purely rationalist paradigm, with the missing component for a theoretical framework being the consideration of the behavioural environment. A possible way of understanding the behavioural environment would be to consider the connectivity that takes place in an office environment.

In an attempt to propose a new research paradigm for office productivity evaluations, Haynes (2005) develops the concepts of "*Buildings Ecology*" (Levin, 1981) and "*Office Ecology*" (Becker, 1990) and proposes the concept of "*Workplace Connectivity*". The principle is that to truly evaluate the impact of the office environment on occupiers' productivity, there needs to be an understanding of the connectivity between the office occupiers and their work environment. The occupier connectivity with their environment consists of:

- a psychological (perceptual) response
- a physiological (biological) response

It is proposed that the office occupiers’ psychological (perceptual) response to their office environment is an area that requires further research, thereby enabling a better understanding of office productivity (Haynes, 2007c).

FUTURE RESEARCH

Research Agenda

1. Establish how organisational culture, more specifically office culture, and management style link to office productivity. The development of management style and cultural metrics would greatly assist in understanding the behavioural environment. Aligned to this kind of research, and a possible linkage between the physical environment and the behavioural environment, would be an evaluation of how cultural cues are sent through the use of the physical environment.

2. Establish further classification of the office occupiers. A greater understanding of the individual could be obtained if personality type questions were included at the questionnaire stage. A standard personality test, such as the Myers Briggs, could be adopted thereby allowing classification of respondents by personality type. Similarly, questions that relate to how the individual works in groups could be included, therefore establishing a better understanding of group dynamics and group behaviour. A possible technique would be one based on the Belbin Team Roles.

Theoretical Framework

The proposed theoretical framework contains a number of levels of connectivity (See Figure 2). The first level of connectivity, workplace connectivity, relates to office environments and the impact the behavioural and the physical environment have on occupiers' productivity. The second level of connectivity is building connectivity. Building connectivity relates to the location of the building, its connection with the local environment, and also to the flow of occupiers within the building. The final level of connectivity is the organisational connectivity. This relates to how people connect to the organisation when not in the office environment. This level of connectivity could be classed as "organisational glue".

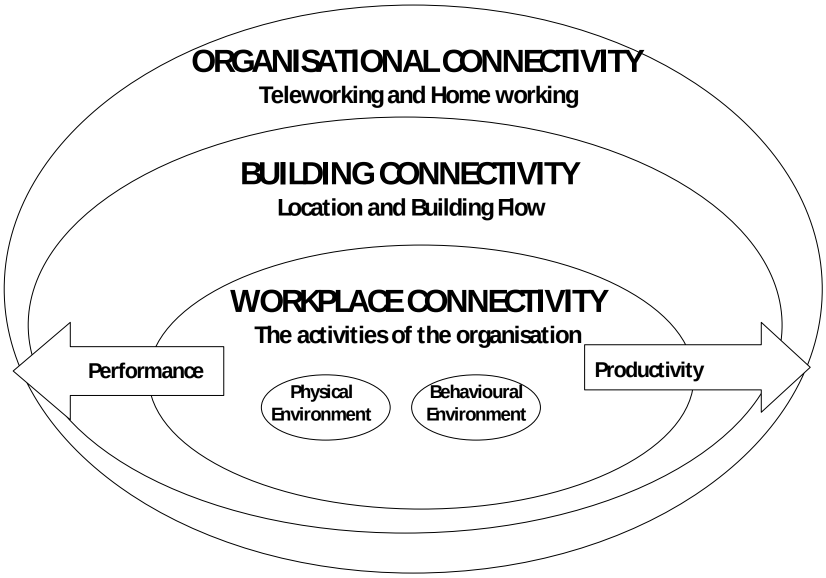


Figure 2 Proposed theoretical framework for levels of connectivity

Methodology

It is proposed that two contrasting methodologies could be adopted. Each provides a different insight to this area of research.

Longitudal Study

A longitudal study would provide an opportunity to establish, in the first instance, a base line data set, so that subsequent evaluations would have terms of reference. This constant review of the office productivity would enable deviations to be established. As part of the longitude design it is suggested that both quantitative data and qualitative data should be collected. The quantitative data could be gathered using the survey method, and the qualitative data could be collected using focus groups and interviews. It is proposed that both forms of data would be useful, but for different purposes, during the period of study. The quantitative data could establish what the issues were with regard to office productivity, and the qualitative data could be used to establish the context, or the meaning, of the quantitative data. It is proposed that this iterative process that includes both quantitative data collection and qualitative data collection would provide insight into the changing, and dynamic, nature of the office environment.

Ethnographic Case Study

A possibility exists for observational and ethnographic type of research to be undertaken to further develop the understanding of the relationship between the behavioural environment and the physical environment. This kind of study could establish the movements of people within the office, with special emphasis being placed on the parts of the office that facilitate and enable interaction and the parts of the office that represent blockages and distractions to the office occupiers. Integrated into this study would be an assessment of the quantity, and quality, of the conversations undertaken in the office environment. If modern office environments are becoming more like knowledge exchange centres, then it seems appropriate to establish the optimum balance between collaborative interactive space and distraction free private individual space.

CONCLUSIONS

This paper has demonstrated the complexity of researching occupier productivity and office environments. The complexity comes from the proposal that the office occupiers' productivity is not only dependent on the physical environment, but also the behavioural environment. The addition of the social context has subsequently meant that the definition of office productivity has remained ill defined.

It is proposed that future office productivity research needs to adopt an office occupier perspective. The adoption of this stance would reveal how office occupiers make sense of their work environment, and how they attempt to create a sense of belonging in their work environment. The occupier perspective also offers the opportunity to identify a potential tension between individual private work and team based collaborative work. A review of the office environment literature has established that this is an area that requires further research.

The future for office and workplace productivity measurement is to establish links between real estate and facilities performance metrics and the organisational performance metrics. Establishing these links will demonstrate a strategic integration between organisational demand and the provision of facilities and real estate solutions.

REFERENCES

Becker, F. (1990) *The total workplace: facilities management and the elastic organization*, Van Nostrand Reinhold, New York.

Becker, F. and Sims, W. (2001) *Offices that work: Balancing communications, flexibility and cost*, Cornell University, International Workplace studies program.

Becker, F. and Steele, F. (1995) *Workplace by Design: Mapping the High-Performance Workscape*, Jossey-Bass, San Francisco.

Brennan, A., Chugh, J. and Kline, T. (2002) "Traditional versus open office design: A longitudinal field study", *Environment and Behavior*, vol. 34,no. 3, pp. 279-299.

Brenner, P. and Cornell, P. (1994) "The Balance Between Privacy and Collaboration in knowledge Worker Teams", *Proceedings of the Fourth International Symposium on Human Factors in Organizational Design and Management held in Stockholm*, Sweden, May 29-June 2, 1994

Cornell, P.(2004) *Go with the Flow*. Steelcase, http://www.steelcase.com

DeMarco, T. and Lister, T. (1987) *Peopleware: Productive Projects and Teams*, Dorset House, New York.

Duffy, F. (1992) *The Changing Workplace* Phaidon Press, London.

Duffy, F. (2000) "Design and facilities management in a time of change", *Facilities*, vol. 18,no. 10/11/12, pp. 371-375.

Fleming, D. (2004) "Facilities management: a behavioural approach", *Facilities*, vol. 22,no. 1/2, pp. 35-43.

Haynes, B.P (2005) *Workplace Connectivity: A study of its impact on self-assessed productivity.* PhD Thesis, Sheffield Hallam University

Haynes, B.P (2007a) "Office productivity: a theoretical framework", *Journal of Corporate Real Estate,* vol. 9, no.2. pp 97-110.

Haynes, B.P (2007b) "Office productivity: a shift from cost reduction to human contribution", *Facilities*, vol. 25, no.11/12. pp 452-462.

Haynes, B.P (2007c) "The impact of the behavioural environment on office productivity", *Journal of Facilities Management*, vol. 5, no.3. pp 158-171.

Haynes, B.P (2008) "The impact of office comfort on productivity", *Journal of Facilities Management*, vol. 6, no.1. pp 37-51.

Haynes, B. P. and Price, I. (2004) "Quantifying the complex adaptive workplace", *Facilities*, vol. 22,no. 1, pp. 8-18.

Heerwagen, J. H., Kampschroer, K., Powell, K. M., and Loftness, V. (2004) "Collaborative knowledge work environments", *Building Research and Information*, vol. 32,no. 6, pp. 510-528.

Hurst, D. K. (1995) *Crisis & Renewal : Meeting the Challenge of Organizational Change*, Harvard Business Press, Cambridge MA.

Leaman, A. and Bordass, W. (2000)" Productivity in buildings: the 'killer' variables", in *Creating The Productive Workplace*, D. Clements-Croome, ed., E and FN Spon, London.

Levin, H (1981) "Building Ecology", *Progressive Architecture*, vol. 62, no. 4, pp. 173-175 April

Laing, A., Duffy, F., Jaunzens, D., and Willis, S. (1998) New Environments for Working: The redesign of offices and the environmental systems for new ways of working, E and FN Spon, London.

Marquardt, C. J. G., Veitch, J. A., and Charles, K. E. (2002) Environmental Satisfaction with Open-plan Office Furniture Design and Layout, Institute for Research in Construction, National Research Council of Canada, Ottawa, RR-106.

Mawson, A. (2002) *The Workplace and its Impact on Productivity*, Advanced Workplace AAAssociates, London, 4.Publication No. 8, available at http://www.occupier.org.

Murray, H.A. (1938) *Exploration in Personality*, Oxford University Press, New York, NY.

Nathan, M. and Doyle, J. (2002) *The State of the Office: The politics and geography of working space*, Industrial Society, London.

Olson, J. (2002) "Research about office workplace activities important to US business – And how to support them", *Journal of Facilities Management*, vol. 1,no. 1, pp. 31-47.

Oseland, N. (1999) *Environmental Factors affecting office worker performance: A review of evidence*; Technical Memoranda TM24: CIBSE, London.

Oseland, N. (2004) "Occupant feedback tools of the office productivity network", available at http://www.officeproductivity.co.uk

Peterson, T. O. and Beard, J. W. (2004) "Workplace technology's impact on individual privacy and team interaction". *Team Performance Management*, vol. 10,no. 7/8, pp. 163-172.

Price, I. (2001) "Linking facilities to corporate productivity? Can it be done?" OPD Conference, March, London.

Rapoport, A (1990) *The Meaning of the Build Environment : A nonverbal communication approach.* The University of Arizona Press

Roethlisberger, F. J. and Dickson, W. J. (1939) *Management and the worker*, Harvard University Press, Cambridge, MA.

Sims, W. (2000) "Team space: planning and managing environments to support team work", *International Journal of Facilities Management*, vol. 1,no. 1, pp. 21-33.

Stallworth, O. E. and Ward, L. M. (1996) "Recent developments in office design", *Facilities*, vol. 14,no. 1/2, pp. 34-42.

Steele, F. (1981) *The sense of Place*, Van Nostrand Reinhold, New York.

Steele, F. (1988) "The ecology of executive teams: a new view of the top", *Organizational Dynamics*, no. Spring, pp. 65-78.

Stern, G. G., Stein, M. I., and Bloom, B. S. (1956) *Methods in Personality Assessment*, Free Press, Glencoe, IL.

Stokols, D., Clitheroe, C., and Zmuidzinaz, M. (2002) "Qualities of work environments that promote perceived support for creativity", *Creative Research Journal*, vol. 14,no. 2, pp. 137-147.

Turner, G. and Myerson, J. (1998) *New workspace, new culture: Office design as a catalyst for change*, Gower Publishing Limited, Aldershot.

Waldrop, M. M. (1992) *Complexity: The Emerging Science at the Edge of Order and Chaos*. Simon & Schuster, New York.

Whitley, T. D. R., Makin, P. J., and Dickson, D. J. (1996) "Job Satisfaction and Locus of Control: Impact on Sick Building Syndrome and Self-Reported Productivity", *7th International Conference on Indoor Air Quality and Climate*, Nagoya, Japan.

AFFECTIVE PSYCHOLOGY IN AUSTRALIAN LOCAL GOVERNMENT CORPORATE REAL ESTATE AND FACILITY MANAGEMENT

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ABSTRACT

This paper provides an overview of a study into affective psychology in managing corporate real estate (CRE) and facility (FM) projects in Australian local government – circumstances rich with emotive possibilities. Environmental Psychology touches on environments and affect from a position of user-centricity, and while more can be done to understand affect and CRE and FM's users, Environmental Psychology deals poorly with political and managerial dimensions – circumstances of considerable relevance to local government.

This study's psychologically-based, orientational qualitative enquiry identified many affective consequences and processes in managing CRE and FM projects. These included: decisions about project's affective consequences sought; affective measures of success; the use of agents to achieve affective outcomes; and more. This study, in a field that is, at best, undertheorised, provides an overarching approach to considering affect CRE and FM projects. While investigated in Australia, the findings have relevance to other jurisdictions and to non-public sector settings.

Keywords: affective psychology, Australia; corporate real estate management; local government;

INTRODUCTION

Providing and managing corporate real estate (CRE) and facilities (FM) in Australian local government occurs in circumstances rich with emotive possibilities. Beside the potential for civic protest and **upset** in response to facility proposals, **happiness** and **satisfaction** (bolded affective words from the *Affective Lexicon* (Clore et al., 1987)) from the community and users are also aspirations of the local government facility providers. Local government is a useful laboratory to examine affective psychology in managing CRE and facilities because of this eruptive potential and the multiplicity of stakeholders inside or outside the local authority body that could erupt.

The study originated in a professional's observation that 'perceptions' were a problematic phenomenon at odds with their 'objective' management. This points towards psychological processes at work as 'perceptions' are internal processes most usually used in psychology for visual and cognitive processes (Pylshyn et al., 1999). The 'heat' that is evident from time-to-time around local government facility decisions suggests an affective, or emotional, basis to the subjective assessments and psychology is at work.

Three psychological functions are evident – affect, cognition, and behaviour (Forgas, 2000). Each operates in its own right, but also interpenetrates and influences the other functions (Clore et al., 1987). These functions form the basis of attitudes (Triandis, 1971), which are of interest here for their contribution to 'perceptions'.

This paper summarises key findings from a doctoral research project (Heywood, 2007). Previous papers have covered some of the study's detailed aspects but this paper provides the overarching framework. After considering the study's background, a summary of the evidence of affect is presented. This points towards a 'Scheme of Affective Management', and five roles of affect in local government CRE and FM.

AIM

Overall, the research aimed to investigate the affective psychology evident in the management of local government facilities because forms of affectively-based subjective assessments ('perceptions') were problematic in practice and a substantial gap in the theory. Therefore, how affect plays a role in effective local government corporate real estate management was the research's central question, but subsidiary questions relating to defining the phenomenon and how it was used were also important.

BACKGROUND

As noted, the research originated in an observation from the practice of managing local government CRE and facilities, and their projects. Such practice has a technical-rational base (Schön, 1983) and struggles with subjective assessments (Walker, 2002). It is beyond the scope of this paper to fully discuss the field's technical, rational and managerial aspects, but Heywood (2007) discusses this more comprehensively.

Recently, CRE and FM practice has emphasised management of CRE and FM for strategic organisational purposes. For local government, these strategic purposes are frequently concerned with people and the delivery of public services and goods to them. This means that for local government CRE and FM, there are consequences for people from the strategic management of facilities. Local government facilities support and facilitate residents' well-being (Michalos and Zumbo, 1999), and, in turn, people form relationships with 'their' facilities. Disruptions to individual facilities through CRE and FM projects provide catalytic opportunities for affective subjective assessments to arise, based on assumed threats to well-being (Nussbaum, 2001).

As local government provides and manages more well-being facilities than other organisations, local government CRE and FM is primed for affective consequences to ensue from its projects. It should be noted that not all of the consequences are negative. These projects also provide opportunities for positive affective effects to occur.

Literature that could be useful in the area of subjective assessments of environments like real estate and facilities – such as Environmental Psychology – deals with people's assessments of environments through concentrating on environments as physical settings and their transactions with human actors (Gifford, 1997). Environmental Psychology also has a perspective of being an agent for positive change and an antidote to hegemonic positions. Types of local government facilities have been considered, see Stokols and Altman (1987), though not specifically in a local government management context. This work is of considerable interest to FM which specifies people and place as important components of its remit and is useful for designing facilities to more meaningfully meet users' needs. However, there is little guidance for the actual management of those environments. Also, much of the literature is concerned with residential and natural environments, and visual assessments of environments, which are of limited utility to managers of real estate environments.

Where affect and environments are connected it is most usually in terms of affective qualities of, or induced by the physical environment, for example: Russell and Pratt (1980). The affective content of events associated with that environment is frequently overlooked (Donald, 2001), or inadequately framed with regard to environmental dimensions and the management and political dimensions of the problem (Manzo, 2003)

In summary, the problem is important because both practice and theory have substantial gaps in dealing with stakeholders' affective subjective assessments of the performance of CRE and facilities.

METHOD

The research's methodology was a psychological based, orientational qualitative enquiry (Patton, 1990). Case study was the principle research method as this is most suitable for context embedded research (Yin, 1994). The empirical study site was an inner to middle suburban municipality in Melbourne, Australia. The four cases were:

- Financing facilities through increasing property taxes;
- A Library-Community Centre project; and
- Two sets of elderly citizens' Independent Living Units.

Of the ways of detecting affect for research purposes language was determined to be the efficacious method being a proxy of emotion in the absence of visual or neurological detection of emotion (more usual in 'pure' research into affect). Therefore, the *Affective Lexicon* (Clore and Ortony, 1988) was used to analyse the affective content of language. Coding, based on the Affective Lexicon, revealed the affective content of the language data (Miles and Huberman, 1994). The lexical structure includes categories for affective evaluations, the psychological functions (conditions) as 'frames-of-mind' (longer-term dispositions), 'states' (brief, temporally bounded), and 'state-like' (similar to but not explicitly states) conditions. Inter-linked conditions, such as 'affective-cognitive conditions' are also provided (Clore and Ortony, 1988; Clore et al., 1987).

EVIDENCE OF AFFECT IN LOCAL GOVERNMENT CRE MANAGEMENT

The study demonstrated an overarching phenomenon of affect in effective local government CRE and FM with many affective consequences and processes in managing their projects. That affect in local government CRE and FM was present was evident in the amount of it in the consequences of CRE and FM, and secondly, in the management practices employed for affective purposes – a consequential 'Scheme of Affective Management'. Affect was evident in three instances. These were:

- The language of CRE and facility projects – evidence of an Affective Domain;
- Project assessments (expectations and evaluations, including evaluation devices such as measures-of-success); and
- Issues to be encountered and managed in CRE and FM projects.

Affective language in local government CRE and FM

The study's theoretical framework showed that affect was a much larger and more complex phenomenon than just *emotion* which is, more properly, defined as a short-term affective state most often associated, and confused, with affect.

While forms of subjective assessment, as ‘perceptions’, provided the impetus for this research, a much larger range of pertinent affective phenomena exists, including moods, affectively nuanced evaluations and affective-cognitive states. Analysis showed that affect is pervasive in the language of local government CRE and FM with between 47.5% and 59.8% in the data for the individual cases (see also Heywood et al. (2005a)). Affect is so pervasive that it constitutes an ‘Affective Domain’ for local government CRE and FM practice. Affect is not just in civic protest, but throughout CRE and FM, even in documents intended to record objective facts.

Affect was evident in all of CRE and FM’s voices though there were different levels of affect in different stakeholders’ voices with municipal stakeholders’ language having more affective content than the Council and Council officer stakeholders. This confirmed the dissonance between CRE and FM and assessors of their effects that provoked the research.

This research provides the field with a better definition of affect than just ‘emotion’, which can be loosely used and was shown, when defined more precisely, to constitute quite a small part of the data. This is notwithstanding the trigger effect of affective states for behaviour and other psychological functions.

Affect in CRE project assessments

Generally, it was expected, by CRE and FM, that affect would be present in responses to their work. The four affectively-based clusters of expectations were:

- General project expectations that stakeholders have affective responses to project proposals;
- Expectations of specific affective consequences from particular management actions;
- Expectations about the utility of affect for management purposes; and
- Affect is a distraction (and an irrelevancy) to the main purpose of achieving project outcomes.

Affect was significantly present in the measures used to evaluate the success, or otherwise, of the effects of projects (measures-of-success), for example: **happiness**, **satisfaction**, **enthusiasm** (all *affective states*). These measures are most readily identified with evaluative, post-project forms of assessment, but they also contributed to ante-project assessments, as expectations.

CRE and FM encounters with, and management of, affect

Affect was found likely to be encountered and managed in two particular and important issues for local government projects. The first was the ‘spectre of civic protest’ which influenced decisions about the conduct of projects and the practices adopted to manage affective outcomes. The second issue was ‘ownership’ of Council facilities which was shown to be a multi-dimensional phenomenon with affective bases and a result of an affective psychological process (Heywood et al., 2005b). Consequently, ‘ownership’ contains some ambiguity, the mishandling of which raised possibilities for the undesirable CRE and FM effect of affective eruptions with reduced possibilities for achieving positive affective measures-of-success.

Using affect in local government CRE and FM – A Scheme of Affective Management

The presence of affect, generally, in project assessments, and particularly in the encounters with and requisite management of affect point towards a 'Scheme of Affective Management' that contained four uses for affect.

The first was affect's use in guiding project processes and in influencing the project's conduct. Four decisions about project conduct with affective consequences were identified:

- To be deliberatively provocative;
- To be unable to avoid being provocative;
- To attempt to avoid being provocative; and
- To attempt to achieve positive affective outcomes.

The second use was affective language as a means of achieving affectively-valued measures-of-success through positive affective outcomes such as **satisfaction** (*affective state*), or even just **acceptance** ((*affective*) *cognitive state*). These were a strong indicator of CRE and FM effectiveness. Affective language was evident in communicating aspects of the facilities, as part of managing them as projects and the affect in them. The first aspect found was in the architect's descriptions, as an evaluation of a proposed building, and how it met the brief. The second was in describing a proposed building for a public, or non-expert, audience. These descriptions also provided evidence for the translation of affect across project stages from that contained in the briefing to communicate the, about to be built, the end result.

Third was the use of agents, both as an integrator and communicator of affective information, and as an affective buffer for CREM, which was discussed fully in Heywood et al. (2007).

Fourth was the use of exemplar projects to expose project stakeholders to various effects from buildings, management arrangements, facility siting, urban design and service delivery. Examples were used in two ways. The first was as an affective evaluative mechanism ('I **like**' (*affective state-like condition*)) to select aspects for use in project briefing, and in informing stakeholders about project processes. Second, there was the use of an 'exposure-affective preference effect' (Zajonc, 1968) to win over stakeholders through familiarising them with facilities and facility management processes, similar to those envisaged for the new facility.

THE ROLES OF AFFECT

Affect's multiple roles in local government CRE and FM was demonstrated using five thematic elements from a cognitive map metaphor containing elements of: *District*, *Edge*, *Landmarks*, *Pathways*, and *Nodes* (taken from Lynch (1960)).

This research demonstrated that there is a *District*, or domain to local government CRE and FM practice that is affectively based.

Given CRE and FM projects' catalytic affective potential, the expectations which are the ante-project assessments of projects and their effects that stakeholders bring with them define an affective *Edge* condition to such projects. This provides affect with a role in the expectations that CRE managers encounter.

Important affectively based ‘measures-of-success’ that were identified constitute a key *Landmark* in projects, influencing the project processes adopted. Affect operates as a *Landmark* in guiding conduct of the projects to achieve desired affective results and consequences. The research showed three identifiable roles:

- Affect used as a trigger;
- Affect used soothingly; and
- Affect treated as a nuisance and endured.

Affect’s role in CRE and FM practices and processes formed *Pathways* used to traverse the ‘Affective Domain’, be that the use of agents to achieve affective outcomes, or their agent’s use of affective language in achieving those outcomes as part of the Scheme of Affective Management.

That affect has a role in local government CREM projects was particularly demonstrated in the concentrated *Node* of negotiating the psychological and affective ambiguities of ‘ownership’ of local government facilities in delivering projects. The use of agents, language, and measures-of-success were affective concentrations evident in the translation of affect across project stages, and producing positive affective outcomes. The presence of affect across all stages demonstrates the many phases and aspects of CRE and FM project processes.

DISCUSSION

Affect matters in local government CRE and FM for two reasons. The first is the importance of the real estate itself and what it does, and the second is the contribution of affective psychology to its effective management.

CRE and facilities are important in local government because they are financially valuable, constituting a majority of local authorities’ asset base, and significant amount of recurrent expenditure. Local government CRE and facilities provide and facilitate important social goods for the municipality. This implies that managing CRE and facilities, and providing and renewing them through projects has social and human consequences that need to be taken into account. Affect may be ignored in local government CRE and FM at some risk of adverse subjective assessments. These include actualised, or potential, civic protest with associated varying amounts of ‘heat’ (affective value) which may, in turn, have flow-on effects to political processes within local government political-governance cycle. Consequently, there may be disruptions to CRE and FM’s Technical-Managerial practice and outcomes. Therefore, how CRE and facilities are managed may make a difference by being more effective for the organisation and thereby provide greater benefit to the municipality and its residents.

Affect also matters, because of facilities’ social and human consequences, in affect’s contribution, as a normal psychological function, to people’s subjective assessments of the effects of CRE, facilities and their management. This contribution has been overlooked in theory and practice to date. That is, the existing literature is inadequate in providing a theoretical basis for understanding such subjective assessments made by the recipients of CRE and facility effects. They are also poorly understood, or overlooked, by practitioners. However, the research demonstrated an unacknowledged contribution of affect in effective CRE and FM practice.

CONCLUSION

This study, in a field that is at best undertheorised, provides an overarching framework to considering CRE and FM projects and the role of affect in them.

Effective local government CRE and FM does include affective practices in its repertoire of practices. Most important in these is the ‘measures-of-success’ which form the basis of assessments. These measures probably relate, most closely, to the originating practical problem of ‘perceptions’. Of those assessments affective ones – **happiness** and **satisfaction** – are important indicators of success. However, the research also revealed significant other roles for affect in shaping project processes and decisions made about them – in the agents used in these processes, and the tools those agents employ, such as language.

While studied in Australia, the findings also have relevance to other jurisdictions and to non-public sector settings. Indeed, the results apply to a more generalised situation – where Technical and Managerial professionals encounter stakeholder affective responses, and the affective practices employed in doing that Technical-Managerial work. The effects of CRE and FM may be, either, those from the physical artefact, or environment, which has results and consequences, or the outputs, results and consequences of management activities themselves.

The literature of people’s assessments of environments was noted as concentrating on understanding them as physical settings. This study contributes to understanding both the socio-political context of environments and environmental types under represented in the literature. The affective practices that this research revealed may now be included as part of local government CRE and FM’s work.

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REFERENCES

Clore, G. L. and Ortony, A. (1988) 'The semantics of the affective lexicon', In *Cognitive perspectives on emotion and motivation,* (eds.), Hamilton, V., Bower, G. H. and Frijda, N. H., Kluwer Academic Publishers, Dordrecht ,The Netherlands and Boston, Massachusetts, pp. 367-397.

Clore, G. L., Ortony, A. and Foss, M. A. (1987) 'The psychological foundations of the affective lexicon', *Journal of Personality and Social Psychology*, 53, 4, pp. 751-766.

Donald, I. (2001) 'Emotion and offices at work', In *Emotions at work: theory, research and applications for management,* (eds.), Payne, R. L. and Cooper, C. L., John Wiley & Sons, Chichester, pp. 281-303.

Forgas, J. P. (2000) 'Introduction: The role of affect in social cognition', In *Feeling and thinking: The role of affect in social cognition*, (ed.), Forgas, J. P., Cambridge University Press, Cambridge, pp. 1-30.

Gifford, R. (1997) *Environmental psychology: Principles and practice*, 2nd ed., Allyn & Bacon, Boston, Massachusetts.

Heywood, C., Missingham, G. and Kenley, R. (2005a) 'Bridging the gap: Exploring expectations and perception-based performance assessments', *Proceedings of Combining Forces 11th Joint CIB International Symposium*, (ed.), Tulla, K., June, Helsinki, Vol. IV, pp. 267-279,

Heywood, C. A. (2007) The role of affect in local government corporate real estate management, PhD Thesis, University of Melbourne.

Heywood, C. A., Missingham, G. K. and Kenley, R. (2005b) 'Ownership and community assets: Managing change processes in strategic local government corporate property management', *Proceedings of 11th Pacific Rim Real Estate Society (PRRES) Conference*, January, Melbourne. Proceedings available at www.prres.net/.

Heywood, C. A., Missingham, G. K. and Kenley, R. (2007) 'Affective roles for agents in local government corporate real estate projects', *Proceedings of cobra 2007*, (eds.), Borello, L. and Thomas-Mobley, L., 6-7 September, Atlanta, Georgia.

Lynch, K. (1960) *Image of the city*, MIT Press, Cambridge, Massachusetts.

Manzo, L. C. (2003) 'Beyond house and haven: toward a revisioning of emotional relationships with places', *Journal of Environmental Psychology*, 23, pp. 47-61.

Michalos, A. C. and Zumbo, B. D. (1999) 'Public services and the quality of life', *Social Indicators Research*, 48, pp. 125-156.

Nussbaum, M. C. (2001) *Upheavals of thought: The intelligence of emotions*, Cambridge University Press, Cambridge.

Pylshyn, Z. W., McFarland, D. J. and Cacace, A. C. (1999) 'Is vision continuous with cognition? The case for cognitive impenetrability of visual perception', *Behavioral and Brain Sciences*, 22, 3, pp. 341-423.

Russell, J. A. and Pratt, G. (1980) 'A description of the affective quality attributed to environments', *Journal of Personality and Social Psychology*, 38, 2, pp. 311-322.

Schön, D. A. (1983) 'From technical rationality to reflection-in-action', In *The reflective practitioner: How professionals think in action*, Basic Books, New York, pp. 21-69.

Stokols, D. and Altman, I. (eds), (1987) *Handbook of environmental psychology*, John Wiley and Sons, New York.

Triandis, H. C. (1971) *Attitude and change*, John Wiley and Son, New York.

Walker, A. (2002) *Project management in construction*, 4th ed., Blackwell Science, Oxford.

Zajonc, R. B. (1968) 'Attitudinal effects of mere exposure', *Journal of Personality and Social Psychology Monograph Supplement*, 9, pp. 1-27.

INDIVIDUAL AND SITUATIONAL INFLUENCES ON PERCEIVED OFFICE NOISE

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ABSTRACT

Noise is among the most frequent complaints in offices. A common reaction of facilities managers to noise complaints in offices is the measurement of physical noise. This approach, however, is not very promising because it is based on the wrong assumption that intensity of physical noise is important in individual office noise experience. Based on the results of a survey with 82 office workers in two different office buildings and the corresponding measurement of physical noise, I argue that non-physical noise characteristics and individual attributes are far more important than intensity of physical noise. Multivariate regression analyses show that the experience of noise is explained by non-physical noise characteristics such as the informational content of noise, sources of noise, individual task and office environment related assessments of task privacy, and traits (sensitivity to noise). Data indicate that physical noise intensity measurements are not related to the experience of noise in any way. Rather, individual noise experience is explained best by sensitivity to noise and ability to concentrate together with ratings of non-physical noise characteristics. These findings indicate that the experience of noise of middle intensity is best explained by a person-environment framework and not by an environmental attributes approach. Implications for facilities management and for further research in office noise are discussed.

KEYWORDS: office noise, perceived noise, person-environment interaction

INTRODUCTION

Noise is among the most frequent complaints in offices. A common reaction of facilities managers to noise complaints in offices is the measurement of physical noise. This approach, however, is not very promising because it is based on the wrong assumption that intensity of physical noise is important in individual office noise experience.

The popularity of this assumption is probably due to the fact that most research deals with high-intensity noise that is injurious to health and detrimental to performance. Low-intensity noise (50-60 dBA), however, is much less researched.

Environmental stress not only influences short-term reactions but also affects health and health related behaviours in the long run. However, negative environmental conditions to not always, under all circumstances and with all people result in experiences of stress because individual reactions are different. Thus, environmental stressors are regarded as risk factors which possibly increase the experience of stress and so influence health.

In this paper, I present a short overview over some results concerning office noise and its perception by office users as well as consequences of office noise. Based on this overview, I propose to understand the effects of noise as an interaction of person and environment factors. Subsequently I present method and results of a study aiming at understanding the relation of physical and perceived noise in offices.

OFFICE NOISE

Low-intensity noise is typical for office environments and among the most common annoying sources in offices (Banbury & Berry, 2005; Sundstrom, 1986) and has been shown to negatively influence motivation (Evans & Johnson, 2000).

In addition to the intensity of noise, the type of work tasks has to be considered: different tasks are not affected to the same degree by office noise (Banbury & Berry, 1998). Particularly, task irrelevant background speech interferes with verbal performance (Banbury et al., 2001): The higher the informational content and intensity of noise the longer the time needed to complete tasks is needed and the more errors are made. Noisy and informational rich environments coupled with tasks of higher complexity lead office users to abandon work on tasks or to leave tasks incomplete. Thus, noise leads to unfavourable effort-output calculations because more effort and time has to be invested in order to achieve satisfying results (Sust & Lazarus, 2002).

There is extensive research evidence on the effects of informational content of perceived office noise: Nemecek and Grandjean (1973) report that noise produced by colleagues in the same office room is the most frequently named source of disturbing noise, independent of its intensity. Sundstrom et al. (1994) found in a survey of more than 2000 clerical workers in different office types that 54% complained about one or more sources of noise. The most frequent sources of dissatisfaction with acoustics in this research are telephones ringing and people talking face-to-face or on the phone. Similar results are reported by Jensen et al. (2005) who review survey results from 142 buildings. Their analyses reveal that the three sources of office noise mentioned above are the most important sources in various types of offices. Occupants in cubicles indicated significantly more dissatisfaction with office noise than occupants of open offices or private offices.

Office noise leads to disturbance and disruption of work and negatively influences office environment satisfaction (Lee & Brand, 2005) but not job satisfaction (Sundstrom et al., 1994).

Furthermore, there is some evidence that office noise reduces work motivation. In a laboratory experiment, Evans and Johnson (2000) compared stress experience and motivation of a group of clerical workers in a low-intensity noise condition that simulated typical open-office levels with workers in a control condition. Their results suggest that stress experience as measured in workers urinary epinephrine levels was higher in the experimental condition. Perceived stress, however, did not differ between the two groups. Motivation measures after a three-hour exposition to the office environment indicated that subjects in the experimental condition were less motivated. Leather et al. (2002) investigated the influence of environmental noise on job satisfaction, well-being, and organisational commitment. Contrary to other research (e.g. Sundstrom et al., 1994) no direct effects were found. However, reduced environmental noise seems to buffer negative effects of psychosocial job stress on job satisfaction, well-being, and organisational commitment.

There seems to be no habituation to sounds that possibly impair concentration in offices (Banbury & Berry, 2005).

In summary, the distracting influences of office noise are well documented as well as its negative effect on office environment satisfaction and various other outcome variables. There are, however, indications that speech privacy (non-physical qualities of noise) is more important than environmental noise level (intensity). Speech privacy refers to office users' ability to hold conversations in the workplace without being overheard and understood by people outside the workplace (Sundstrom et al., 1982). Speech privacy thus not only refers to noise level but also to noise events. The required degree of speech privacy varies between people and their needs and attributes. Measures of environmental quality attributes such as office noise therefore have to include individual influences that affect people's assessments of their environments. The person-environment relationship therefore is regarded as a complex interaction.

From the person-environment interaction perspective, perceived office noise is regarded as a function of both, the physical environment and individual characteristics. In this research we investigate the relative contributions of person and environment factors to perceived noise.

METHOD

82 office workers from two different buildings of the same financial sector company participated in the survey. All participants worked in similar open offices with 65 and 100 workplaces respectively. The two samples did not differ significantly in age, sex, or job type.

During one week physical noise levels were logged for about 10 hours per day. In addition, participants completed a survey with questions regarding their overall job satisfaction (Baillod & Semmer, 1994), noise sensitivity (Zimmer & Ellermeier, 1999), perceived noise (sources, intensity, duration, and frequency), and task privacy (Oldham, 1988). In order to control individual situations one item scales (mark on a continuous line between two poles) regarding general health status, general hearing status, and perceived stress were used. The exclusion criterion used was a value below two standard deviations below the mean. Furthermore, participants were asked to indicate whether they considered themselves as being in an individual situation that impaired their performance or psycho-physiological well-being.

Based on these criteria 16 participants had to be excluded from the sample. Thus the final sample consists of 66 participants.

RESULTS

Physical noise measurements for the two locations show a statistically significant difference ($p < 0.05$): the mean noise level in location 1 was 56 dBA (min 51.2, max 62.6) and for location 2 a mean of 51.2 dBA (min 48.9, max 55.3) was measured. There was no corresponding difference in office users' assessments of the noise levels. No significant differences in perceived noise level, duration of disturbing noise, and frequency of noise events were found. However, the two groups differed significantly on their assessment of task privacy ($p < 0.05$) with higher ratings of task privacy in the louder office environment.

There are no significant correlations between physical noise level and perceived noise level, duration or frequency. Physical noise level correlates significantly with task privacy ($r = 0.24$, $p < 0.05$).

Differences in perceived noise cannot be explained by physical noise properties. To further research this matter, multivariate regression analyses with perceived noise intensity, duration, and frequency have been carried out. Independent variables were physical noise, number of disturbing noise sources in the office environment, sensitivity to noise, age, and task privacy.

Results show that perceived noise intensity is explained by task privacy (beta = -0.35, p = 0.002), sensitivity to noise (beta = 0.31, p = 0.007), and number of disturbing noise sources in the office environment (beta = 0.26, p = 0.022). The regression model is significant (F = 8.362, p = 0.000) and explains 36 percent of the observed variance (adjusted R2 = 0.362). Multivariate regression analysis of perceived duration of noise at the workplace did not reach statistical significance. Frequency of noise is explained by task privacy (beta = -0.32, p = 0.007), sensitivity to noise (beta = 0.29, p = 0.013), and number of disturbing noise sources in the office environment (beta = 0.24, p = 0.037). This model reached significance (F = 6.817, p = 0.000) and explains about 30 percent of the observed variance (adjusted R2 = 0.305).

DISCUSSION

Statistical results show that perceived noise in offices is best explained through non-physical noise characteristics. Perceived intensity and frequency of noise in offices are not correlated to physical noise measures. Instead the observed variance in those measures is best explained by task privacy, sensitivity to noise, and number of disturbing noise sources in the office environment. Thus, with low-intensity noise, as is typical for office environments, personal traits (sensitivity to noise), individual possibilities to regulate interaction and control over information (task privacy), and physical characteristics of noise (perceived sources of noise, but not noise intensity) jointly influence noise perception. Physical noise level interestingly does not play a central role in this relation. Physical noise level, however, correlates positively with task privacy, indicating that more noise is associated with more task privacy. This correlation can be explained in two ways: (1) more noise can mask single disturbing noise events. Due to the presence of more noise, the intelligibility of disturbing speech of colleagues may be reduced. This leads to higher perceived task privacy. (2) More noise can be compensated by additional task related efforts (cf. Hockey, 1997). These extra efforts may be detrimental to health in the long run because they can result in permanent overstraining of individual resources.

Based on the data collected in this study, no conclusions regarding these two explanations can be made.

Generally, the findings indicate that the experience of low-intensity noise is best explained by a person-environment framework and not by an environmental attributes approach.

Limitations of this study consist in the rather small sample. Both the number of subjects and the number of different office rooms limit the ecological validity of the analyses. More research in more heterogeneous office settings is desirable. Furthermore, more sophisticated physical noise measurements would contribute to greater ecological validity. In our study, the noise measurement device was placed in one single location in the offices researched. Multiple measurement points and the measurement of not only noise intensity but possibly more appropriate measures such as Articulation Index (AI) or Speech Intelligibility Index (SII) can prove advantageous for the study of noise in offices (Venetjoki et al., 2006).

CONCLUSIONS

Based on the results from our study, complaints of office users about office noise are best understood in terms of distractions and disturbances or as complaints about speech / task privacy. Data indicate that physical noise intensity measurements are not related to the experience of noise except for the number of sources of noise in the office environment. The measurement of physical noise intensity therefore is an inadequate reaction to complaints about noise. An adequate reaction to noise complaints consists in the analysis of office users' privacy needs, their characteristics (sensitivity to noise) and their assessment of office acoustics. In addition, physical measurements with regard to speech privacy (such as AI or SII) have to be set into relation with data provided by office users. The combination of self-reported data and physical measurements is necessary because perceived noise is determined by both individual characteristics and the physical office environment. The crucial element of effects of the office environment for office users work behaviour is not the physically measurable quality but the function of office environment characteristics for individuals and their work tasks. If this function is optimised, positive effects on performance, satisfaction, health and well-being can be expected.

REFERENCES

Baillod, J. & Semmer, N. (1994). Fluktuation und Berufsverläufe bei Computerfachleuten [Turnover and careers of computer professionals]. Zeitschrift für Arbeits- und Organisationspsychologie, 38, 152-163.

Banbury, S. & Berry, D. C. (1998). Disruption of office-related tasks by speech and office noise. British Journal of Psychology, 89, 499-517.

Banbury, S. & Berry, D. C. (2005). Office noise and employee concentration: Identifying causes of disruption and potential improvements. Ergonomics, 48 (1), 25-37.

Banbury, S., Macken, W. J., Tremblay, S. & Jones, D. M. (2001). Auditory distraction: Phenomena and practical implications. Human Factors, 43, 12-29.

Evans, G. W. & Johnson, D. (2000). Stress and open-office noise. Journal of Applied Psychology, 85 (5), 779-783.

Hockey, G. R. J. (1997). Compensatory control in the regulation of human performance under stress and high workload: A cognitive-energetical framework. Biological Psychology, 45, 73-93.

Jensen, K. L., Arens, E. & Zagreus, L. (2005). Acoustical quality in office workstations, as assessed by occupant surveys. Proceedings Indoor Air 2005, Sept. 4-9. Beijing, China.

Leather, P., Beale, D. & Sullivan, L. (2002). Noise, psychosocial stress and their interaction in the workplace. Journal of Environmental Psychology, 23 (2), 213-222.

Lee, S. Y. & Brand, J. L. (2005). Effects of control over office workspace on perceptions of the work environment and work outcomes. Journal of Environmental Psychology, 25, 323-333.

Nemecek, J. & Grandjean, E. (1973). Results of an ergonomic investigation of large-space offices. Human Factors, 15 (2), 111-124.

Oldham, G. R. (1988). Effects of changes in workspace partitions and spatial density on employee reactions: A quasi experiment. Journal of Applied Psychology, 73 (2), 253-258.

Sundstrom, E. (1986). Work places. The psychology of the physical environment in offices and factories. Cambridge: Cambridge University Press.

Sundstrom, E., Herbert, R. K. & Brown, D. (1982). Privacy and communication in an open plan office: A case study. Environment and Behavior, 14 (3), 379-392.

Sundstrom, E., Town, J. P., Rice, R. W., Osborn, D. P. & Brill, M. (1994). Office noise, satisfaction, and performance. Environment and Behavior, 26 (2), 195-222.

Sust, C. A. & Lazarus, H. (2002). Bildschirmarbeit und Geräusche [Working with VDU and noise]. Dortmund: Bundesanstalt für Arbeitsschutz und Arbeitsmedizin.

Venetjoki, N., Kaarlela-Tuomaala, A., Keskinen, E. & Hongisto, V. (2006). The effect of speech and speech intelligibility on taks performance. Ergonomics, 49 (11), 1068-1091.

Zimmer, K. & Ellermeier, W. (1999). Psychometric properties of four measures of noise sensitivity: A comparison. Journal of Environmental Psychology, 19, 295-302.

KNOWLEDGE CREATION IN ENTREPRENEURIAL FIRMS: THE ROLE OF REAL ESTATE MANAGEMENT ACTIVITIES

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ABSTRACT

How does the educational level of workers affect knowledge creation in entrepreneurial firms? Entrepreneurial firms have a particular vulnerability, which is their human capital, and require particular management skills to prevent losses. This article interweaves the disciplines of knowledge management and entrepreneurship, where the purpose is to develop a model that depicts the knowledge creation relationship of entrepreneurial firms in particular and its environmental context related to real estate management. This article is based on the results of a survey in Sweden that consisted of an investigation of the offices of 967 enlisted growth firms covering the entire country, forming a basis for further theoretical development. This finding suggests that education level has a gravitational character according to traditional location theories. The empirical findings create a basis for conceptualising a model of knowledge creation in entrepreneurial (in contrast to conservative) firms performing under dynamic and competitive environments. Three concepts from the theories of entrepreneurship are transferred to real estate management factors where the educational level of staff would play a significant role.

KEYWORDS: knowledge, entrepreneurship, workplace, growth firm

INTRODUCTION

Entrepreneurial firms of today do not always necessarily grow in terms of numbers of employees. Rather, growth often means growth of turnover, because skills in outsourcing reduce the need to employ staff in Western industries. Firms that are successful with growth parameters such as “turnover” and “employees” are surprisingly neither very young nor large. In fact the average age of the firms listed in the Gasell list, published annually in Sweden, is 15 years. Therefore the word “entrepreneurial” is preferred to “growth” or “start-up”. From the resource-based perspective, the value of a firm is related to its accumulation of knowledge. The entrepreneurial firm must operate in a business environment with various factors, such as fluctuations of business cycles, which influence market access (Dettwiler et al., 2006a). Some firms prosper from a hostile environment by opportunist and risk management (Lindelöf and Löfsten, 2006). Both the theoretical and physical firm boundaries have in recent decades become looser due to an increased propensity to outsource and respectively “insource”. Entrepreneurial firms of today are characterised by keywords like “cross disciplinary teams”, “knowledge sharing between teams”, etc. Knowledge must be developed and created in both core business-related matters as well as domain knowledge that supports the core business, like facilities management and corporate real estate management (REM). The location of the workplace is often a crucial factor relating “nearnesses” to various factors like staff and owners’ homes, client distance, image, etc. (Dettwiler et al., 2006b). The knowledge-intensive society of today promotes education which is spread out to society and the industry. In some sense, educational level might be connected to the knowledge accumulation of firms. Some questions arise: *Is there any relationship between the real estate concerns of entrepreneurial firms and knowledge* *accumulation? Is the development of knowledge of the various issues of entrepreneurial firms a harmonious one?* This paper aims to connect the knowledge creation of entrepreneurial firms and its surroundings to real estate issues, in this particular case with REM variables: location, relocation and the propensity to rent (instead of owning) the premises.

ENTREPRENEURIAL FIRMS

Miller (1983) describes capability to scan the environment through variables as; the financial control system, dynamism, competition and heterogeneity that play a significant role for the analysis of his conceptualisation of *entrepreneurial* and *conservative* firms. The literature on the relationship between entrepreneurship and its environment suggests that conservative and entrepreneurial firms manifest quite different characteristics in coping with their environments.

The environment is a term used to explain a number of factors relevant to a firm's environment which affect the design of the management system and include the significance of industry-related technology level, environmental factors, industry competition, price competition, etc. Segers (1999) claimed that growth firms often enjoy the advantage of dynamic, entrepreneurial management embodied in a system that is flexible and highly responsive to change, and who are willing to accept financial, technological and marketing risk.

Among conservative firms, innovation is performed reluctantly and occurs only as a result of challenges by competitors, whereas among entrepreneurial firms innovation is considered as a natural state. Networks are intrinsically linked to the concept of interaction outside the firm. An entrepreneurial environment should encourage both spontaneous interaction and formalised interaction between staff within the firm and toward various external actors.

Certain environmental characteristics may elicit entrepreneurial behaviour on the part of organisations (Covin and Slevin, 1991). Dynamic environments have been found to encourage entrepreneurial firm-level behaviour (Miller et al., 1988). Organisations often respond to challenging environmental conditions, such as those in high technology environments, further related to the concept of *dynamic hostility*. Several studies have indicated that the relationship between entrepreneurial posture and firm performance is moderated by environmental conditions.

Unwillingness to participate in a network for various reasons inhibits location on multiple sites. Avoiding relocation or entering new contractual relations can be related to the classification of the conservative firm described by Miller (1983), which is a definition through four facilitators that constitute the concept of entrepreneurial orientation leading to innovation: (1) the environment must yield challenges, (2) information, (3) the ability to innovate, and (4) appropriate management decision methods for innovative projects. Decisive features of the environment can thus be related to access to facilities and resources. Access to facilities and resources that promote innovation and reliance on the financial force is a quality of the environment. Complex innovation requires multidisciplinary settings of facilities from the environment and openness to apply the facilities within the firm.

Several studies have indicated that the relationship between entrepreneurial posture and firm performance is moderated by environmental conditions. It is found that small growth firms are generally expected to favour differentiation strategies, since only rarely will they be able to utilise economies of scale.

Small firms may possess various bundles of resources that serve as the foundations for development. According to the resource-based view (Penrose, 1959), differences in resources, like accumulated knowledge, should be utilised and lead to differences in sustainable competitive advantage. Miller (1983), therefore, maintains that there should be some common relationships between environmental dimensions and those of strategy. The dimensions of *dynamism, hostility* and *heterogeneity* have often been used to characterise the environment.

A Swedish survey revealed the high significance of security and protecting intellectual property and business ideas among growth firms (Dettwiler and Bröchner, 2003). The risk-taking dimension refers to the willingness of management to commit significant resources to opportunities in the face of uncertainty. The assumption is that conservative firms tend to be risk-adverse, non-innovative and reactive, and entrepreneurial firms tend to be risk-takers. This is not entirely true. Miner (1990) argues that entrepreneurs take calculated risks based on specific conditions, and findings demonstrate that growth firms are generally expected to favour differentiation strategies, which generate a high degree of flexibility and the ability to respond to changes in the external environment (Covin and Slevin, 1991; Miller, 1983).

Literature on entrepreneurship often relates to technological development and innovation. Lindelöf and Löfsten (2006) reveal the advantages of NTBFs' (New Technology Based Firms) acting in a dynamic environment of competition; three components were adopted from Miller (1983) as latent constructs: (1) *innovativeness*, (2) *risk-taking* and (3) *proactiveness.* The three variables relate to the *behaviour* of the firms, which is in fact deduced from the individual and collective activities of the staff. The latter variable, proactiveness, is related to the firm's propensity to compete with its rivals. Furthermore, the behaviour of achieving the growth goals of entrepreneurial firms is related to innovation and technological development (Slevin and Covin, 1994). Dettwiler et al. (2006a) have further developed the concept of the entrepreneurial environment to include the *business environment* for all industry sectors, which also includes the influence of the fluctuation of gross domestic product (GDP), later reduced to business cycles (Dettwiler, 2008).

KNOWLEDGE CREATION

Penrose (1959) pioneered the resource-based view of firms, which has since become an accepted concept of research, referring to the accumulation of tangible and intangible resources in growth firms. The resource-based view relates to the competitive advantage that is created through specific capabilities and assets. The accumulation of knowledge unique to the firm matters, and there has been recent progress in the analysis of the knowledge structure found in firms (Laursen et al., 2001). Alvarez and Busenitz (2001) theoretically linked the concept of entrepreneurship and resource-based theory and identified particular entrepreneurial resources: entrepreneurial knowledge and the ability to coordinate resources. The crucial resources, in the present context, are knowledge of facilities and facilities management, in addition to the obvious physical resources that are constituted by the offices and facilities controlled by the firm.

Porter (1990) described knowledge resources as one of the factors constituting a nation's competitive advantage. From a more micro perspective, Nonaka and Takeuchi (1995) theoretically developed a model in which the "raison d'être" of a firm is to create knowledge. This idea is in fact very similar to the resource-based view of Penrose. Knowledge is created by various mechanisms between tacit and explicit knowledge. According to Nonaka and Takeuchi (1995), "ba" is an abstraction of "space" and "time" as a common notion. Knowledge is created through a repeated four-phase process – explicit and tacit knowledge interchange through the so-called SECI process: (1) Socialisation, (2) Externalisation, (3) Combination, and (4) Internalisation. When (4) is attained, the process continues to (1) and proceeds from the beginning. In the socialisation phase, communication happens between individuals, whereas in the other three phases, exchange of knowledge happens between group and organisation. The model thus implies that very small firms with inferior external interaction are inhibited from developing knowledge in those three phases (Externalisation, Combination and Internalisation) (Figure 1).

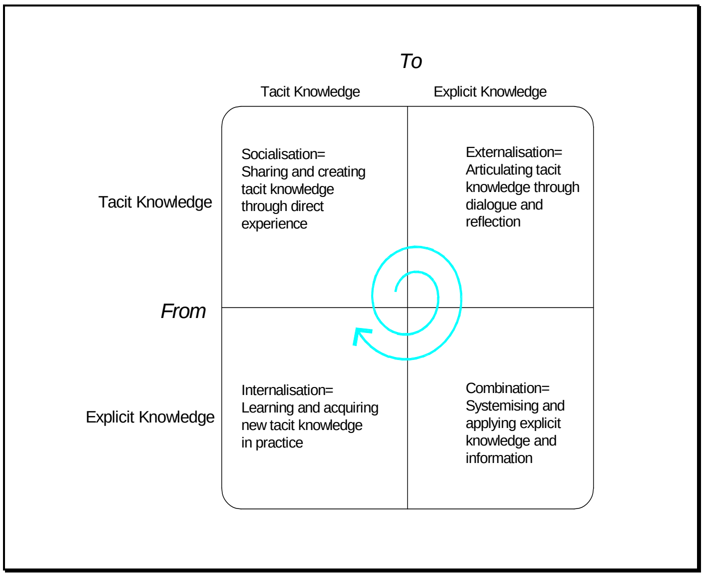

Figure 1. Knowledge conversion processes (Fong, 2005)

The ideas of knowledge creation are further developed by Fong (2005), who highlights five processes in knowledge creation in cross-disciplinary teams from the construction sector. Firstly, the importance of *crossing boundaries* by various kinds of interaction between team members is regarded as a platform for the other processes. The second process is *knowledge sharing*, which focuses on differences of knowledge that can be transferred rather than similarities in knowledge. Based on two case studies of large companies, Kalling and Styhre (2003) see linkages between knowledge sharing and cost reduction and productivity. Third is *knowledge generation*, which is enabled through interaction and communication in primarily social networks. Fourthly, *knowledge integration* is expressed as "marrying" the different perspectives, and the fifth process involves collective project learning, where failures have a value in the project as objects for increased learning.

The processes often require continuous changes of groups that are sometimes spontaneously created and dissolved. Starting up a firm can also be similar to a project, where the founders, and primarily employed staff, assemble together to find a market segment to conquer and therefore must find a competitive advantage by creating specific knowledge. Aldrich and Ruef (2006) referred to three types of entrepreneurial knowledge: (1) previous work experience, (2) advice from experts, and (3) imitation and copying. Knowledge and international growth are enhanced by fostering social capital and thus facilitating international expansion (Yli-Renko et al., 2001).

Barnett (1994) placed two ideologies of competence – operational and academic – against each other and explored the changing definitions of knowledge competence. The *educational level* is thus related to the character of knowledge and is different to that of operational character. Operational FM related to daily routines of maintenance might be more relevant to tacit knowledge, whereas explicit knowledge might refer to explicit knowledge with writing, and reading as a tool for knowledge transfer would then be more related to strategic FM. A successful operational FM is however strongly dependent on capabilities in strategic FM in, for example, activities of quality management with continuous improvement and benchmarking capabilities.

As a firm grows, various resources are accumulated (Penrose, 1959) where knowledge is regarded as an important core resource. Nonaka and Takeuchi (1995) created a “knowledge spiral model” (Figure 1) with four modes of knowledge creation through the interaction of tacit and explicit knowledge: socialisation, externalisation, combination and internalisation. The model represented in a spiral is expressed by knowledge of the fourth mode, internalisation, being further transferred to the first mode, socialisation, where the process proceeds.

The model of Nonaka and Takeuchi has been integrated in a REM context by Puddy *et al.* (2001), who relate the deployment of REM policies to four factors obtained from factor analysis concerning the REM function of the Post Office in the UK. The social interaction has high importance for effective collaboration that enables the mobilisation and conversion of tacit to explicit knowledge. Generally speaking, growing firms rely on their tacit knowledge in REM, whereas professional REM providers, mature and large firms tend to have explicit REM policies. However, a more elaborate view will show differences between sectors. According to Nonaka (1988), a “bottom-up” management style relates to the entrepreneur who acts in chaotic surroundings. Hierarchies prevail in the “top-down” management style, where explicit knowledge is the dominating dimension. He further explained that explicit knowledge should be more dominant in the western world, whereas tacit knowledge is more evident in Japan.

THE SWEDISH SURVEY

The empirical material of this survey is assembled from an existing database, the Gaselle list, provided by Soliditet, owned by Bonniers Affärsinformation. The main criterion for a Swedish firm to be listed is reporting a minimum rate of turnover growth during the preceding four years. Incidentally, the number of firms that fulfil the criteria of the Gaselle list has decreased over the last five years. The present survey is based on the Gaselle list of 2002, containing 967 listed firms. The database also includes annual company turnover, number of employees and changes (measured in % during a four-year period) in employee numbers and turnover. The present questionnaire was distributed in November and December 2004 by post to the whole population of 967 firms on the 2002 Gaselle list. The questionnaire consists of 35 questions and statements, among which 30 variables have two time values, the periods 1998 to 2000 and 2001 to 2003. The first period, 1998 to 2000, corresponds to three years of high growth of the Swedish GDP and the second period to a three-year period of low GDP.

After a second reminder, the responses were 387 (40%). 58 (10%) of the 580 non-respondent firms were randomly selected for additional telephone interviews during February and March 2005. Almost all (98.3% of the non-respondent sample) orally answered five control questions selected from the original questionnaire. The survey results were registered in SPSS version 12.0.1 with the last check of the accuracy of the variables in April 2005. The Wilcoxon signed t-test indicates that generalisation of the whole population is significant. However, the propensity to estimate image values appeared to be higher among the non-respondents.

Since it is probable that there are differences in REM patterns among industries, the mean values of the studied variables are calculated for the three main categories according to the SNI (Swedish Standard Industrial Classification 2002, corresponding to the EU recommended standard, NACE).

Table 1. REM variables that correlate with educational level

Correlation with Educational Level	No Correlation with Educational Level
Office Location in City Cores	Office Location in Suburbs
Office Location in Rural Areas (Negative Correlation)	Relocation Abroad
Office Location in Company Parks	
Spread to Multiple Sites	
Relocation within Sweden	
Propensity to Rent Offices	

We observe several correlations, listed in Table 1. Location in suburbs seems to be particularly distinct from other alternatives regarding educational level. However, office location in rural areas is negatively correlated to educational level. This might indicate that REM variables correlated to educational level are then linked to traditional location theories.

DISCUSSION OF THE MODEL

We learn from the observations of Fong (2005) that five discernable processes contribute to knowledge creation. Age does in fact appear to be a relevant dependent variable in the present Swedish survey. A question arises therefore: *are there different patterns depending on the age of an organisation or company?* The educational level of the staff might play a role; the propensity to acquire new knowledge has a different character according to the ideas of Nonaka and Takeuchi (1995). Tacit knowledge is developed from the branch-specific knowledge that is sometimes not formulated through literature, whereas explicit knowledge is in fact formulated and a source for knowledge within education.

The proposed model in Figure 2 suggests a process of knowledge development with an entrepreneurial environment. The educational level of staff plays a role, with a staff-related “ambience” of knowledge development where the “culture” depends on the educational level of staff and their interaction capabilities. The entrepreneurial “spirit” has implications for real estate decisions; in our particular case, location, relocation and the propensity to own or rent the premises. The particular status of a firm’s environment has consequences for REM behaviour. Therefore the three extracted factors of innovativeness, risk taking and proactiveness are managed differently depending on the educational level (Table 2).

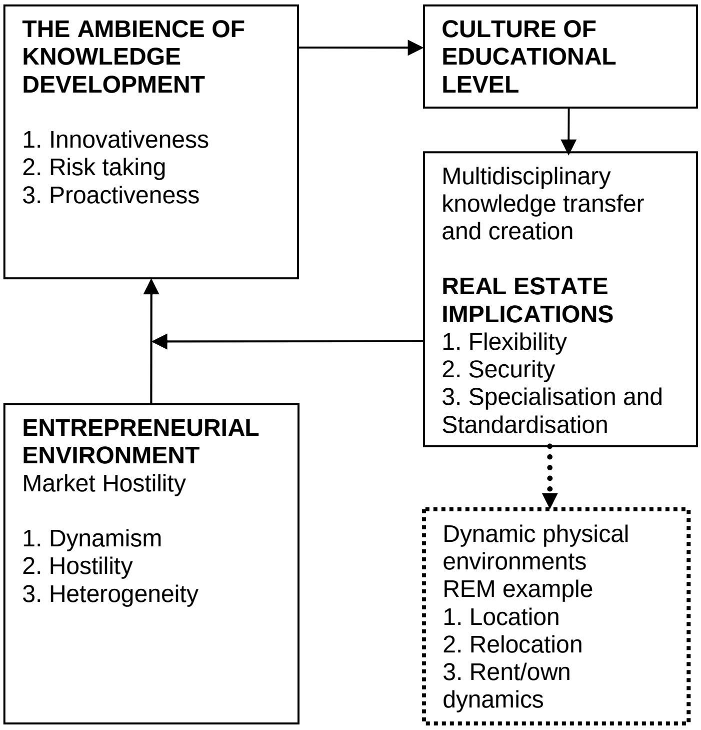

Figure 2. A model of the entrepreneurial environment, educational level and real estate implications

The real estate implications urge flexibility; not only physical but also from a variety of financial perspectives (Gibson, 2001). This paper has argued that real estate decisions are strongly related to the particular environment and conditions that prevail for entrepreneurial firms.

Table 2. Linking real estate implications to entrepreneurial theories

Entrepreneurial Factors	KM Transfer	Real Estate Implications
Innovativeness	Tacit knowledge: earlier business cycles influence lifelong learning, Explicit knowledge: literal acquisition	High flexibility in multiple dimensions, Physical and financial, Promotion of interaction
Risk Taking	Tacit knowledge: protect from "imitators" Explicit knowledge: Protection of intellectual property	Protection of "competitive" advantages and security have physical implications, must excel in REM
Proactiveness	Tacit knowledge: Focus of knowledge base through experienced staff Explicit knowledge: Finding source of information/knowledge at cutting edge of the business specialty	Creating facilities for virtual and real interaction for cross-disciplinary teamwork. Keeping knowledge within firm; security incitements

REFERENCES

Aldrich, H.E. and Ruef, M. (2006), *Organizations Evolving.* Sage Publications.

Alvarez, S.A. and Busenitz, L.W. (2001), "The entrepreneurship of resource-based theory", *Journal of Management*, Vol. 27, No. 6, pp. 755-775.

Barnett, R. (1994), *The Limits of Competence: Knowledge, Higher Education and Society*, Open University Press, Bristol PA.

Covin, J.G. and Slevin, D.P. (1991), "A conceptual model of entrepreneurship as firm behaviour", *Entrepreneurship Theory & Practice,* Fall, pp. 7-25.

Dettwiler, P. (2008), "Modelling the Relationship between Business Cycles and Office Location: The Growth Firms", *Facilities*, Vol. 26. No. 1/2, forthcoming.

Dettwiler, P., Lindelöf, P. and Löfsten, H. (2006a), "Business environment and property management issues: a study of growth firms in Sweden", *Journal of Corporate Real Estate,* 8 (3) pp. 120-133.

Dettwiler, P., Lindelöf, P. and Löfsten, H. (2006b), "Utility of location: A comparative survey between small new technology-based firms located on and off Science Parks - Implications for facilities management", *Technovation*, 26 (4) pp. 506-517.

Dettwiler, P. and Bröchner, J. (2003), "Office space change in six Swedish growth firms", *Facilities,* Vol. 21, 2003, No. 3/4, pp. 58-65.

Fong, P.S.W. (2005), "Co-creation of Knowledge by Multidisciplinary Project Teams", In Love, P., Fong, P.S.W. and Irani, Z. (eds.) *Management of Knowledge in Project Environments* (pp. 41-56), Oxford: Butterworth-Heinemann.

Gibson, V. (2001), "In search of flexibility in corporate real estate portfolios", *Journal of Corporate Real Estate,* Vol. 3, No. 1, pp. 38-456.

Kalling, T. and Styhre, A. (2003), *Knowledge Sharing in Organizations,* Liber AB, Malmö.

Laursen, K., Mahnke, K. and Vejrup-Hansen, P. (2001), *Firm growth from a knowledge structure perspective*, Paper prepared for LINK Conference Copenhagen, Dept. of Industrial Economics and Strategy, Copenhagen Business School, 7th-8th August 2001.

Lindelöf, P. and Löfsten, H. (2006), "Environmental Hostility and Firm Behaviour-An Empirical Examination of New Technology Based Firms on Science Parks", *Journal of Small Business Management,* Vol. 44, No. 3, pp. 386-406.

Miller, D. (1983), "The correlates of entrepreneurship in three types of firms", *Management Science,* Vol. 29 No. 7, pp. 770-91.

Miller, D., Droge, C. and Toulouse, J.M. (1988), "Strategic processes and content as mediators between organizational context and structure", *Academy of Management Journal,* Vol. 31, No. 4, pp. 544-69.

Nonaka, I. (1988), "A Dynamic Theory of Organizational Knowledge Creation", *Organization Science,* Vol. 5, No. 1, pp. 14-37.

Nonaka, I. and Takeuchi, H. (1995), *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. Oxford University Press, Oxford.

Penrose, E.T. (1959), *The growth of the firm.* Basil Blackwell, Oxford.

Puddy, J.R., Price, I. and Smith, L. (2001), "REM policies and standards as a knowledge management system", *Facilities,* Vol. 19, No. 13/14, pp. 504-514.

Slevin, D.P. and Covin, J.G. (1994), "Entrepreneurship as firm behavior: a research model", in Katz, J.A. and Brockhaus, R.H. (Eds), *Advances in Firm Emergence, Growth, and Entrepreneurship*: Volume 2, JAI Press, Greenwich, CT. pp. 175–224.

Yli-Renko, H., Autio, E., Sapienza, H.J. (2001), "Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms", *Strategic Management Journal* 22, 587–613.

MODELLING KNOWLEDGE EXCHANGE AMONG END-USERS USING SOCIAL NETWORK ANALYSIS

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ABSTRACT

This paper considers how facilities managers engage in knowledge exchange between different suppliers and end-users and considers tools that may be used to understand these exchange processes. The research considers the various forms of knowledge exchange that are prevalent in such communities, focusing on the learning process arising from users' ongoing activities. It draws on concepts from social network analysis (SNA), which considers the interplay between various actors and stakeholders throughout a project's lifecycle. It seeks to understand ways in which FM organisations can elicit and encode tacit 'uncodified' knowledge embedded in their social networks for innovation and organisational learning, whilst fostering a knowledge culture among end-users.

KEYWORDS: social network analysis, end-user, knowledge exchange, actors

INTRODUCTION

This paper considers the theoretical basis for understanding how facilities manager engage in knowledge exchange and the learning process with suppliers, managers, owners and other end-users of a facility. It seeks to comprehend rapidly changing facilities management initiatives undergoing rapid change using the tenets of the social network theory so that the underlying *social* aspects of knowledge exchange, especially those pertaining to tacit 'embedded' knowledge, can be better understood.

This study forms part of a research initiative on 'learning through life', funded under the Knowledge and Information Management (KIM) Grand Challenge initiative in the UK. This paper seeks to explain the theoretical basis of the work undertaken. It is expected that once fully developed, this application of the social network theory – one aimed at analysing and improving the social aspect of knowledge exchange – would become an important tool for enhancing learning and improving the management of knowledge in a facilities environment. The research also explores the possibility of effectively using IT systems, usually associated with the codification and dissemination of explicit 'codified' knowledge, for the dissemination and exchange of tacit knowledge among a facility's end-users.

KNOWLEDGE EXCHANGE AS A SOCIAL PHENOMENON

In recent decades, knowledge exchange has increasingly become a concern for organisations (Marouf, 2007), primarily because of its impact on organisational learning and innovation. Initially this interest in knowledge exchange (KE) reflected the fact that knowledge work was now seen as a significant contributor to a firm's value-adding capabilities (Hansen, 2002). However, this interest remained focused, at least initially, on explicit knowledge only. This emphasis later broadened to encompass tacit, embedded knowledge due to various relatively recent findings that discovered that tacit 'uncodified' knowledge was of far more value to the organisation than explicit 'codified' knowledge. This was especially the case with the process critical to maintaining competitiveness in the market- that of innovation. Furthermore, research found that surprisingly, knowledge within organisations was more often than not tacit (Leonard D et al., 1998).

With this increased awareness that knowledge was more often tacit, situational and embedded within social groups and social situations, the importance of the *social* aspects of knowledge retention and transfer is beginning to be emphasised fervently in the Knowledge Management literature (Bresnen et al., 2003). Besides recognising the significance of tacit knowledge, Bresnen et al. (2003) also found in their study that 'the processes of knowledge capture, transfer and learning…rely very heavily upon social patterns, practices and processes in ways that emphasize the value and importance of adopting a community-based approach'. This finding is important as it sheds new light on the community-related and social aspects of knowledge capture, transfer and learning. This major finding that knowledge capture, transfer and learning (whether it be tacit or explicit knowledge) are dependent upon the *social* structures within organisations demanded that further investigation be done into the phenomenon.

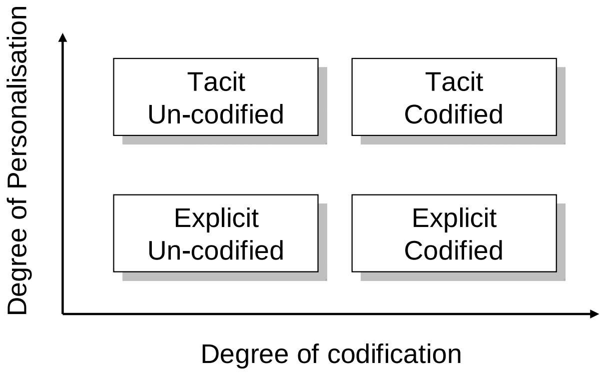

Figure 1. Personalisation versus codification (adapted from Hansen *et al* (1999)).

Later, other academics, such as Tsai and Ghoshal (1998) noted among their findings that knowledge exchange in internal organisational units provided the most opportunity for mutual learning in organisations. Baum and Ingram (1998) found evidence that organisations that were able to share knowledge effectively inter-unit were more likely to survive that those who were less proficient at knowledge sharing. The question of why some organisational units were more skilled at knowledge exchange while others were not, was answered by some scholars in terms of individual personality traits as opposed to situational limitations (Hinds and Pfeffer, 2001). Others such as Reagans and McEvily (2003) explained knowledge exchange from the social network perspective and interrelationships.

Against this background, this current work considers the process of knowledge exchange in organisations' social networks (that are seen to run in parallel to the formal organisational structure). Social Network Analysis (SNA) was identified as the key technique for studying this phenomenon because of its ability to capture the social facet of organisations.

SOCIAL NETWORKS AND SOCIAL NETWORK ANALYSIS

Social networks are perceived as social structures made of nodes that either represent individuals or organisations that are tied by one or more specific types of inter-dependencies (Scott, 2000). Ties and inter-dependencies vary in nature depending upon whether they share information and resources electronically or through face-to-face interaction and whether they are based on friendship, work or advice (Nohria, 2000). Social Network Analysis (SNA) views these social relationships based on inter-dependencies in terms of nodes and ties. Nodes depict the individual actors within the networks, while ties are the relationships between the actors. Within an FM context, the type of tie between any two actors has significant consequences on the overall flow of knowledge exchange within intra-organisational units and extra-organisational units such as suppliers or facility users.

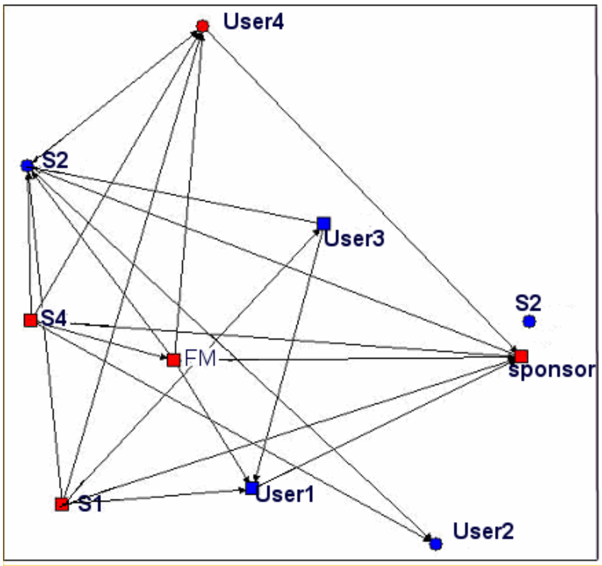

Figure 2: Illustrative schematic of nodes in an FM social network

The theory and application of social network analysis (SNA) has developed considerably since the 1930s. It has, however, experienced an unprecedented interest since the 1990s with the emergence of sophisticated tools available for users (Scott et al., 2005). Initially used by the researchers in social and behavioural sciences, it now emerges as a key technique in modern criminology, sociology, anthropology, geography, communication studies and social psychology. Criminology applies SNA for uncloaking criminal or terrorist networks and for exposing business ties and financial flows to investigate possible criminal behaviours. It is extensively used in epidemiology to understand how patterns of human contact aid or inhibit hospital-acquired infections among patients and staff and the spread of HIV among prison populations. SNA has also been used by organisations to find emergent leaders through network analysis, and to improve the functioning of various project teams.

The majority of social network studies employ “whole-networks” or “egocentric” designs. “Whole-network” studies examine sets of interrelated actors or objects that are, for analytical purposes, regarded as a bound social collectives or groups (Scott J et al., 2005). This form of analysis assumes non-permeable and strict network boundaries that usually do not exist in the real world but simplify the analysis. “Egocentric” studies focus on a focal actor and the relationships in its locality (Scott J et al., 2005). In an attempt to understand the focal role (and to ascertain if one exists *at all*) of the Facilities Manager (FM) during the process of knowledge exchange among the various end-users of a facility, this research undertaking has applied an egocentric approach to the study with the FM as the focal actor and the other professions forming the relationships within its locality. Social network analysis has specifically been selected for the process as it has allowed the relationships and not the transactions among the actors to be studied. Another advantage of using SNA is that SNA allows better codification of exchanges within social settings as compared to techniques that do not consider the social aspects of transactions within organisations.

THE ROLE OF I.T.

Computer Aided Facility Management (CAFM) is the technical support system used to assist facilities-related functions such as lease management, strategic planning and move management. While CAFM has been regarded as representing one extreme of *explicit* knowledge exchange, the authors feel that it ought to evolve as a tool that aids in tacit knowledge dissemination as well. During the current research, the possibility of using the CAFM of organisations, as a tool of connecting networks will also examined. As multiple stakeholders formally use the CAPM, there remains, as yet, an unexplored possibility that CAPM may actually disseminate knowledge throughout the FM-centred network very effectively. The exchanges within the network (studied during the research), hence, will also monitor the usage pattern of the technical support system.

COMMUNITIES OF PRACTICE

Originally developed by Wenger in 1991 (Wenger, E. and Lave, J. 1991) the Communities of Practice approach is now widely used in the analysis and facilitation of knowledge transfer in a range of organisational environments (Roberts, J. 2006). Wenger (1999) later identified communities of practice as a mechanism through which knowledge is held, transferred and created. Wenger also found that while communities of practice are an integral part of our daily lives, existing at work and outside, they can be a powerful learning tool (Wenger, 1999).

The primary actors

Although closely related to the actor-network theory, that considers both human as well as non-human actors as part of a network, social network analysis is founded on the interactions of human actors alone. Since projects are linked to their environment through different types of relationships to gain information, knowledge and other resources, neither they nor permanent organisations can be understood without taking their relations to other organisations into consideration (Jensen 2006). The human actors studied are representative of actors from within the organisation as well as other organisations involved in the relocation project.

As the situation that forms the core of the study is a relocation of a large educational facility to a refurbished locality, the actors in the network include the facilities manager and his team members; sponsors; directors and top management; users of the educational institution comprising of several categories of actors such as faculty, students, support staff; people who will be inconvenienced by the project such as neighbouring facilities, educational partners, long-distance students and local authorities; facility owners; space planners; various administrative departments such as the Information Technology and the Finance Departments of the institution as well as contractors, builders, consultants and legal advisers. Chotipanich (2004) showed that the environment of FM practice is populated by relationships that originate form the macro-environment, the business sector, the organisational characteristics, the facility type and the specific FM function. The actors being studied are representative of all five areas of Chotipanich's (2004) environmental model.

The work involves investigation into the political, personal and power-related issues that arise among the end-user community during this relocation exercise that specifically relate to knowledge exchange. Firstly the investigation questions the central position of the Facilities Manager in the scenario represented by the case study and secondly investigates. the characteristics of the exchanges of knowledge among the end-user actors. The aim is to determine the closeness of knowledge-exchange ties among the actors discussed previously, to building upon previous research such as that by Marouf (2007) that commendably found that the strengths of the *business* relationships and not those of *social* relationships among actors of such organisational networks that determined the exchange of public as well as private tacit knowledge within the organisation.

PROPOSED METHODOLOGY

Whilst the knowledge management literature has discussed knowledge retention, knowledge transfer and knowledge sharing in varying degrees, the focus of the current study is on the observation of knowledge exchange in social settings within the chosen organisations, as this aspect denotes a two-way flow of knowledge dependent upon the closeness of the formal and social bonds between the actors involved.

This is an egocentric SNA study that concentrates on the Facilities Manager as the focal actor to understand the nature of knowledge exchange among the facility's end users. Data is assembled on relationships involving the Facility Manager as this focal object (the ego) and the other objects (alters) linked to it. A case study involving relocation of a large educational facility forms the basis of the data.

While the decision to select objects and actors within a network is difficult, an event-based approach based on the participation in the relocation activities will be used to describe the boundary specifications. Data collection will involve actors from the various departments within professional bodies (e.g. BIFM) as well as all those external players involved. is the intention is to use 'expanding selection' (Scott J et al., 2005) that allows research to commence with a provisional 'fixed' list of objects deemed to be in a network but linked objects are later added to the list as they are identified. This allows a relatively uncomplicated boundary specification at the start while allowing the network diagram to develop as further relationships with other objects are identified. This has the added advantage of drawing from the knowledge of participants during the investigation so that time is saved while setting the initial boundaries. As noted by Blackburn (2002) defining the boundary of the network being studied too narrowly reduces the chance of observing the influence of key actors but on the other opens up a risk 'invisible others' working to perhaps undermine the study partially because the researcher remains unaware of their existence.

BENEFITS OF APPLYING SOCIAL NETWORK ANALYSIS TO FM

The role of the facilities management team is rapidly evolving, and is beginning to play a significant role in the strategic decision-making process. Hence, in order to make an effective case when procuring organisational resources for the FM function or to increase the efficiency and influence of the FM function, it is imperative that its ability to influence and learn from other stakeholders be understood far more clearly than is currently the case.

As discussed, knowledge exchange of the tacit type is ever more important in organisational learning and innovation than the explicit type. In order for the FM function to be able to take advantage of the knowledge (whether it be product-related, service-related or process related) running through its network of users and suppliers, it needs to be aware of the *nature* of networks that exist among the primary actors. Only then can existing knowledge management tools and techniques be applied effectively. Organisations need to look into the networks supporting the FM function and SNA is a technique providing advantages mentioned earlier.

This paper has attempted to highlight the importance of social network analysis to the modern day organisation. In particular, it identifies the potential role of facilities management as a catalyst for social exchange. Through the use of formal techniques like social network analysis it is envisaged that conventional tools used in space planning and knowledge exchange might be augmented.

REFERENCES

Baum, C. and Ingram, P. (1998) “Survival Enhancing Learning in the Manhattan Hotel Industry”, Management Science, Vol. 44, pp. 996-1016.

Blackburn, S. (2002) “The Project Manager and the Project Network”, International Journal of Project Management, Vol.20, pp. 199-204.

Bresnen, M., Edelman, L., Newell, S., Scarbrough, H. and Swan, J. (2003) “Social Practices and the Management of Knowledge in Project Environments”, International Journal of Project Management, Vol. 21, pp. 157-166.

Chotipanich, S. (2004) “Positioning Facility Management”, Facilities Vol.22 No. 13/14w pp.364-372.

Hansen, M. (2002) “Knowledge Networks: explaining effective knowledge sharing in multiunit companies”, Organisation Science, Vol.13, No.3, pp. 232-48.

Hansen, M. T., N. Nohria, and T. Tierney (1999) "What's your strategy for managing knowledge?" Harvard Business Review, 77 (March-April): 106-116

Hinds, P. and Pfeffer, J. (2002), “Why organisations don’t know what they know, cognitive and motivational factors affecting the transfer of expertise, available at: www.gobi.stanford.edu/research papers/library/RP1697.pdf

Leonard, D. and Sensiper, S. (1998) “The role of tacit knowledge in group innovation”, California Management Review, Vol.40, No.3, pp. 112-32.

Marouf, L.N. (2007) “Social networks and knowledge sharing in organisations: a case study”, Journal of Knowledge Management, Vol.11, No.6, pp.110-125.

Nohria, N. (2000), Is a network perspective a useful way of studying organisations?, in Nohrian, N. and Eccles, R. Networks and Organisations, Harvard Business School Press, Boston, MA, pp. 1-21

Pieter van donk, D. and Riezebos, J. (2005) “Exploring the knowledge inventory in project-based organisations: a case study”, International Journal of Project Management, Vol.23, pp. 75-83

Reagans, R. and McEvily, B. (2003) “Network structure and knowledge transfer: the effects of cohesion and range”, Administrative Science Quarterly, Vol.48, pp. 240-67.

Roberts, J. (2006) “Limits to communities of practice”, Journal of Management Studies, Vol.43 No.3, pp623-639

Scott, J. (2000), Social Network Analysis, Sage Publications, London.

Scott, J., Carrington, P. J. and Wasserman, S. (2005), Models and Methods in Social Network Analysis, Cambridge University Press, NY.

Tsai, W. and Ghosal, S. (1998) “Social capital and value creation: the role of intra-firm networks”, Academy of Management Journal, Vol.41, No. 4, pp. 464-76.

Wenger, E., Lave, J. (1991), Situated Learning: Legitimate Peripheral Participation, Cambridge, Cambridge University Press.

Wenger, E. (1999), Communities of Practice: Learning Meaning and Identity, Cambridge University Press, Cambridge, UK.

Wenger, E., McDermott, R. and Snyder, W. (2002), Cultivating Communities of Practice, Harvard Business School Press, Boston.

THE POTENTIAL OF KNOWLEDGE MANAGEMENT PROCESSES FOR FACILITATING PFI PROJECT

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ABSTRACT

Knowledge management (KM) is one of the strategies that can be used to improve organisational competitiveness and performance. Like the Private Finance Initiative (PFI), KM attempts to improve service performance. Facilities Management (FM) now has an increasingly important role to play in PFI projects. It is therefore important within the PFI-FM context, to manage knowledge for facilities, particularly on its processes, the approaches to dealing with problems, and the management of day-to-day operations. This allows facilities managers to be more effective at both the operational and managerial levels. The aim of this paper is to identify knowledge management's potential and its relevance to the integration of facilities management practice in PFI projects. Reviews on current practice, issues and problems, indicate that it would be beneficial to adapt knowledge management in FM organisation, particularly at the operational level. By adopting KM, it could facilitate the effectiveness of managing services and later overcome the shortfalls in meeting expectations and the desired performance level of FM organisations. A discussion is also included on the future research direction for the development of a conceptual framework to support the integration of facilities management practices with relevant knowledge management principles.

KEYWORDS: knowledge management, operational stage, PFI.

INTRODUCTION

An awareness of the importance of delivering and managing services in PFI projects has been highlighted in various government reports, journals and printed articles. In order to achieve the quality of services and level of performance targeted, there is a need to understand the scope and impact of PFI contracts. Further, this can lead to a better understanding of the facilities management approach particularly in the operation and maintenance stages.

The main function of a facilities management team is to act as a support function to the organisation (Alexander, 1997). However, in the PFI context, its role in the operation and building services and property management are more critical and demanding (Underwood and Alshawi, 2000). The operational and maintenance function in PFI projects such as hospitals clearly involve high operational risk of failure (Chotipanich, 2000) and demanding level of maintenance services activities. Since facilities management deal with long-term operational level and strategic level, there are several challenging operational and management problems that occur on PFI projects.

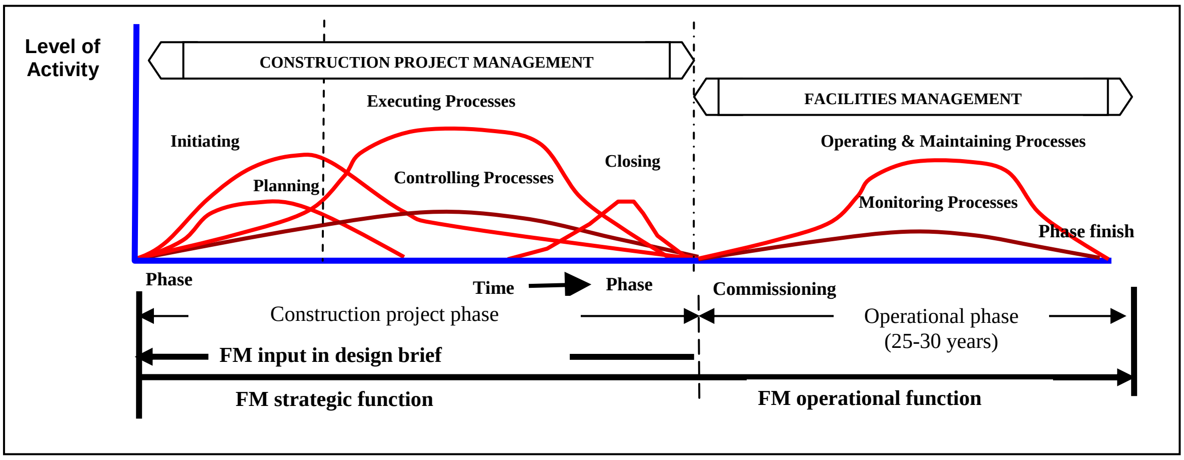
The project organisation especially FM service providers are engaged to deliver and to perform to a level of services required. These are aligned with the nature of PFI contracts which are driven by services performance. Thus, in the PFI-FM context, knowledge of managing facilities, processes and approach for dealing with problems, and management of day-to-day operation help the facilities manager to be effective, both at the operational and managerial level.

OPERATION AND MAINTENANCE IN PFIs PROJECT

The nature of the PFI procurement with project long life span that usually took place for 25 to 30-year, makes the operation and maintenance period pack with high degree of uncertainty (Nutt, 2000). This is why most PFI's stakeholders choose to outsource their facilities services. In contrast, for other types of procurement, the whole life cycle of the project including operation and maintenance period takes up only 2 to 5-years. Thus, PFI shifts the normal practice of existing facilities management approach towards new PFI-FM approach (Payne, 1997; Zhang and Kumaraswamy, 2001). These new approaches are geared to produce a high level of services performance as stipulated in the contract.

Figure 1 illustrates the inclusion of the project management and facilities management functions across PFI projects' life-cycle. Construction project management involves the organisation of the project structure and its implementation towards the completion of a project. Once the facility is completed, facility manager is responsible for operating, maintaining, monitoring and performing the service delivery of the project for the next 25 to 30-years.

Figure 1. Inclusion of facilities management function in PFI project life-cycle (Adapted from PMBOK Guide, 2004)



In PFI construction projects, the involvement of facility management not only take places in the operation stage, but covers all stages, as early as at the design brief stage. In addition, there is a continuous relationship between FM input and knowledge provided throughout the PFI project life cycle. Positioning the FM function at the earlier stages of the PFI contract arrangement can lead to better information and knowledge flows of the built facilities. It can be done through the influence of facilities design towards its operation and maintenance (El-Haram, 2002)

The operation phase of PFI projects represents the most significant uses of facilities management practice. Therefore, the need of facilities management knowledge in PFI projects is becoming a main concern during the operational and maintenance phase. Processes and practice developed within PFI-FM project organisations generate important knowledge and require FM organisations to manage it. For instance, in considering design for efficient operation for new facilities, FM can provide an input of reliable life-cycle cost data from the design stage through to the operational FM brief (Nutt, 2000). Further, a study by

Moore and Finch (2004) on facilities management in South East Asia provided an interesting insight into the importance of management ability and knowledge of managing facilities. In their study they found the need to have a good understanding of FM is essential in order to cope with challenges and issues of complex projects. Thus it perceives the facility manager must be equipped with knowledge of facilities and management to carry out his integrated support role (Kincaid, 1994).

Studies by Mustapa and Carrillo (2007) on PFI-FM service providers highlighted the crucial phases of information and knowledge used by FM service providers in PFI projects. They identified two main phases that involves substantial amount of facilities management knowledge. First, the facilities managers need to develop the solution and to project the mobilising the services delivery activity at the earlier stage of operational PFI project. At this stage, the facilities manager acts on strategic demands, and develops tactical plans in line with the strategy. Meanwhile, at later stages where it involves operational tasks, facilities managers are required to deal with issues such as defects, changing nature of the project and legislation issues. Hence, the use of FM knowledge is becoming a significant challenges in order to cope with these current demands both for operational and strategic level of FM at this stage.

Problem Identification

An exploratory study done by Mustapa and Carrillo (2007) found that FM service providers face two key challenges in managing and operating PFI facilities. These are on meeting demanding performance requirements and managing stakeholder expectations. The study also found that during the operational stage, FM organisations have little control of managing changes in legislation and requirements imposed by the legislative authority. Along with the problems identified, a report by Partnership UK (2006) on the assessment of performance of FM practice in PFI school projects found that there are differences in interpretation of service levels between service providers and the public sector. This leads to difficulty in FM service providers managing and delivering services according to stakeholders' perspectives. Another concern of FM service providers during the operational phase is on the performance measurement mechanism.

Studies by Akintoye et al, (2003) highlighted some issues that impact PFI contractors' performance during operational phase of their contract. These include difficulty in specifying the quality of services and difficulty in pricing facilities management (FM) services. During the bidding stage, the precise definition of a high quality service may be indefinable, which allows different interpretations and can result in post-contract disputes between client and contractors. In relation of difficulty pricing FM services, this also occurs when less or no information is available in pricing the operational and maintenance aspects at earlier stage of PFI.

Further, the emphasis of long term relationships is also highlighted and considered as an issue during operational stage (HM Treasury, 2000). This indicates that success can be achieved only if the public authority and the contractor approach the project in a spirit of partnership. This can be best done by understanding each other's business, sharing a common vision, good knowledge transfer and trust between the parties. More attention needs during operational phase due to ensure smooth tasks on services and to meet the service performance as outlined in the contract. Further, it leads FM service providers delivering the services at their highest level.

From the problems and issues identified above, there needs to be an improvement in facilities management knowledge processes, predominantly in PFI contract scheme. Any approach to incorporate PFI and FM practice is generally to enhance the effective level of service delivery and performance service level made by FM organisations. The adoption of applicable knowledge management principles can assist facilities managers and their organisation to incorporate and exploit knowledge into PFI-FM practices.

OBJECTIVES AND METHODOLOGY

This research aims to improve FM process in PFI projects through identifying areas of FM knowledge applied especially during the operation and maintenance stage. Information and knowledge flow in PFI-FM practice was reviewed to identify the research problems and research gaps. Subsequently, integrating knowledge management principles in facilities management processes is expected to lead to improvement in service efficiency and performance level.

POTENTIAL OF KM TO FACILITATE FM AT OPERATIONAL PFI PROJECTS

An integration of knowledge management into operational practice allows for connecting knowledge and performance, as knowledge gains economic value when it is used to solve problems, explore opportunities and make decisions that improve production performance (Mohamed, 2006). In relation with value, PFI contract agreement is merely focus on value for money. Thus, by integrating knowledge management practice into PFI-FM practice will improve value for money in its operational stages. Through the process of knowledge management, intangible assets of FM organisations are better recognised and exploited to create value and knowledge both internally and externally for the benefit of the organisation (Davenport and Prusak, 1998)

The nature of facilities management practice present challenges for the integration of knowledge management within the PFI-FM practice context. An understanding of the potential offered by knowledge management and the way in which knowledge management can be used effectively within FM organisation, will become increasingly crucial for the organisations to manage services delivery and performance effectively. Indeed knowledge management in different organisations may serve different organisational purposes. Impact from these studies in this area may be extremely valuable, especially in FM organisations that have distinct knowledge management programme.

Improved coordination and communication in PFI-FM practice can be achieved through an approach of knowledge management. The adoption on this knowledge management processes can assist facilities managers and their organisation to incorporate and exploit knowledge into PFI-FM practices. In relation with the operational phase in construction projects where the facilities management function take place, a number of academics and practitioners have been expressing an interest in its relationship with knowledge management. Several researchers (Wong and Aspinwall, 2006; Gray, 2001; and Liao, 2002) have described the importance of having knowledge management in facilities management practice. They considered knowledge management is one of the strategies that can be used to improve organisational competitiveness and performance.

Since most project-related problems, solutions, experiences and know-how knowledge are in the heads of personnel and organisations during the construction and operational phases, capturing them and reusing in future projects can create advantages for an organisation. In the PFI-FM context, the FM service providers are responsible for day-to-day managing of information on their operational tasks and functions based on output specifications and contract documents. Thus, knowledge of the contract documents and output specifications are those categorised as implicit knowledge in PFI-FM contractual context that have to be managed. By referring the contract document, it helps both the operational team and management team to draw clear understanding of the content and awareness of their business scope. The contract document also communicates the required services to deliver, the number of operational staff required for each task, tasks to be done and level of services performance needed.

Thus, during the operational and maintenance stages of PFI projects, FM service providers are responsible for communicating the required services to deliver to their staff at operational level. It then helps both the operational team and management team to draw a clear understanding of the content and awareness of their business scope. Failure to understand and comply with the stipulated contract specification will results in contractual defects and performance penalties. With regard to the transfer and channelling of information from the document and output specification stated, Craig and Sommerville (2006) view that inter and intra-discipline communication between the distinctive parties and professionals is often problematic. Faniran et al. (2001) added that the lack of integration and co-ordination between the industry's distinct professions can be perceived as a major contributory factor to poor project performance.

In a view of PFI projects, information overload is a major problem for many facilities managers, who find they spend all their time attending to basic operational problems (Barret and Baldry, 2003). A further way to ease the information overload is to ensure that all of the facilities team, both in-house and contractors know exactly what is expected of them. Ali (2004) added that during the operational stage of a construction project, it involves plenty of information and requires some stages of decision making. It also demands an efficient level of communication. Thus, sharing information may help to solve the problem of incompatible communication and also help in establishing integration where information is freely exchanged in a disciplined manner amongst the project parties.

Process of knowledge creation and transfer in knowledge management processes are seem to be relevance in facilities management practice. Hence, it can be seen that the importance of adapting the knowledge management principles into the PFI contract practices acts as a medium to practice knowledge sharing and efficient knowledge dissemination throughout the contract duration.

DISCUSSION AND FUTURE RESEARCH DIRECTION

From the literature undertaken, it was deduced that facilities management knowledge is about supporting the business of an organisation and using its essential requirements as a driver for facilities improvement. In managing the services over a long time period, there are inevitable challenges in facilities management practice. Apart from the issues and challenges outlined, FM's knowledge facilitates the effectiveness of managing services with regards to the better understanding and integrated approach from both operational and managerial strategy. Effective communication helps organisation to understand each other's requirements and working practices, which can lead to fewer misunderstanding. By applying that, it facilitates the effectiveness of managing services.

In the next stage of research, it plans to investigate knowledge management adoption and innovative work practice in situations where FM service providers deal with highly demanding performance of day-to-day operational task as stipulated in PFI contract arrangements. Thus, the research seeks to understand actual practices and characteristic of knowledge embedded in personnel and organisation at operational stage of PFI projects. This can be done through assessing and establishing effective communication requirements, knowledge management tools and as well as examining the structure of organisation.

This research can be done through a form of qualitative research method based on detailed surveys and case studies involving PFI construction sectors. This method would involve surveying project groups and finding out their knowledge management practices, the nature of knowledge used or required, the tools and models used for sharing knowledge and the gaps existing in current practices with a view to introducing better alternatives. As such, the method is 'problem driven' in response to practitioners' perception of where knowledge flows exist and shares throughout the facilities management practice. From this approach, it then provides a gap and opportunity to draw a conceptual framework that can enhance the facilities management knowledge processes, predominantly in PFI contract scheme.

CONCLUSIONS

A review on existing literature indicates, that is has been beneficial to adopt knowledge management in the construction environment. Having highlighted the challenges and issues facilities management (FM) organisations face in the course of managing facilities and delivering services, the adoption of knowledge management is seen as beneficial and a potential solution to the problem. Facilities management knowledge facilitates the effectiveness of managing services with regards to the better understanding and integrated approach from both operational and managerial strategy. Knowledge transfer through effective coordination and communication helps organisation to understand each other's requirements and working practices. This could subsequently lead to fewer misunderstandings in the contract and improved interaction between personnel. By doing so, it facilitates the effectiveness of managing services and overcome the shortcomings in meeting expectations and levels of performance needed by FM organisations.

REFERENCES

Akintoye, A., Hardcastle, C., Beck, M., Chinyio, E., and Asenova, D. (2003), "Achieving best value in private finance initiative project procurement", Construction Management and Economics, Vol. 21 No. 6, pp. 461-470.

Alexander, K. (1997), Facilities Management: Theory and Practice, E & FN Spon, London.

Ali, K.N (2004) An Online Knowledge Management System for Reactive Maintenance Projects in the UK, Unpublished PhD Thesis, Salford University, Manchester.

Barret, P. and Baldry, D. (2003), Facilities Management: Towards Best Practice. 2nd Edition, Blackwell Science, Oxford.

Chotipanich, S. (2004), "Positioning facility management", Facilities, Vol. 22 No. 13-14, pp. 364-372.

Davenport, T. and Prusak, L. (1998), Working Knowledge - How Organisations Manage What They Know. Harvard Business School Press, Boston.

El-Haram, M.A. and Agapiou, A. (2002), "The role of the facility manager in new procurement routes", Journal of Quality in Maintenance Engineering, Vol. 8 No. 2, pp.124-134.

Gray, C. (2001), "A problem solving perspective on knowledge management practice", Decision Support Systems, Vol. 31 No. 1, pp. 87-102.

HM Treasury (2000), Public Private Partnerships (PPP) - The Government Approach, HM Treasury, London.

Kincaid, D. (1994), "Integrated Facility Management", Facilities, Vol. 12 No. 8, pp. 20-23.

Liao, S.H. (2002), "Problem solving and knowledge inertia", Expert Systems with Applications. Vol. 22 No. 21-31.

Mohamed, S.F (2006), Improving Construction Site Management Practices through Knowledge Management, Unpublished PhD Thesis, Loughborough University, Loughborough.

Moore, M. and Finch, E. (2004), "Facilities management in South East Asia", Facilities, Vol. 22 No. 9-10, pp. 259-270.

Mustapa, M. and Carrillo, P.M. (2007), "Facilities Management Knowledge in PFI Projects", in Egbu, C. and Tong, M. (Eds.), Proceedings 3rd PROBE Conference, 20-22 November 2007, Glasgow, PROBE, pp. 361-369

Nutt, B. (2000), "Four competing futures for facilities management", Facilities, Vol. 18 No. 3-4, pp. 124-132.

Partnerships UK (2006), Report on Operational PFI Projects, Partnerships UK, London.

Payne, H. (1997), "Key legal issues in projects procured under the private finance initiative", Engineering, Construction and Architectural Management, Vol. 4 No 3, pp. 195-202.

Underwood, J. and Alshawi, M. (2000), "Forecasting building element maintenance within an integrated construction environment", Automation in Construction, Vol. 9 No 2, pp.169-184.

Wong, K.W. and Aspinwall, E. (2006) "Development of a Knowledge Management Initiative and System: A Case Study", Expert Systems with Applications, No. 30, pp. 633-641.

Zang, X.Q. and Kumaraswamy, M. M. (2001) "Procurement protocols for public-private partnered projects", Journal of Construction Engineering and Management, Vol. 127 No. 5, pp. 351-358

TARGETING CLIENT GOALS WITHIN A PERFORMANCE FRAMEWORK: FACILITY MAINTENANCE KPIS AS FACILITATORS OF STRATEGIC ORGANIZATIONAL OBJECTIVES

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ABSTRACT

While such higher-level client objectives as health, creativity, innovation and interaction are increasingly being addressed through facility design and management, the crucial role of building maintenance is frequently overlooked. For instance, inpatient units with nature view, natural light and ventilation is being designed to influence patient recovery in healthcare facilities. Such outcomes could, however, be negated through improper maintenance that could potentially lead to nosocomial infection, patient fall, among others. Facility design and business processes are typically conducted in isolation from building maintenance, possibly owing to the erratic nature and unpredictability characterizing the latter. In this paper the authors illustrate a series of KPIs (Key Performance Indicators) in facility maintenance that could be successfully utilized to address such higher-level client objectives as health and creativity. Two types of indicators are introduced based on: (1) normative models in biophysics and physiology; and (2) empiricist models of Environment-Behavior studies. When combined, the two sets of indicators address the issue from the perspectives of building engineering and user-environment interaction, respectively, in a holistic approach to support strategic organizational objectives.

KEYWORDS: facility management, maintenance, performance indicators, organizational goals

INTRODUCTION

Over the past three decades organizations across the world have been implementing radical transformations to their business processes designs (USGSA, 1999; Allen et al, 2004). Veering away from earlier emphasis on maintaining rigid hierarchies and straight-jacketed processes, organizations in the late twentieth century, in both the corporate and government sectors, found themselves focusing on smaller and less hierarchical units, enhancing mobility, and infusing greater autonomy in decision-making (Rashid et al, 2006). The reason for such a transformation possibly originated in some ground breaking studies during the past decades. For instance, Peters and Waterman (1982), in their seminal study of the best performing corporations during the 1970s, found that inter-workgroup team encounters resulted in the germination of many of the best ideas in the corporate sector. The study shed light on the fact that traditional policies and processes may not deliver excellence, and appropriate physical environment is essential to address broader organizational goals. These developments, among others, led to a strategic rethinking in organizations, across building sectors, of the way they conduct business, changing their focus to creativity, health, productivity, learning, satisfaction and similar broader constructs, and the physical design necessary to promote such outcomes. The architectural design industry responded by providing appropriate physical environment to support the business process realignment. Calls for change in building engineering practices were also emerging during the 1990s, in response to this trend. One of the most straight forward appeals came from Gross (1996), who incorporated a broader definition of 'performance' which included economic, social, and other processes in a designed facility (as opposed to mere performance of building systems and sub-systems). He cited productivity in workplace, health, and well being of building occupants as important performance dimensions.

PROBLEM STATEMENT

While business practices and the physical environment design were and are being re-engineered to address the higher-level organizational goals, a critical aspect of facility-related organizational activity never found its way to the decision-making process – the science of facility maintenance. Exclusion of building maintenance however represents a missed opportunity (at the very least). For instance, inpatient units with nature view, natural light and ventilation is being promoted to influence patient recovery in the United States. Such outcomes could, however, be negated through improper maintenance that could potentially lead to nosocomial infection, patient fall, among others. Perhaps, the erratic nature and unpredictability characterizing building maintenance practices have precluded its formal inclusion in design and business processes decision-making.

In this paper we will discuss two sets of indicators, and will illustrate the use of the facility maintenance KPIs to support organizational strategic decision-making. We will start with a specific example to help articulate our thesis. For this example we will use healthcare as the building sector, since it represents a complex and conflicting set of performance parameters including those of building physics as well as the socio-cultural aspects of work settings. Although facility maintenance is a broad and hierarchical domain, let's start with one specific decision involving flooring (flooring system) in inpatient units. Designers of inpatient units have several options for flooring, including terrazzo, sheet vinyl, vinyl composition tile, vinyl planks, rubber, and carpet. Decisions are made based upon several performance parameters (an example set is listed in Table 1) in a subjective or objective manner.

Table 1. Typical performance aspects considered for inpatient unit flooring

Performance aspect	Subjective or Objective Measures
Patient safety: Infection control	Potential of microbial growth in flooring materials
Acoustics	Potential for noise reduction
Biomechanics: Orthopedic benefits	Comfort underfoot for caregivers
Patient safety: Static coefficient of friction	Slips and fall incidents in aging population
Biomechanics: Rolling resistance	Ease of operating carts, beds, equipment on wheels, etc.
Cost	Capital dollars for procurement and installation
Lighting	Potential of contribution to glare and other undesirable

Performance aspect	Subjective or Objective Measures
	lighting conditions
Durability	Ability of the flooring material to withstand the desired traffic load without undue wear and tear
Efficiency of operation	Room turnaround time for new admission
Ambience	Perceived warmth and comfort by patients; Image of the institution as an environment for healing

It needs to be underscored that facility maintenance parameters (other than a few immediate concerns with routine maintenance) are typically absent from such lists. In a healthcare setting the absence is particularly concerning since such settings are acutely sensitive to construction/renovation activities, and dust and airborne particulates contribute to serious health and safety concerns (for instance Mahieu et al, 2000).

The necessity for inclusion of KPIs related to maintenance could also be emphasized by the fact that many of the parameters in Table 1 are influenced by routine and periodic maintenance. Those include infection control, acoustics, coefficient of friction, durability, efficiency of room turn around, and ambience. Further, these parameters are intricately linked to supportiveness of the flooring system in a holistic patient care environment. For instance, assisting patient to the bathroom is affected by the performance in the areas of static coefficient of friction and rolling resistance (in some cases). Patient safety is affected by infection control, acoustics, lighting, and slips and fall, among other. In such a context, what is the appropriate strategy to integrate maintenance related performance parameters into the decision-making process?

HARD AND SOFT INDICATORS

In this paper we will illustrate the use of hard facility maintenance PIs along with a set of 'soft' indicators to support organizational goals. The set of 'hard' PIs includes objective indicators for maintenance policy justification and budget allocation. It was developed as part of a research project funded by the U.S. General Services Administration (USGSA). However, organizational outcomes are also influenced by cultural, social and personal factors. The second set of ('soft') indicators, developed as part of a doctoral dissertation work in Georgia Tech, is based on theories and models in the field of Environment and Behavior (EB, a multi-disciplinary field that originated from environmental psychology in the 1960s). It integrates variables from the physical, environmental and cultural/ personal domains, taking into account variations in setting types, personal attributes and cultural factors.

The USGSA funded study focused on GSA office buildings and the Georgia Tech study used courtrooms as the setting. We will however continue to draw parallels (and use) the healthcare example throughout this document. By doing so, we intend to show the ease of mapping to other building types, as well as maintain uniformity. Readers may notice that translation to other setting types is fairly straight forward. We will start with the maintenance PIs used in the GSA study, and subsequently address the soft PIs and modalities to support strategic decision-making.

Existing maintenance performance indicators

Several maintenance performance indicators have been developed in recent past. Such indicators include Building Performance Index (BPI), Manpower Source Diagram (MSD), Maintenance Efficiency Index (MEI), Managerial Span of Control (MSC), Business Availability (BA), Manpower Utilization Index (MUI), Urgent Repair Request Index (URI), Preventive Maintenance Ratio (PMR) and Maintenance Productivity. Owing to length limitations we will provide below brief descriptions of the indicators. For detailed descriptions of the indicators please refer to Shohet et al (2003), Chan et al (2001) and Augenbroe et al (2002).

Building Performance Index (BPI): This indicator monitors the physical state and fitness for use of the building and of the different systems in it, scaled from 0 to 100 expressing its physical and functional (performance) states (Shohet et al, 2003).
Manpower Sources Diagram (MSD): This diagram expresses the composition of the manpower to carry out maintenance. - in-house work forces vs. outside contractors (outsourcing), to rationalize balanced effective and economic maintenance (Shohet et al, 2003).
Maintenance Efficiency Index (MEI): This indicator examines the maintenance efficiency as calculated on the basis of the Annual Maintenance Expenditure (AME) with respect to the physical and performance state of the buildings, as expressed by the Building Performance Index (BPI). The MEI provides a quantitative indication of the efficiency with which the available resources are spent. (Shohet et al, 2003)
Managerial Span of Control (MSC): This indicator is defined as the ratio between the managers and the respective number of personnel directly subordinated to them. The advantages of a wide span of control find their main expression in the savings of overhead expenses, but in certain conditions a wide span causes difficulties in control. On the other hand, the advantages of a narrow span of control lie in the low quantities of day-to-day co-ordination and in the fact that the manager has ample time to deal with exceptional cases, but the overhead expenses are high. (Shohet et al, 2003).
Business Availability (BA): BA indicates how well the maintenance works have been performed to support the business. (Chan et al, 2001)
Manpower Utilization Index (MUI): MUI reflects how well the maintenance workplace has been utilized. It is useful for identifying whether the maintenance workforce is over, fully or under-utilized, and for assessing the general productivity of the maintenance personnel. (Chan et al, 2001).
Urgent Repair Request Index (URI): This is a ratio of the number of urgent repair requests arising from guests and in-house staff, and the number of general requests for repair of the building facilities. A high value of URI will mean the engineering staffs are heavily engaged in urgent repairs, being distracted from carrying out normal corrective and preventive works, and in the long term the building will suffer from loss of business and prestige (Chan et al, 2001).
Failure frequency and unit repairing time: The sum of urgent and general repairs is sometimes referred to as the failure frequency. In particular, the average time required to repair each fault is of concern, as it indicates how capable the engineering staff are to respond to and rectify failures (Chan et al, 2001).
Preventive Maintenance Ratio (PMR): In a report of power plants (Barber et al, 1995) the average PMR was between one and two. It is expected that the PMR of office buildings will not be as high as that for power plants, as the latter requires a much higher reliability. For

long-term improvement, the management must turn their attention to shifting the maintenance emphasis from corrective maintenance to preventive maintenance. As the preventive maintenance program gradually matures, the ratio should increase if the engineering systems are maintained healthy.

Maintenance Productivity: Based on the awareness that studies on building maintenance so far lack the capability of comparing various policies on resulting building quality and maintenance costs and, this indicator was developed for policy justification and budget allocation by using the Markov decision processes. The discrete Markov chain model captures both the time-dependence and randomness of the building system performance regarding replacements of building components and affecting the scope of maintenance activities. This gives insight into the relation between yearly maintenance costs and the quality of the building, both on short as well as a long term (Augenbroe et al 2002).

Soft Indicators

The main difference between the hard and soft indicators lies in the specificity of their applications. For instance, hospitals have office spaces, storage areas, imaging and treatment/procedure areas, and inpatient care units, among others. The office and storage spaces, however, are not very different from similar spaces in other building sectors. The strength of the hard indicators lies in their applicability across setting types. It is, however, commonly understood that certain spaces in any facility are significantly more crucial to overall facility performance, such as surgical suites or patient rooms in a hospital and courtrooms in a courthouse. Such spaces of critical functions determine to a large extent how the facilities perform as a whole, where generalized indicators may not prove sufficient for strategic decision-making. The soft PIs provide the specificity required in decisions related to spaces of critical functions. The soft data, typically collected in Post-Occupancy Evaluations (POEs), are sensitive to changes occurring in the cultural and organizational domains, and captures instrumental as well as symbolic functions (e.g. hope and healing in a patient care environment).

In the Georgia Tech study, POE data from 26 courtrooms in the U.S. were used, that included as-built description of the settings (hypothesized physical design correlates of aggregated performance dimensions) and evaluative data, where users rated the degree to which the setting supported courtroom functions. A series of principal component analyses were conducted to arrive at a small number of dimensions that explain a larger set of performance assessments. Subsequently, a set of multivariate regression models were developed that articulated the association between the variables and the performance dimensions. The set of soft PIs developed constitutes those most influential to courtroom functions. They are: 1) NVT (Near Visual Task Indicator), 2) FVT (Far Visual Task Indicator), 3) SCI (Speech Comprehension Index, 4) SPI (Speech Privacy Index), 5) CPI (Courtroom Physical Support Indicator), 6) PPI (Public Physical Support Indicator), 7) WPI (Workstation Physical Support Indicator), and 8) CSI (Courtroom Symbolism Indicator). Owing to page limits we are not elaborating on the development of the soft PIs. Please refer to Pati et al. (2005) for complete details.

Plotting the values of all the PIs on a single map (Figure 1) provides a visual support for decision-making. The bold line shows how a hypothetical courtroom performs on the eight PIs. The dashed, bold line within it could represent the minimum criteria. The circles represent the rating scale. In this manner, one or more courtrooms can be mapped and assessed together.

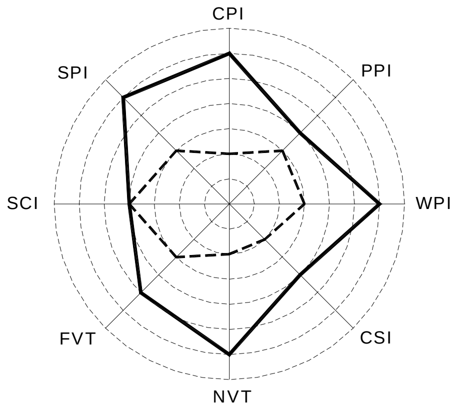

Figure 1. A KPI radar map showing a hypothetical courtroom.

INTEGRATED DECISION-MAKING

To illustrate the use of hard maintenance PIs along with the soft PIs in strategic decision-making, let's continue with the healthcare example. Using similar principles as mentioned above, sets of soft PIs could be developed for healthcare settings (the hard PIs are designed to be generally consistent across building types, with straight forward recalibration techniques to adapt the PIs to a particular building type). In the context of inpatient room design (a space type critical to patient care and recovery) the courtroom specific soft PIs could be replaced with inpatient room specific aggregated measures. Table 2 outlines a list of potential PIs for inpatient rooms. The candidate functions to be aggregated to create the PIs are listed in the last column. More indicators could be added to this initial list of PIs, as needed. Further, as with the courtroom PIs, physical and cultural attributes of the space and the people working in the spaces could be combined in the PI models to improve context-specificity of the predictions. Finally, these PIs (or subsets of PIs) could be developed along several directions of required performance predictions during strategic decision-making. Such directions could include: 1) clinical efficiency, 2) patient safety, 3) patient satisfaction, 4) staff satisfaction; directions that are of particular interest to the owners.

Table 2. List of potential patient room aggregated performance indicators

Performance Indicator	PI	Interpretation	Examples of functions for aggregation
NVT: Near visual task indicator	PI1	How well is the patient room environment predicted to support proximal visual tasks?	Charting; reading from equipment/ monitors
FVT: Far visual task indicator	PI2	How well is the patient room environment predicted to support visual tasks conducted from a distance?	Monitoring patient conditions from the corridor or door; viewing TV from patient bed; viewing TV from family space
SCI: Speech comprehension indicator	PI3	How well is the patient room environment predicted to support speech comprehension?	Comprehending physician's instructions; understanding patient's speech; understanding

Performance Indicator	PI	Interpretation	Examples of functions for aggregation
			care giver's directions
SPI: Speech Privacy Indicator	PI4	How well is the patient room environment predicted to afford speech privacy?	Privacy of physician-patient-care giver conversations conducted inside the room; privacy of patient-family conversations
RPI: Room physical support indicator	PI5	How well is the patient room's physical attribute predicted to support functions conducted within it?	Patient admission; access to toilet; patient-family interaction; special procedures (intubation, code; ECMO life support, etc) – access to patient head, space for equipment.
PPI: Public physical support indicator	PI6	How well is the family support area's physical attributes predicted to support functions conducted within the patient room?	Waiting during procedures; access to toilets; access to refreshments; overnight sleeping accommodation
WPI: Workstation physical support indicator	PI7	How well is the physical attribute of clinical workstations predicted to support functions conducted within the patient room?	Charting/documentation; hand washing
RSI: Room symbolism indicator	PI8	How well is the patient room environment predicted to portray appropriate symbolic values	Hope; healing environment; health; sincerity

With incremental progress in decision-making (or consensus building) on the desired attributes of the physical environment, increased specificity will dictate selection (or evaluation of alternatives) in design and specification. That is one good example where the facility maintenance PIs promises to convert a missed opportunity to a considerable enhancement in information support. Let's go back to the example of flooring systems introduced in the problem statement. At a certain point in the decision process available alternatives in flooring will impact the predicted performance on various dimensions outlined in Table 2. However, as also mentioned in the problem statement, many of the performance outcomes influenced by the flooring system are affected by, and affect (depending on which aspect is assigned a greater weight, and acceptable levels of capital and life cycle costs), the facility maintenance activities. Among the hard PIs that could actively interact with strategic decision-making in this example are the Maintenance Efficiency Index, Managerial Span of Control, Business Availability, Manpower Utilization Index, Urgent Repair Request Index, Preventive Maintenance Ratio and Maintenance Productivity. In the prevailing scenario where facility maintenance is kept outside the purview of strategic decision-making, performance predictions could potentially have an adverse impact on long term outcomes that owners are interested in – safety, efficiency, recovery, satisfaction, and retention, among others. Integrated performance assessment involving hard facility maintenance PIs offer significantly more accurate prediction of outcomes, over the long run.

The functioning of both the soft and hard PIs are, however, entirely dependent on availability of data from buildings-in-use, as a recurring protocol of facility management. Such protocols are increasingly being adopted by large organizations both in the government and private sectors. The objective of this paper was twofold: 1) to illustrate how PIs can support higher-level decision-making, and 2) to show how facility maintenance could play a crucial role in facilitating organizational decision-making. From that perspective our worked out examples pertaining to GSA offices and courtroom in the United States, and a hypothetical patient room, clarifies the potential role facility maintenance PIs could play in addressing strategic organizational objectives. In an era witnessing increasing emphasis on evidence-based design, this paper demonstrates the instrumental function of hard and soft PIs in addressing higher-level organizational goals.

REFERENCES

Allen, T., Bell, A., Graham, R., Hardy, B. and Swaffer, F. (2004), Working without walls: An insight into the transforming government workplace. www.degw.com

Alner, G.R. and Fellows, R.F. (1990), Maintenance of local authority school building in U.K.: a case study, Proceedings of the international symposium on Property Maintenance Management and Modernization, Singapore, pp.90-99

Augenbroe, G. and Park, C.S. (2002), Towards a Maintenance Performance Toolkit for GSA, interim report submitted to USGSA

Barber, F. and Hilberg, G. (1995), Comprehensive maintenance program ensures reliable operation, Power Engineering, Vol.99, No.12, pp.27-31

Chan, K.T., Lee, R.H.K. and Burnett, J. (2001), Maintenance performance: a case study of hospitality engineering systems, Facilities, Vol.19, No.13/14, 494-503

Gross, J. G. (1996), Developments in the Application of the Performance Concept in Building. Paper presented at the Applications of the Performance Concept in Building, Tel Aviv, Israel, pp.(I)1 – (I)11.

Hutcheson, J.M. (1994), The life cycle economics of buildings, Facilities, Vol.12, No.5, pp.11-15

Mahieu, L. M., De Dooy, J. J., Van Laer, F. A., Jansens, H. and Ieven, M. M. (2000), A prospective study on factors influencing aspergillus spore load in the air during renovation works in a neonatal intensive care unit. Journal of Hospital Infection, Vol.45, No.3, pp.191-197.

Pati, D., Park, C. S., and Augenbroe, G. (2005), Roles of quantified expressions of building performance in AEC. Innovations in Architecture, Engineering and Construction. Rotterdam, June 15-17, Netherlands.

Peter, T.J. and Waterman, R.H.Jr. (1982), In Search of Excellence. New York: Harper and Row, Inc.

Rashid, M., Kampschroer, K., Wineman, J. and Zimring, C. (2006), Spatial Layout and Face-to-face Interaction in Offices– A Study of the Mechanisms of Spatial Effects on Face-to-face Interaction. Environment and Planning B: Planning and Design, Vol. 33, pp. 825–844

Shohet, I.M., Lavy-Leibovich, S. and Bar-On, D. (2003), Integrated maintenance monitoring of hospital buildings. Construction Management and Economics, Vol. 21, pp. 219-228

Thoreson, B.P., Slack, D.C., Satyal, R.P. and Neupane, R.S.S. (1997), Performance-based maintenance for irrigation systems, Journal of Irrigation and Drainage engineering, Vol.123, No.2, pp.100-105

USGSA (1999), The Integrated Workplace: A Comprehensive Approach to Developing Workspace.

COST SAVINGS FROM PERFORMANCE-BASED MAINTENANCE PARTNERING

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ABSTRACT

New procurement approaches combined with performance-based building approaches should reduce costs, but empirical qualitative and quantitative studies are lacking. We studied the cost savings on project level by adopting a performance-based maintenance partnering approach. In a performance-based maintenance partnering approach the contractor has incentives to improve his way of working. Innovative, cost-effective solutions that meet the performance criteria can be achieved, especially if the principle of whole-life costing is being adopted. Indirect cost savings are expected as well. It enables maintenance contractors to assume responsibility for certain activities which they are better equipped to perform than their clients. The findings show that performance-based partnering reduces both direct and indirect costs compared to a traditional procurement approach. The essential preconditions are long-term involvement and freedom in the maintenance design and process for the contractor, giving opportunities for product and maintenance process improvements.

KEYWORDS: maintenance, procurement, transaction costs, whole life costs

INTRODUCTION

The construction industry needs to adopt strategies for change and innovation and to change its orientation from cost of services to value and performance. It must take a longer-term view of value and adopt new procurement methods based on adding value for clients and a concept of performance (e.g. Courtney, 2005; Egan, 1998). In a performance-based maintenance relationship contractors no longer work as suppliers of capacity only, but become active participants in the overall maintenance process of a project for a specific agreed-on period. Performance criteria are explicitly stated by the client (Author, 2007). The professionalism of Dutch housing associations has led to paying more attention to maintenance processes and partnerships in the supply chain of maintenance, leading to performance-based maintenance agreements. European legislation for public tendering is not mandatory for Dutch housing associations. A breakthrough of performance-based maintenance partnering is obstructed by distrust, desired flexibility in decision-making and fear of disturbance of price competition. The existing adversarial relationship between clients and contractors make it difficult to introduce new procurement principles. The client organization’s objectives are likely to change over time and external circumstances may change. Therefore any long-term cooperation must incorporate a degree of flexibility. Even more important is the fact that Dutch housing associations fear a disturbance of price competition using long-term performance-based agreements. Together with their desired flexibility in maintenance policy they restrict the contract period to maintenance work intervals. Contrary, they admit that a long-term partnership will enable them to derive the greatest possible advantage from the performance-based maintenance approach (Author, 2007). Those advantages are improves performance and service during a long maintenance period, adopting principles of life-cycle costing and whole-life costs. This will reduce the costs too.

This paper focuses on the cost savings of performance-based maintenance partnerships compared to traditional maintenance tendering based upon technical specifications. The research question is: To what extent does performance-based maintenance lead to project cost savings compared to the traditional way of conducting maintenance works? In the study costs have been calculated for two or more maintenance intervals (processes).

This paper expands on the current literature on the subject by evaluating expected cost savings from performance-based partnering. Next the research method is described, followed by the findings of the study. The paper finishes with conclusions and discussion.

EXPECTED COST SAVINGS BY PERFORMANCE-BASED PARTNERING

There is a general belief that new procurement approaches combined with performance-based building approaches will improve performance and service and reduce costs (e.g. Bresnen and Marshall, 2000; Egan, 1998; Saad et al., 2002; Trimmer and Kidston, 2003). Innovative, cost-effective solutions that meet performance criteria can be achieved, maintenance cycles can be extended, and change orders are reduced. Moreover efficient risk allocation will lead to cost savings.

Wood (2006) studied whether partnering is actually delivering win-win outcomes for both parties involved. He interviewed 10 major UK clients and 10 national contracting organizations. Lower costs for the client and guaranteed work for the contractor are the strongest and most consistent messages expressed by Wood's respondents. Black et al. (2000) surveyed by postal questionnaire clients, consultants and contractors involved in construction projects. Most benefits attributable to partnering expected from the parties are better relationships rather than project-based benefits (such as improved design, quality improvement, reduced cost etc.). "It can be inferred that because a better relationship between the parties produces the project-related benefits, the project-based benefits have not been rated highly by the respondents" (Black et al., 2000). We believe that project-related benefits are becoming more obvious in maintenance relationships if the whole service life of a building is involved and contractors keep responsibilities for a long period.

Whole-life costing

If principles of whole-life costing are adopted, reducing of the production costs can be realized by:

- planning the maintenance activities according to the existing level of quality, the desired quality and the desired service life of a building;
- ensuring better coordination between work to the substrates and to the finishing (e.g. undercoats and final painting).
- conducting maintenance activities 'just-in-time' based upon performance measurements.

The performance-based relationship offers the contractor greater opportunities to plan the maintenance activities to the requirements of the client during the duration of the maintenance period, and to coordinate maintenance activities with each other. This is the result of the contractor's long-term involvement in, and responsibility – including financial responsibility – for the maintenance project under the performance-based partnering agreement. The fact that the same contractor takes responsibilities for both the paintwork and maintenance work to the substrates is also important. In the initial process, a thorough analysis of the causes of defects will be conducted. The contractor will select the solution offering the lowest costs over the entire service life. Performance-based partnering offers a better guarantee of actually achieving the advantages of condition-based maintenance than the traditional approach, since it is the contractor who conducts the performance measurements and who also bears the risks relating to the timely performance of maintenance activities. The deterioration can be predicted more accurately and maintenance cycles may be extended, for example from six to seven years. Accordingly, in a maintenance scenario of thirty years, there would be only four maintenance intervals and rather than the current 'traditional' five. This view is based on experiences with performance-based partnering and the results of performance measurements.

Transaction costs

Client and contractor both make transaction costs. Reducing of the transaction costs can be realized by performing process activities by the client or contractor that is best equipped to perform the activity and by a better management of the entire maintenance process.

In the traditional maintenance approach, many activities are duplicated, i.e. conducted by both client and contractor, because information is lost following the once-only tendering process. In the performance-based approach, clear agreements are made with regard to which party is responsible for which activity during the co-operation period. Site supervision by the client is not needed if performances are specified. We expect that process improvements and indirect cost reductions will become particularly apparent after the initial process. The costs of collecting project information, consultation, condition assessments and the design of alternative maintenance scenarios will decrease dramatically due to the continuity of the performance-based partnering agreement.

RESEARCH METHOD

Direct and indirect project costs

In this research distinguish is made between direct project costs and indirect project costs. The direct project costs represent the production costs for a certain maintenance period. For the client actual payments tot the contractor represent the production costs (the bid price). The indirect project costs are the transaction costs in connection with the procurement process. See Table 1.

Table 1 Direct and indirect costs

	Direct costs	Indirect costs
Project costs	Production costs: labour, materials, equipment, transport	Transaction costs
Non-project specific costs	Not applicable	Relation specific costs Overhead costs

The production costs can be influenced if principles of life-cycle costing and whole-life costing are adopted. The transaction costs can be influenced by the kind of relationship between the client and the contractor. The kind of specifications may influence both. The overall project costs for the client include the bid price and his own transaction costs.

Waara and Bröchner (2006) argue that transactions costs for the contractor could easily be measured, being the bidding costs. We think it takes a lot of effort to make the bidding costs of the contractor transparent is working in a performance-based manner. The indirect project costs (transaction costs) depend on the process activities that must be conducted by the client and the contractor respectively throughout the maintenance period of the complex. The contractor is working as a maintenance engineer. The costs for providing advice about maintenance solutions and for conducting performance measurement are being part of the bid price or priced separately.

Projects

An initial study included ten projects (Author, 2005). In order to make a thorough comparison, 12 more projects were selected. Each project involves exterior maintenance of housing estates owned and managed by a housing association. 13 housing associations and 9 maintenance contractors are involved. The number of projects of one housing association is between 1 and 4; the number of cases of one contractor is between 1 and 6. The cost comparison assumed a performance-based approach, with the applicable basic premises in terms of performance level and maintenance period. The contactors had produced a maintenance scenario, including a price, for this period. The maintenance scenario influences both the direct and the indirect costs. The notional direct and indirect costs of the traditional procurement approach could be closely estimated, based on the quality level and maintenance period. The maintenance history of the building played a significant part here. It was assumed that the direct costs of painting – including preventative maintenance work – are cyclically recurrent.

Presumably the size and scope of the project will influence the proportion between direct and indirect project costs per procurement approach. Here a distinction has been made between ‘simple’ projects, ‘complex’ projects and ‘total facade’ projects, depending on the scope and type of maintenance work involved, and the lead-time of the (initial) process. Ten projects could be classified as ‘simple’, 7 cases as ‘complex’ and 5 as ‘total façade maintenance’. The cases studied vary in terms of the characteristics of each housing estate, size, maintenance history and original quality, and working methods. Accordingly, they are not directly comparable one against the other. However, each case enables a comparison to be made between the long-term performance-based approach and the traditional approach in terms of direct and indirect project costs. The distribution of size and construction years is large. The number of dwellings is between 27 and 360. One housing estate was built before the Second World War. The housing estates involve single- en multi-family dwellings. Generally, the traditional approach as well as the performance-based approach of both the clients and contractors shows a great variety. There are differences in process steering by the housing association closely connected with the given freedom in maintenance solutions by contractors and the monitoring of performance by contractors and/or third parties commissioned by the client. Experience may affect the production costs as well as the transaction costs. Two of the 13 involved housing associations were not experienced in performance-based maintenance partnering. That means that the projects in this research were the first projects procured performance-based. The number of performance-based maintenance contracts of experienced housing associations differs strongly. Just a few clients see performance-based partnering as the only procurement method.

Calculation model

A calculation model was developed that calculates the net present value of the direct and indirect project costs at project level. The initial process and the subsequent processes consist of all activities conducted during a maintenance interval. Following the initial process, one or more subsequent processes will take place. It is assumed that these subsequent processes will be equal in scope and cost, although the actual maintenance activities undertaken in each can vary.

The model distinguishes 25 process activities. The activities are based upon the traditional maintenance process and the performance-based maintenance process (see Author, 2007). The process activities in the initial and subsequent processes can be clustered into five phases: specification, selection, contracting, work and supervision, and after-care. Table 2 shows the process activities of the phase contracting.

The costs are based on a differentiation in hourly charges per activity, with the level of charges depending on the various wage scale groups applied by both client and contractor. The model assumes that each party will have three such groups. Third parties, such as consultants or inspection agencies, may perform some activities; the costs involved being charged to the client and/or contractor.

Table 2 Process activities phase contracting

	Traditional		Performance-based	
	Client	Contractor	Client	Contractor
Collecting or adjusting project information				
Consultation about functional specifications and performance criteria	N/A	N/A		
Inventory				
Condition assessment				
Collecting external advice				
Inviting tenders and assessment subcontractors	N/A		N/A	
Designing or adjusting maintenance scenario’s	N/A	N/A	N/A	
Formulating or adjusting offer				
Assessment offers		N/A		N/A
Consultation about offers				
Working out and consultation about activity plans				
Commissioning and confirmation work				

FINDINGS

From the results the overall project costs appear to be lower for performance-based partnering than for traditional maintenance tendering. This concerns all kind of projects. The average overall project costs difference is 20%. In all cases, the direct costs (bid price minus the indirect costs of the contractor) of performance-based partnering are lower, or at worst the same, as in the traditional approach. The share of the indirect costs of the client in the overall project costs is small, in traditional working method as well as in performance-based partnering. The cost savings on bid prices by performance-based partnering are the biggest for 'total façade' projects, followed by simple projects. See Figure 1.

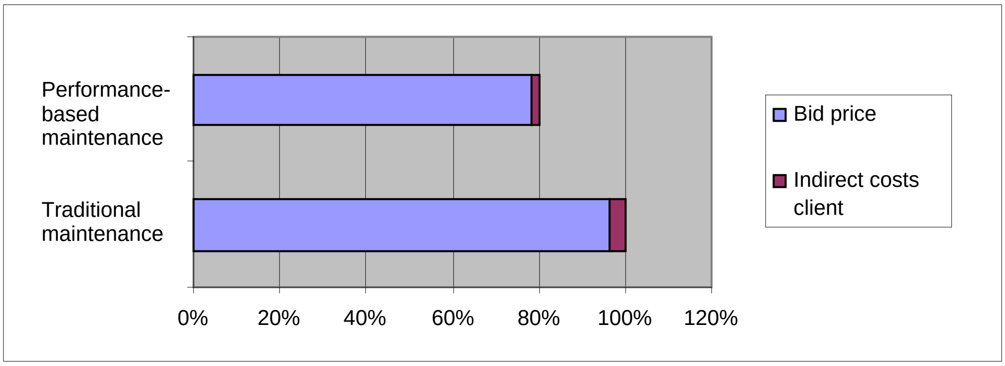

Figure 1 Average overall costs client, initial process and subsequent processes,

The indirect costs of the client are lower in case of performance-based partnering in the initial process as well as in subsequent processes. On average for all projects the indirect costs of the client are 51% lower in case of performance-based partnering. See Figure 2.

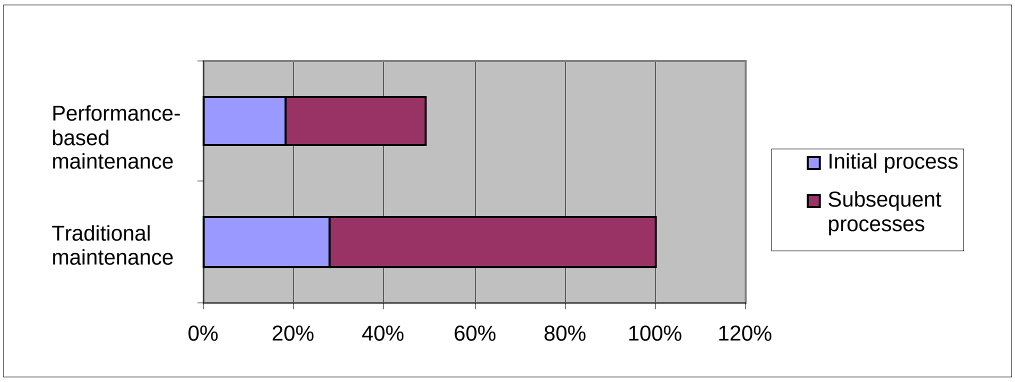

Figure 2 Average indirect costs client, initial process and subsequent processes,

In all phases with the exception of 'after-care', the costs of performance-based partnering are lower. Cost savings are relatively the biggest for the phases of 'specification' and 'selection'. Because of the fact that the client will continue the relationship with the contractor after the initial process, time and costs being spent for selection are in subsequent intervals very low. See Figure 3. Cost savings in contracting and work and supervision are very clear in the subsequent processes. Not surprising is that the client spends more time and money for after-care if applying a performance-based partnership.

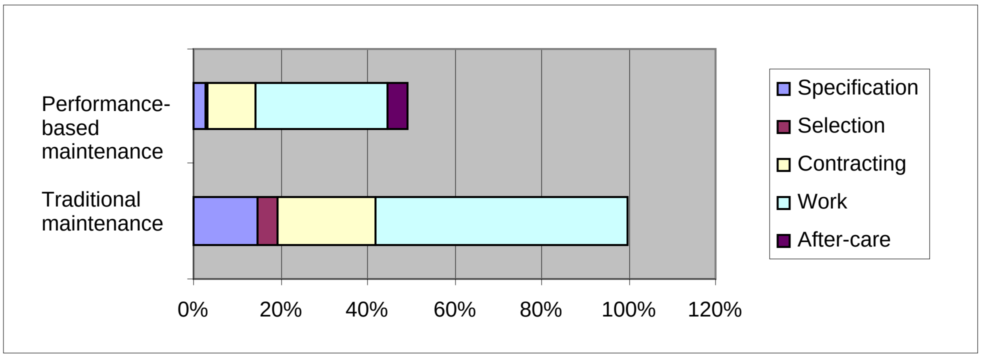

Figure 3 Average indirect costs client, initial process and subsequent processes per phase

The indirect costs of the contractors are a part of the bid price. This research project made these costs transparent. Contractors are not involved in the phases of 'specification' and 'selection'. Contractors will spend hours in the phase of 'after-care' only if working performance-based. Those 'extra' hours are amply compensated by saving hours in the process phases contracting and work and supervision, especially during subsequent maintenance processes.

On average the indirect costs of the contractor are 21% lower in the case of performance-based partnering. See figure 4. During the initial process contractors spend on average more hours. The expectation was that 'simple' projects are an exception, but this is not true. Contractors spend also more hours in most of the simple projects during the initial process if working performance-based compared to traditional maintenance. Clients give contractors free reins.

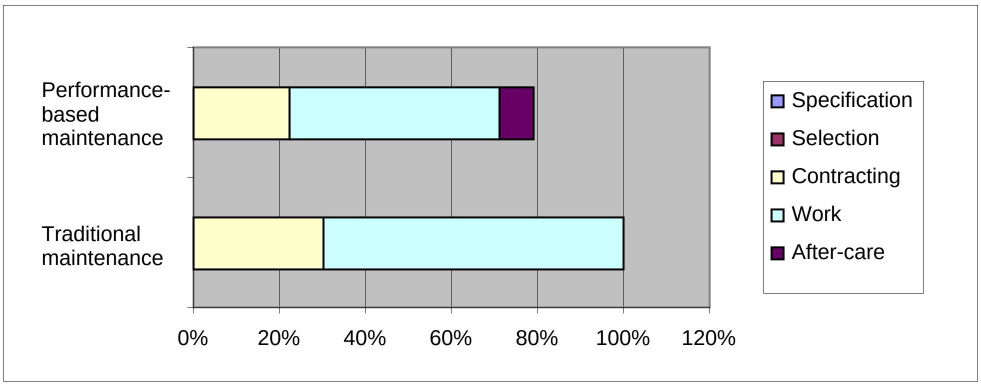

Figure 4 Average indirect costs contractor, initial process and subsequent processes per phase

CONCLUSIONS AND DISCUSSION

Long-term, performance-based partnering offers many advantages compared to the traditional approach. One of the main benefits is that long-term performance-based partnering reduces both direct and indirect costs. The essential preconditions are long-term involvement and freedom in the maintenance design and process for the contractor, giving opportunities for product and maintenance process improvements. The findings show that average overall project costs are 20% lower. The phases ‘specification’, ‘selection’, ‘contracting’ and ‘work and supervision’ become markedly less expensive in case of performance-based partnering. The ‘after-care’ phase is markedly more expensive in every case when the performance-based approach is adopted, because of conducting periodic performance measurements. For the contractor the initial process is more expensive within the performance-based approach. That this method is nevertheless less expensive overall for the contractor is due to the cost reductions in the subsequent processes. Indirect cost reductions become particularly apparent following the initial process, once both parties have gained experience with the project. The direct costs can be reduced not only in terms of savings on manpower and materials, but also – and especially – in terms of incidental costs such as the hire of scaffolding and site costs. Scaffolding hire represents a growing proportion of the total direct project costs. Longer maintenance cycles enable this type of expenditure to be reduced significantly.

The client’s initial selection of contractors is likely to cost more time in the performance-based approach than in the traditional method. The selection will not be for each individual project, but the client will divide all his projects among a number of pre-selected contractors. Prior to the initial phase of the first project (or projects) the client and contractors will be required to devote considerable time to seeking out the most appropriate partnership form(s), agreeing unit prices and decisive performance indicators, and drawing up the relevant framework contracts. However, these activities are also part of the traditional working method, albeit under different names. Like selection, the evaluation of contractors and the assessment of customer satisfaction will also take place outside the confines of individual projects, although project-related aspects will also be taken into account in the evaluation.

Because maintenance activities are assigned to the contractor for a long period, covering a number of subsequent processes and maintenance intervals, it is no longer necessary to re-bid for each period. This continuity will result in lower indirect project costs throughout the subsequent processes for the contractor. It is questionable whether this cost benefits should be calculated in unit prices beforehand. The findings show that on average the indirect costs of the contractor are 21% lower in the case of performance-based partnering. This means that new activities by contractors, especially advice about maintenance solutions and performance measurement, do not raise contractors’ transaction costs, at least on the project level. The execution of these activities demands additional capabilities from the contractor (Author and Van Mossel, 2007); relation specific costs and overhead costs may increase. Moreover maintenance contractors must be able to achieve a sufficient level of turnover under performance-based partnering agreement in order to be able to perform these ‘advisory tasks’ in satisfactory manner. Due to the continuity of the performance-based partnering agreement maintenance contractors can improve their internal business processes, with more efficient logistical deployment of manpower and equipment, and more efficient purchasing of materials. This will reduce the overhead costs.

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REFERENCES

Author (2005), “Cost savings of Long-Term Performance-Based Maintenance Partnering”, in Kähkönen, K. and Sexton, M (Eds), Understanding the Construction Business and Companies in the New Millennium, VTT RIL, Helsinki, pp 280-292.

Author (2007), “Performance-based maintenance partnering: a promising concept”, Journal of Facilities Management, Vol. 5 No. 2, pp. 129-142.

Author and Van Mossel, H.J. (2007), “Contractor selection for performance-based maintenance partnerships”, International Journal of Strategic Property Management, Vol. 11 No. 2, pp. 65-76.

Black, C., Akintoye, A. and Fitzgerald, E. (2000), “An analysis of success factors and benefits of partnering in construction”, International Journal of Project Management, Vol. 18, pp. 433-434.

Bresnen, M. and Marshall, N. (2000), “Partnering in construction: a critical review of issues, problems and dilemmas”, Construction, Management and Economics, Vol. 18 No. 2, pp. 229-37.

Courtney, R. (2005), Revaluing Construction 2005 – The Challenge of Change, Conference Report, PSIBouw and CIB, Gouda.

Egan, J.S. (1998), Rethinking Construction (The Egan Report), DETR, London.

Saad, M., Jones, M. and James, P. (2002), ”A review of the process towards the adoption of supply chain management (SCM) relationships in construction”, European Journal of Purchasing & Supply Management, Vol. 8 No. 3, pp. 173-183.

Trimmer, G. and Kidston, N. (2003), Assessing procurement, Trimmer CS and The Housing Corporation, London.

Waara, F. and J. Bröchner (2006), “Price and Nonprice Criteria for Contractor Selection”, Journal of construction engineering and management, August, pp. 797-804.

Wood, G. (2006), “Addressing the economic realities of Partnering arrangements within the UK construction industry”, in Mc Dermott, P. and Khalfan, M.M.A. (Eds.), Proceedings Symposium on Sustainability and Value through Construction Procurement 2006, University of Salford, Salford, pp. 614-625.

MAINTENANCE BUDGETING METHODS

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ABSTRACT

In Germany, public facilities are in need of rehabilitation. Strategies to maintain the value of buildings are ignored by governmental entities at all levels. Reactions are based on the occurrence of damage and are not preventative in character. Consequential damages and the associated economic, ecological and sociocultural losses are disregarded. It is important to allocate financial resources appropriately so that maintenance measures can be undertaken before serious damage occurs. The professorship of Facility Management at the Universität Karlsruhe develops maintenance strategies and methods for budgeting maintenance to address these issues. Empirical maintenance data for 20 buildings (schools and office buildings) were compiled that cover their complete past life-cycles. The data from this survey includes information about all maintenance measures that were carried during the lifetime of each facility. The real estate holdings that make up this 20 building sample have a floor area of 190,000 square metre and included over 24,000 maintenance measures. Financially, the upkeep for these 20 buildings ran up maintenance expenses of 1.76 billion euros. In addition to the maintenance expenses, the evaluation of the actual building substance expressed in euros was part of the analysis. The maintenance data that was collected on these real estate holdings enabled the development of a budgeting system. Common methods of budgeting were validated using the data. The result is: these methods are unsuitable. Their results produce maintenance estimates that differ enormously from real maintenance expenses. Realistic methods for predicting and budgeting the cost of future maintenance expenses do not exist currently. In practice, the maintenance staff responsible for facility upkeep have huge problems every year as they try to calculate a budget for the following year. Due to missing knowledge about real maintenance requirements and other cost relevant factors, mostly previous year values are used for budgeting. This approach is imprecise. In order for the planning and budgeting of maintenance measures the results of the investigation provide the required support.

KEYWORDS: building maintenance, maintenance expenditure, budgeting methods

INTRODUCTION

Buildings and public facilities shape our cities and municipalities. In Germany, many public facilities are in ramshackle condition and in need of rehabilitation. This is the result of a lack of a strategy to maintain the value of these public buildings. Civil servants and other individuals responsible for these facilities often fail to act before damage has occurred to facilities, and preventative actions are too late at this stage. The consequence of poor planning in terms of public facility management is expensive damage to buildings and economic, ecological and sociocultural losses. The poor condition of public buildings in Germany is often not only unaesthetic, but also results in negative impacts on health, comfort, creativity and productivity for building users and occupants. Against this background, a strategic maintenance programme for public facilities is imperative. However, most building owners do not have fully developed tools to calculate upcoming maintenance costs, a fact which complicates this task.

Germany’s public authorities own an enormous building-stock. This fact alone makes it clear that a strategic maintenance programme that would deal with the all-encompassing and increasingly a complex maintenance of such huge holdings should be put in place. In the past, maintenance measures were often planned poorly and, as a consequence, the financial resources necessary for repairs were not available in a timely fashion (Kalusche and Oelsner, 2003). In order to maintain the value of our buildings, budgeting carefully is of vital importance. Unfortunately, the recognition of the urgency of budgeting for facility maintenance has not been a matter of high priority prior to now, and other issues have been the focus of government facility managers (Henning and Klapproth, 2004).

The challenge, in terms of budgeting maintenance costs, is handling the long-term use of buildings. In comparison with non-durable goods, the service life of building is much longer, lasting several decades. The demands and requirements that government entities have for their facilities can undergo major changes over time. Against this backdrop, forecasting maintenance costs is difficult. Many factors influence maintenance expenses, including parameters that are usage-dependent, building-dependent, and site-dependent. Quantifiable information about the amount of influence these different parameters have on maintenance demands and the accordant maintenance costs rarely exist.

Public building owners need to pay greater attention to maintaining the value of their buildings, as the need for these facilities will endure. The goal should be to provide healthy and comfortable facilities that support the creativity and productivity of the people that inhabit these public spaces. This can only be achieved if financial resources are set aside and allocated for preventative maintenance measures. The Department of Facility Management at the Universität Karlsruhe (TH) has developed maintenance strategies and methods for maintenance-budgeting as a part of the BEWIS (Optimized upkeep strategies to maintain value of buildings) research project.

PREVIOUS BUDGETING METHODS

Four different approaches to the determination of maintenance budgets have been identified:

- Key data-oriented or history-based budgeting,
- Value-based budgeting,
- Analytical calculation of maintenance budgets,
- Budgeting by condition-description.

Using key data-oriented budgeting methods, budgeting results are derived by making rough estimations of general key figures. Using this method, a budget can be calculated easily and without much time and effort, but the key figures only provide rough reference values. Only the average expense of maintenance over several years can be reflected, and high uncertainty situations are not projected by this method.

The value-based approach calculates the maintenance budget using only general flat rates, which are multiplied by a percentage value for the building. Depending on the approach, either the building value, replacement value, or the replacement value based on the year 1913 is used. Only minor knowledge of maintenance costs and projections are necessary to complete this type of calculation. When using these value-based approaches, the only relevant factors are those that determine cost. The annual rise in building prices are not taken into account by this method. Therefore, each year this method is applied, the funding available for maintenance actually decreases.

In comparison to the two methods described above, the calculation of maintenance funds using analytical methods is much more precise. Analytical methods include the consideration of different variables, such as building age, number of technical installations, or the kind of use. These variables allow a more precise and building-specific calculation to be made.

Most of the described methods are based on adapting the replacement value to so-called correction factors that could occur due to certain impacts. However, there are also other methods that employ completely different approaches to maintenance calculations. The condition-based budgeting method requires detailed knowledge of different components. The maintenance requirements are assessed via systematic and periodic building inspections. Early identification of necessary maintenance measures helps to prevent consequential damages. This approach to the calculation of maintenance budgets requires a comparatively large time commitment.

All these budgeting methods were analyzed in the BEWIS research project (Optimized maintenance strategy to maintain the value of existing buildings).The project analyzed maintenance data on 20 existing public buildings, and enabled the research team to compare real budgets with budgets produced using the different methods outlined above.

BEWIS RESEARCH PROJECT

The analyses that are a product of the BEWIS research project were generated from the lifecycle data of the 20 building data set. The research project was initiated by the Department of Facility Management at the Universität Karlsruhe (TH), and included facilities of several German towns and municipalities and buildings of the Catholic Church. Within the project, 20 office and school buildings were analyzed in terms of the maintenance measures that had been conducted in these facilities and their costs. The data covers these facilities from the point of construction until the current day, and they were collected empirically.

- cost of building construction
- year of construction
- type of use
- geometrical dimensions (building size dimensions)
- maintenance measures differentiated by:
    type of measure (DIN 31051, German Institute for Standardiziation))
    affected component
    time
    costs of the measure
- repair backlog for the analyzed buildings [€]

The analyzed buildings were constructed between 1952 and 1984. In 2004, when the project analyses were completed, the age of the buildings was between 20 and 52 years old. Depending the type, age, and size of the buildings, somewhere between 700 to 2 500 datasets were collected and analyzed for each facility. Each dataset represents one maintenance measure. Altogether approx. 29,000 data sets were analyzed.

To compare the lifelong maintenance costs for the facilities, it was necessary to consider the rising cost of maintenance interventions. All the cost data were indexed with the official price index list of the German Federal Statistical Office for the base year 2004.

EVALUATION

The construction value-based budgeting methods were tested by the BEWIS Research Project using the data sets from the 20 buildings that were part of the project. Calculating the maintenance budget using this method, building costs had to be multiplied using a defined percentage (yearly standard rate). The maintenance costs depended primarily on the building construction costs. The value of the percentage rate varied between 0.8% and 3.0% of the construction costs (HK). The different percentage rates are multiplied by the construction costs of the analyzed buildings. The calculated maintenance costs and the real maintenance expenses of the buildings are shown in the figure below.

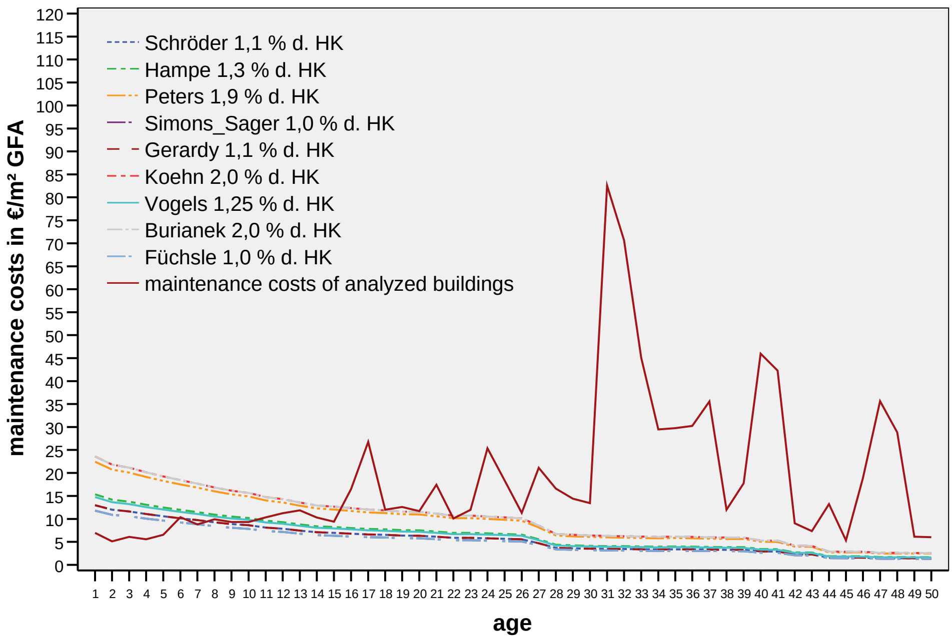

Figure 1: comparison calculated costs with real maintenance expenses, (Schröder, 1989), (Hampe, 1986), (Peters, 1984), (Simons und Sager, 1980), (Gerardy, 1980), (Koehn, 1976), (Vogels, 1977), (Burianek, 1973), (Füchsle, 1970)

The construction cost-based methods did not include a mechanism to estimate the rising cost of annual maintenance measures. Because of this inflation-adjustment calculation was missing, the maintenance funds set aside using this method actually decreased over the years. As a result, the employees responsible for maintenance had less funding available each year with which to maintain the value of their buildings. Figure 1 shows that real cost requirements for maintenance increase each year, as buildings get older .

The deviation in construction costs based on maintenance expenses to the real expenses are shown in the following figure.

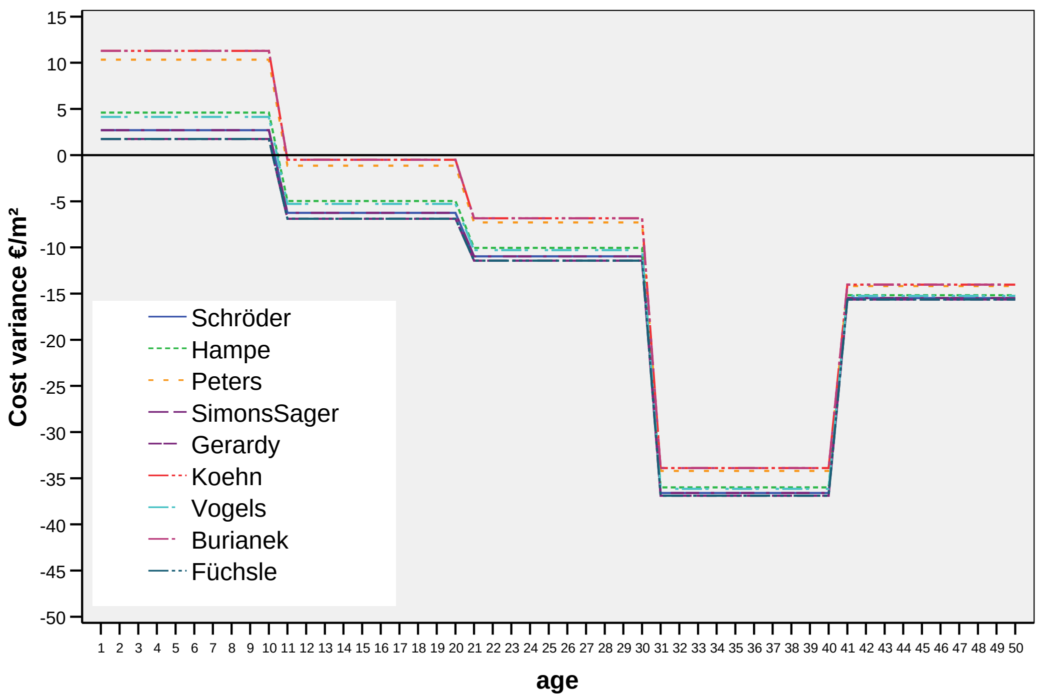

Figure 2: Variations of the calculated values of the real maintenance costs

The analysis shows, that all calculated values for all budgeting methods fall below the real maintenance costs after 10 years. Maintenance costs that were calculated in this manner will be under-funded.

In the context of the research project, key figure-oriented budgeting, replacement value-oriented budgeting, and analytical budgeting methods were also tested. The percentage deviation of the calculated value estimates from the real cost data are shown in the following chart:

Table 1: Percentage deviation of the calculated values from the real maintenance expenses

Budgeting Method	Process	Deviation (age 0-30)
Key figure-oriented	IIBV	-57 %
	BMI Büro	207 %
	BMI Schule	157 %
	FM Monitor	22 %
	OSCAR	22 %
	IFMA	116 %
Value oriented	EFNMS	77 %
	Christen / Meyer-Meierling	11 %
	Frutig / Reiblich	33 %
	IPBau	170 %
analytical	Naber	-43 %
	KGSt	-8 %
	AMEV	19 %
	Berliner	94 %
	Essener	-23 %

The analyses illustrate the lack of reality based methods for the calculation and estimation of maintenance funds.

PRACTICAL APPLICATIONS

In practice, the fact that the budgeting methods that are being used to project maintenance costs for publically-owned facilities fall short of real needs, as described above, is a problem. The Facility Management staff that are responsible for calculating maintenance budgets for facilities are using budgeting methods that will cause their projected budgets to fall short in terms of real needs each year. Because essential knowledge about real maintenance requirements and other cost relevant factors are missing in the previous year estimates that are being used, the calculation of maintenance budgets continues to be imprecise and unpractical. Rational and reliable calculations are not possible using these methods. This fact belies a general lack of transparency in the planning and budgeting of maintenance measures that this project was able to uncover.

To maintain the value of public buildings, the allocation of the appropriate amount of financial resources for maintenance has to be predicted ahead of time and appropriate methods for the calculation of these costs have to be employed. The Department of Facility Management at the Universität Karlsruhe (TH) developed a method for calculating maintenance budgets which would enable Facility Managers dealing with public holdings to calculate accurate budget projections for the maintenance of their real estate portfolios. The BEWIS research project was able to contrast and compare different budgeting methods and finally identify parameters that affect maintenance costs. The budgeting method this project produced can be used as a tool for the future estimation of maintenance costs for facilities of all types.

REFERENCES

Burianek, P. (1973), *Folgekosten bei Gebäuden*. Dissertation an der Technischen Universität München, Fakultät für Bauwesen

Füchsle, G. (1970), *Planung von Verwaltungsgebäuden.* Dissertation an der Wirtschafts- und Soziawissenschaftlichen Fakultät der Friedrich-Alexander-Universität Erlangen-Nürnberg

Gerardy, T. (1980), *Praxis der Grundstücksbewertung*. Verlag Moderne Industrie, München,

Hampe, K. (1986), *Vergleich des Einflusses unterschiedlicher Konstruktionen, Baustoffe und Ausstattungen bei sonst gleichen Gebäuden auf die Herstellungs- und Baunutzungskosten*. Im Auftrag des Bundesministeriums für Raumordnung, Bauwesen und Städtebau, bearbeitet im Institut für Bauforschung e.V. , IRB Verlag, Stuttgart

Helbling Management Consulting, Studie, 2000: *„Facility Management in der Immobilien-wirtschaft“*, Zürich

Henning, P. und Klapproth, T. (2004), *Integration der Wartung und Instandhaltung von Gebäuden in der Planungsphase*. In: Facility Management

Institut für Bauforschung e.V. (2001), *Bauunterhaltungskosten beanspruchter Bauteile in Abhängigkeit von Baustoffen und Baukonstruktionen*; Forschungsbericht , Hannover,

Kalusche, W. und Oelsner, U. (2003), *Instandhaltung von Gebäuden und ihre Finanzierung*, Forum der Forschung – Heft 16, Hrsg. BTU Cottbus

Koehn, G. (1976), *Die Folgekosten von Immobilien – Optimale Nutzung von Gebäuden unter besonderer Berücksichtigung der laufenden Betriebskosten*. Studio-Verlag, Ittigen/Bern

Peters, H. (1984), *Instandhaltung und Instandsetzung beim Wohnungseigentum.* Bauverlag, Wiesbaden

Simons, K. und Sager, R. (1980), Berechnungsmethoden für Baunutzungskosten; Schriftenreihe Bau- und Wohnforschung des Bundesministers für Raumordnung, Bauwesen und Städtebau, Bonn

Schröder, J. (1989), *Zustandsbewertung großer Gebäudebestände*. In: Schweizer Ingenieur und Architekt, Nr. 17, 1989, Verlags AG der Akademisch-Technischen Vereine, Zürich

Vogels, M. (1977), *Grundstücks- und Gebäudebewertung marktgerecht.* Bauverlag GmbH, Wiesbaden

THE MANAGEMENT OF SMALL PUBLIC REAL ESTATE PROPERTIES: THE PORTFOLIO OF THE UNIVERSITY OF CATANIA

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ABSTRACT

The topic of property management has been widely studied, but Italian Central and Local Public Administrations are not yet able to guarantee the quality of the property management. Unlike large portfolios of real estate that can benefit from economies of scale, the management of small heterogeneous portfolios is more onerous. The present study defines procedures aimed at ensuring the quality of the maintenance facilities of small real estate portfolios. This research paper considers the guide-lines for a comprehensive management system for the real estate at the University of Catania, including both the maintenance of the buildings' physical components, and the management of the required facilities. Starting from the needs of the users, the control of technical and managerial problems is oriented towards limiting risks that can impair the quality of the real estate in the use.

KEYWORDS: quality, control, public real estate, facility management

INTRODUCTION

Beginning at the end of the 1990's, the regulations for university autonomy clearly showed the necessity for Italian universities to adopt a managerial policy directed towards efficiency and inexpensiveness. The management of heritage real estate properties does not represent the core business of the University: real estate properties are considered to be assets which are instrumental to the carrying out of the university's functions. The characteristics of these properties, the services that they provide to users, and their state of conservation must satisfy in the best way possible the specific demands of their users. Therefore, the main objective in the management of university buildings is to guarantee, through the distribution of services to the buildings and to individuals, a functioning which conforms to the needs determined by the use. This requires a complex managerial system in which services which support the carrying out of university activities (cleaning, having a porter, sorting mail, maintenance of the equipment, etc.) and services of building maintenance (preventative and of repair after a break-down) are integrated.

The necessity of coordinating multiple and heterogeneous activities associated with the limited availability of financial resources requires a profound change in the procedures of real estate property management and of the tools which support the managerial activities (Barret, 1998). The principal problems which are currently found in the management of university buildings can be traced to: 1) a lack of professionalism with regards to specific competences in the planning and control of managerial and maintenance activities: the gap between competences sought and the professional profiles of the personnel employed in the technical offices of Italian universities determines, in particular, a scarce capacity in optimizing and rationalizing the managerial activities; 2) deficiencies in the systematization of the groups of information necessary to the management: the document archives are usually not computerized. This produces considerable difficulties in the integration of technical, administrative and economic data, increasing the risk of managerial decisions founded on incomplete information; 3) an inadequate knowledge of heritage real estate properties: the partial knowledge of the morphological, dimensional, material and constructive characteristics of the buildings, of their location, of the activities that take place in them, of the regulatory regime to which they are subject and the absence of information updates compromise the efficiency of maintenance choices and of their planning through time.

The projects which are contracted out for the execution of works or the acquisition of services and provisions by state Universities are currently regulated, in Italy, by the Code of Public Contracts (Legislative Decree 163/2006). Valid support to the mandatory legislation is provided by facultative technical rules which, in the area of real estate management, have permitted the diffusion of the culture of the maintenance of heritage real estate properties (Di Giulio, 2003).

The study of the pilot project of the University of Catania is aimed at identifying a model and a method for the management of heritage university real estate properties which, although being limited in number, require high levels of consideration with respect to the Classes of Needs of Use, Safety, Well-Being and Management (Regulation UNI 8289). In order to guarantee throughout time the meeting of the needs determined by the specific use allocation, the owner Institution must carry out a transversal action of control during the entire management process, taking - when necessary - timely corrective action, aimed at guaranteeing a constant quality of services to the buildings and to the people who use them.

THE CASE STUDY: THE UNIVERSITY OF CATANIA

The management of the heritage real estate properties of the University of Catania is carried out according to the *insourcing* model for the management of public heritage real estate properties. According to this model, the Institution assigns the managerial, planning, projection and legal-administrative functions to internal personnel, while assigning - in accordance with the procedures of the law - the executive activities of work, services and provisions to external bodies. The functions of design and planning of a technical-maintenance nature are carried out by internal personnel - the Technical Services Department - while the executive activities are externalized. The objective of the Institution is to define a progressive change in management procedures, moving from a traditional approach - in which the maintenance activities are usually carried out in response to "break-down incurred" - to a logic founded on the planning of preventative interventions. At the same time, in order to improve the efficiency of the management system, the Technical Services Department intends to start up an integrated management of heritage real estate properties, which regards not only the maintenance of the physical components of the buildings, but also the organization and the running of all of the services necessary to their functioning.

Heritage Real Estate Properties

The University of Catania is the owner of heritage real estate properties which have been allotted to the hosting of complex and differentiated activities, which can be divided into five macro-categories: *didactics*, which includes the activities relative to basic teaching methodology (classrooms) and to advanced teaching methodology (didactic laboratories); *research,* which includes the activities of study, experimentation and presentation carried out by the Departments; *administration,* which includes the directional, administrative, accounts and public relations offices; *services,* which includes the support activities to didactics, research and administration; *infrastructures,* which includes the spaces allotted to mobility and rest breaks.

The heritage real estate properties examined are heterogeneous in terms of age, location, morphological, dimensional, material and constructive characteristics of the buildings and in terms of the activities that take place in them. The properties situated in the city of Catania are located in part in a suburban area - the University Campus, which hosts many faculties with the same infrastructures and services, with buildings framed in reinforced concrete and steel - and in part in the historical city centre - with independent buildings, in stonework masonry (Figure 1). Other buildings are stationed outside of the territory of the Municipality of Catania, as in the case of the Faculty of Architecture, which is situated in the city of Syracuse. The properties located in historical city centres are all subject to the scenery restriction (Legislative Decree 42/2004), to which, for the buildings with historical-artistic value, the cultural restriction is added. A part of the properties is University property or has been given to the University on a free loan for perpetual use. For such properties the Institution must guarantee special and standard maintenance. Other buildings, on the contrary, are being leased by the University: for these the Institution must guarantee only the standard maintenance.

Figure 1. The real estate at the University of Catania: Main Building and School of Law

Among the principal problems encountered is an inadequate knowledge of the assets: the information necessary for the management of these properties is insufficient and incomplete, the archives are structured in a fragmentary way and are not computerized. The information held by the Technical Services Department is limited to the location of the buildings, to the property deed or lease contract, to the use allocation, to the type of conservation restriction that the building falls under and to the partial knowledge of materials and construction techniques. Moreover, the information is not constantly updated over time, nor is it updated after maintenance interventions are carried out. The needs of the building users are made apparent only when a break-down is reported and the decisions relative to the maintenance of the buildings are founded on needs that are hypothesized by university technicians. At the same time, the Technical Services Department is not adequately informed on the property policies of the University and functions by hypothesizing management strategies to carry out.

The Technical Services Department

The recent reorganization of the Technical Office has led to the creation of two sectors: The Department of Building Development and Special Maintenance, which concerns itself with special maintenance interventions, and the Department of Heritage Real Estate Properties, which concerns itself with standard maintenance interventions. However in these sectors the roles and responsibilities of the staff are not clearly defined. The Manager of the Technical Services Department assigns tasks which are established based on workload and professional profiles to the technical personnel as needed.

The Technical Services Department manages university real estate property assets by assigning the planning and design of the special maintenance and the management of "break-down incurred" interventions for standard maintenance to internal technical personnel. The special maintenance work is conducted with contracts in public record. The carrying out of standard maintenance work, instead, is done by external firms through fiduciary piece-work contracts (negotiated procedure, regulated by article 125 of Legislative Decree 163/2006).

The special maintenance interventions are identified and planned in the three-year plan of Public Works. The standard maintenance interventions, on the contrary, are carried out upon notification via telephone of the break-down to the Technical Services Department. The management task of reporting these break-downs is carried out, according to rotation, by all of the employees of the Office.

METHODOLOGY

The proposed management model is based on the willingness of the owner Institution to move from a management system that considers maintenance as a sum of corrective interventions, carried out in response to "break-downs incurred", to a system of planned actions, for the large part preventative, aimed at satisfying the needs of users, supporting university activities in the best way possible. This change requires new procedures, new tools and new methods of managing information, which take into account both the needs of the owner Institution as well as the needs of the users (Pinto and De Medici, 2005).

With the goal of verifying the method of assessment of users' needs and of the services guaranteed by the buildings a sample property, the Military Barracks Abela, was selected. This building is one of the sites of the Faculty of Architecture of Syracuse (Figure 2). It accommodates didactic activities (lecture halls and computer labs) as well as research activities (professors' offices).

The proposed method determines and plans the maintenance activities in function with both the services provided by the building, as well as with management requirements and the needs of the users (Figure 3). The analysis of the building resources leads to a hypothesis of management and, in particular, of maintenance that require, for each building, a compatibility check with the normal carrying out of the instituted university activities. Such a check has as its goal the identification of possible interferences between managerial/maintenance activities and the carrying out of activities by users (for example, maintenance activities that require the interruption of the electric energy supply can compromise lab experiments for which constant electric energy is indispensable). The result of the compatibility check allowed for the identification of corrective solutions, in order to optimize the planning of the managerial activities. In the proposed method, therefore, the user needs influence the choice and the planning of the maintenance activities, following the principle of *maintenance as a service*: the quality of the service is determined by its capacity to satisfy the users of the building in question.

BUILDING DATA

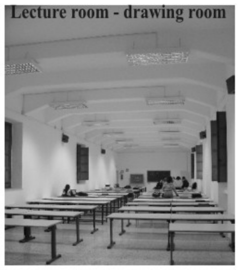
Building

Location:	Siracusa (Italy)	**Designer:**	-----------------
Name of the building:	Caserma Abela	**Primal function:**	barracks
Conservation laws wich concern the building:	Legislative Decree 42/2004	**Present function:**	School of Architecture
Building typology:	building with inner courtyard	**Owner:**	Italian State, Military Government Property
Age of construction:	-----------------	**Tenant:**	University of Catania
		Legal claim:	public licence of free loan for perpetual use

Exterior façades

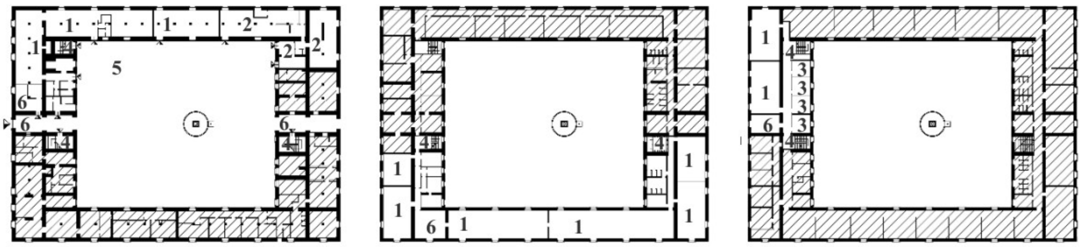
Courtyard

Lecture room - drawing room



Building characteristics

number of floors:	- underground floors 3 aboveground floors	**courtyard:**	1740 m^2
		bearing structure:	stonework masonry
number of exterior façades:	4	**vertical closures:**	wooden doors, windows and shutters
number of façades in the courtyard:	4	**horizontal closures:**	wooden trussed roof
maximum height:	16 m	**vertical interior partitioning:**	hollow block masonry
useful volume:	8433 m^3	**horizontal partitions:**	beam-and-block floor
covered area:	2028 m^2	**inclined partitions:**	armoured concrete stairs



plan of the ground floor **plan of the first floor** **plan of the second floor**

1. lecture room - drawing room **2. computer laboratory** **3. office of professors and researchers** **4. stair** **5. outdoor rest stop area** **6. indoor rest stop area** **area with restricted access**

Activities and dimensions

DIDACTICS	**USEFUL SURFACES**
lecture room - drawing room	**1170** m^2
computer laboratory	**157** m^2
RESEARCH	**USEFUL SURFACES**
office of professors and researchers	**135** m^2
INFRASTRUCTURES	**USEFUL SURFACES**
outdoor rest stop area	**1740** m^2
indoor rest stop area	**194** m^2

NUMBER OF USERS

professors:	***133***	professors- researchers:	***12***
students:	***1032***	technical staff aiding in teaching and research activities:	***8***

Figure 2. Identification File

The assessment of user needs is fundamental in defining the expected levels of quality: these needs are indispensable both in outlining the maintenance strategies, as well as in checking the maintenance service provided.

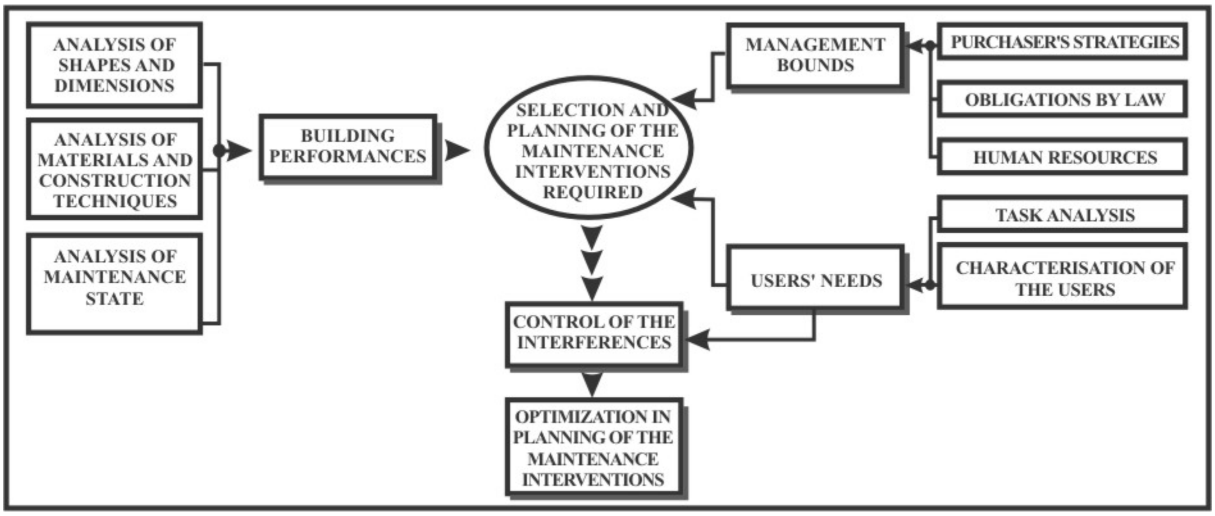


Figure 3. Methodology

The minimum services required by the university buildings were determined on the basis of the needs set by the activities which take place in them, classified according to the five macro-categories previously defined (*didactics, research, administration, services* and *infrastructures*). The proposed managerial model, therefore, has as its object not only the buildings and the technical elements which compose them, but also the system composed of the activities and the spaces allotted to host them. Not all of the services required have the same importance: some of these are particularly important because they can impair the carrying out of the university activities hosted (for example, control of the natural lighting and efficiency of the video-projection system are priority requirements in the lecture halls).

In order to assess user needs the Table of Expected Quality was formulated, and organized according to three levels of detail: Classes of Need, Classes of Requirement and Requirements. To better assess user needs, the list of needs reproduced in the UNI 8289:1981 regulation was enriched with the insertion of needs of a new definition. Subsequently samples of users were selected (corresponding with the various user profiles present in this building site of the Faculty of Architecture), to whom this Table of Expected Quality was shown. The users were then asked to evaluate the importance of the list of needs, by indicating the value attributed to each entry, according to a qualitative-type point evaluation scale, from least important to most important. This allowed researchers to organize the needs of the users according to a hierarchization of importance defined by the users themselves.

The number of individuals involved in didactic activities in the Military Barracks Abela is high: 1032 students and 133 professors and lecturers, following a rotation which covers two time ranges, the morning (8:30 a.m. to 2 p.m.) and the afternoon (3 p.m.-7 p.m.), five days a week. The research activities are carried out by 12 instructors/researchers, whose work takes place in one single time range (8:00 a.m. to 7 p.m.). The technical personnel, who support the teaching and research activities, is composed of 8 individuals, whose rotation takes place during one single time range (8 a.m. to 7 p.m.), five days a week. The survey of the range of time in which the activities are carried out allows to highlight the mutual interferences and to check the compatibility with the managerial/maintenance activities.

This research project experimented with the application of the Quality Function Deployment method (Akao, 1990; Franceschini, 1998), usually applied in design in order to project a product/service that satisfies the market requirements. The evaluation matrix used in this method, the Relationship Matrix, adapting it to the specific needs of this case, is able to translate the current user needs into specific techniques of maintenance work. In this matrix the conditions that the building must satisfy in order to support the instituted activities are listed (Figure 4). The columns reproduce a list of the managerial/maintenance services of the buildings. The phases of construction of the Relationship Matrix were: the assessment of the users' needs; the review of the technical characteristics required to the buildings; the creation of a relationship matrix; the hierarchization of the technical characteristics.

Significance of the users' needs

1.negligible 3.important 5.indispensible
2.preferable 4.many important

Relationships between needs and maintenance activities

weak △ medium ○ strong ●

USERS' NEEDS: DIDACTICS — **Technical characteristics required to the building**

1st level Class of needs	2nd level Class of requirements	3rd level Requirements	Needs' significance	Floor integrity	Floor cleanliness	Wall integrity	Wall cleanliness	Ceiling integrity	Ceiling cleanliness	Window integrity	Window cleanliness	Efficiency of the obscuration system	Efficiency of the window's manoeuvre systems	Efficiency of the door's manoeuvre systems	Efficiency of the cooling system	Efficacy of the heating system	Efficacy of the lighting	Efficacy of the video projection system	Efficacy of the sound-reinforcement system	Efficacy of the elevators
SAFETY	Protection of the Users	Protection by falls	4	●	○	○	△	○			△	○		○			○			
		Emergency evacuation	4	●	○									●			●			
		Roughness control	3	●		●				○										
		Easily of use and maneouvre	5	△								●	●	●	△	△	●			●
		Resistance to intrusion	3							●			●	●						
	Fire protection	Limiting of fire spread	5	△	△			○		●			△	△	●	●	●			●
		Limiting of explosion risk	5												●	●	●			
		Lack of noxious emission	4	○		○		○		○					●	●				
		Fire resistance	3	○		○		○		○										
		Noxious gas disposal	3							○			●	●	△	△				
COMFORT	Thermal and Hygrometric Comfort	Control of the ambient temperature	5	○		○		○		●		●	●	●	●	●	△			
		Control of the dampness	3	○		○		○		●			△	△	●	●	△			
		Control of the ventilation	5							●			●	●	●	●				
		Control of the solar radiation	4								●	●	●							
	Visual comfort	Control of the artificial lighting	5							○	○	○	○				●			
		Control of the natural lighting	5							●	●	●	●	△						
		Visibility of the speaker	5								○	●					●	○		
	Acoustic comfort	Control of the noise	5	●		●		●		●			●	●	○	○	△	△		
		Control of the speaker's audibility	5	○		○		○		○									●	
USABILITY	Adaptability of the Rooms	Availability to be equipped with furnishings and supplies	3	●	○	●	○	●	○	●										
	Accessibility to the Rooms	Accessibility through stairs	3	●	△					△	△	●					●			
		Accessibility through elevators	3	○								○					○			●
		Technical characteristics' significance		277	41	144	13	159	9	378	118	279	338	295	266	266	322	20	45	122

Figure 4. The Relationship Matrix

In order to identify the maintenance activities, the needs required by each activity carried out by the users were compared with the technical characteristics required to the buildings, specific to each location (Figure 4). This comparison allowed for the outlining of specific techniques of the maintenance activities in order to guarantee the upkeep of service levels offered by the building. The maintenance activities were selected and planned for *aggregate systems*, groups of technical elements that are tightly linked – physically and functionally – which can be the object of joint interventions. In the Relationship Matrix each technical characteristic can condition the fulfilment of several needs. The relationships between needs and building's characteristics are expressed in a qualitative way, based on the intensity of the correlation, defined according to a numerical scale. The intensity of the correlation is represented by symbols located at the intersections of the Relationship Matrix: these indicate relationships which are weak (∆), medium (○), and strong (●).

Starting from the scale of priorities of the needs set out by the user, the Relationship Matrix allowed, by applying the *Independent Scoring Method*, the defining of an order of priorities of technical characteristics required to the buildings. In the first phase of such a method, the symbols that represent the relationships between needs and technical characteristics (Δ, ○ e ●) were converted into their equivalent numerical values (1, 3 and 9), which were then used as numerical coefficients of the Relationship Matrix. In the second phase the sum of the results of the level of relative importance of every need and the quantified value of the link between technical characteristics and satisfied need was calculated.

The result of this evaluation is a ranking of the technical characteristics, in terms of efficiency demanded to the elements of the building, based on their priority in relation to the services required. Starting from this ranking, the priority and the frequency of the maintenance operations can be established in the Maintenance Plan.

CONCLUSION

The decision and planning activities of a service presuppose the capacity to prepare lists of priorities able to guide and organize choices. Such a necessity is more pressing when the financial resources available are limited. In these cases the definition of a support method to the management/maintenance choices of a heritage property constitutes a strategic objective in order to rationalize the use of the available resources.

The proposed method allows the guiding of the choices regarding university buildings both in function of their adequacy to the use and of their state of conservation, as well as in function of the user needs, realizing a direct participation of the users in the processes of heritage real estate management.

In the management of university heritage real estate properties - characterized by limited dimensions, a strong heterogeneity, elevated differentiation of the instituted activities - the phase of the assessment of user needs assumes a great importance. This phase, in fact, constitutes a guide for the designing and planning of the management/maintenance activities, defining in it not only an order of priority, but also a control tool for verifying the quality of services provided to the buildings and to the users.

REFERENCES

Akao, Y. (1990), Quality Function Deployment, Productivity Press, Cambridge.

Barret, P. (1998), Facilities management, Butterworth, London.

Di Giulio, R. (2003), Manuale di manutenzione edilizia, Maggioli, Rimini.

Franceschini, F. (1998), Quality Function Deployment, Il Sole 24 ore, Milano.

Pinto, M.R. and De Medici, S. (2005), "Quality Assurance in the Facility Management for Public Real Estate", in Kähkönen K. (Ed.), The Conservation of Monuments in the Mediterranean Basin, VTT and RIL, Helsinki, pp. 35-48, vol. IV, sect. I.

AN INTEGRATED SYSTEM FOR MANAGING COMPLEX BUILDINGS: AN APPLICATION FOR THE NEUROINTENSIVE CARE UNIT OF THE HOSPITAL G. RUMMO, BENEVENTO

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ABSTRACT

The introduction of information technology systems within the complex building produces an impact not only on the organizational structure of the different users of a building, but also on most of the interrelationships between system functions. As such, information technology, communication and building automation can be considered as factors in the system, becoming factors of production for the organization that occupies the facility. Management and maintenance of the buildings then become elements of productivity by helping to supporting the efficiency and reliability of the system in total. The Department of Configurazione e Attuazione dell'Architettura at the University of Naples Federico II has developed the research project SIGEM "Integrated System for Managing Complex Buildings" aimed to investigate new operational models for maintenance, safety and efficiency of resources and testing of an integrated system for the Neuro-intensive care unit of the G. Rummo Benevento hospital (Italy).

KEYWORDS: complex buildings, human tasks, efficiency.

INTRODUCTION

The SIGEM research is centred on the idea that the effectiveness and the efficiency of complex buildings management can be improved by integrating all involved processes and services; it is developed an ITC integrated tool to optimize all management flows, avoiding crossings, intersections, repetitions and, in all, material and immaterial resources waste.

Since many heterogeneous factors and processes, such as customer care and quality management, energy saving, security have to be merged in the management of complex buildings (e.g. hospitals, airports, malls etc.). More and more sophisticated tools and infrastructures need to support managers and, in general, any sort of figures that are involved in the buildings carrying out. Each user category can suffer actions, decisions and behaviour of some other user categories such as each category can affect actions, decisions and behaviours of other users. Therefore, each management service has been observed finding out relations with all other services where the data analysis are based on a set of "Activity area" and "Architectural functional centre". The interrelation matrix (which comes form previous analysis phases) indicates the "key actions" for two or more processes and their characteristics elements, so called "Integration factors", that can be time, place, required resource, involved actors, effects or side-effects.

The study is divided by the following sub-objectives:

- study of new or organizational and operational processes for the management and monitoring of maintenance, control systems security and value for resources of the building system;
- identification of the representative model and implementing processes for managing interactive and integrated activities, identification of the actors involved and the bodies of maintaining efficiency of the system construction;
- study of the demonstrator characteristics for management monitoring and optimization;
- testing of the integrated system for the management and monitoring of maintenance, safety and efficiency of resources on a pilot project.

THE ACTIVITY MODEL IN HOSPITAL SERVICES SUPPLYING

Together with an high functions and technological complexity hospitals are characterized by some aspects related to the particular categories of users we have to take in account for an integrated management of the building. There are different active actors, performing care and assistance activities, and passive actors receiving the outcome of those activities. The research has been founded on the identification and selection of hospital services by studying hospitals activities in order to understand their organizational model. The activities model has been structured on a relation grid of the different entities which characterize each activity area, it gave us the opportunity to have a detailed description of hospital services observing their providing formalities. Each action is linked with the whole of their different actors, together with the other functional and organizational aspects; the activities grid shows relations that each category of operating users establishes with different supplied actions of the services (both by considering activity areas and functional units of the building and by selecting other operators with which they interact).

To study activity model we have selected the following users:

- in-patients
- day hospital patients
- physicians
- nurses
- nurses supporters
- health care technicians
- administrations personnel
- technical personnel
- visitors/caregiver

Services necessary to assure health care functionalities of the hospital has been selected as:

- building functioning services
- systems functioning services
- safety systems services
- security systems services
- hygiene services
- administration support services

Building and systems functioning services and safety and security systems services have been analyzed in relation to their information contents in order to identify nature and typology of data used in the supplied actions. Then the study has been oriented to understand services controlling criteria applied by different actors in managing those data. As we consider that the control is the main element to guarantee the services efficiency, the study has been developed by analyzing all factors that are able to control each services supplying, in terms of actors, actions, formalities and their reciprocal relations. Each service is interpreted as a process, than we identified in each action the *control object*, by meaning that the typology of most sensible data is coming from any internal or external situation, eventually occurring. Control object is linked to technical and organizational elements that we have to observe to verify the process. A list of *events* has been defined which are able to change information exchanged, those one which have a negative impact on the regular providing of the services and, at the same time, it is specified what is routine or special monitoring. The possibility to govern *service risk situations* determined by events occurrence can be assured identifying the whole of *tasks* to proceed for managing each situation. Balancing the events effects on the process each task has been defined to activate operations affecting the regular developing of the process, also considering other processes involved.

DEFINITION OF THE PROCESSES FOR MAINTENANCE SERVICES AND SECURITY.

The definition of the actions that compose each service and of the data streams to each action is deemed uniquely determined when the structure of the process is known, which is the real "DNA" of services. The knowledge of a process is essential for understanding its mode of development; therefore it has been structured the analysis of the information content of each service and the identification of the rules which govern the relations between the actions.

The processes structure have been investigated by the development of corresponding flowchart. To reach the fulfillment of an integrated model, the construction of the process has been developed through the identification of intersections with other services or within the same one in order to define a matrix of the exchanging information for understanding the potential for integration.

In a process actions have been identified that can affect the outcome of at least another one process. According to this approach all actions have been identified those which let it possible to have a feedback on the state of another process or to change its output, both in terms of setting/correction, or alteration. These actions, called key actions, were identified by the development of a matrix that points out the relationships between the different processes, where lines indicate the process to which the key action belongs, and the columns indicate these processes which suffer from interference.

The integration of management services mostly depends on the characteristics of actions that can generate effects on other services than those to which they belong.

The operational procedures required the following steps:

- identification of sets of services and processes where each action is a potential issue of integration;
- identification of the characteristics of key actions based on the knowledge of their nature (type) and their own factors of integration;
- knowledge of the relations between the actions of the processes.

Factors integration

The analysis of the interchange area of the services should be aimed at identifying the characteristics of the relationship between the involved processes, also by pointing out the relations for:

- place
- time
- resources
- actors
- effect

Every action that is engaged in a relationship with another process has its own set of data that can find matching actions in other processes and thus it represents a potential factor of integration.

The area of integrated management is defined by identifying key actions or those actions which trigger possible trade with the processes belonging to other services. The recognition of key actions involves the research and the identification of the matching actions in the related processes. It is therefore necessary for integrated management, to exactly know what are the integration factors: *how* and *where* the interaction between two processes occurs, and particularly *what are* the exchanged factors that can have relapses over another process or even more than one.

Identification of services and processes through integrated key actions

Within each service, the key actions can be differently allocated and at the same time they can share, fully or even partially, that input and output data of the action.

The identification of services and processes which can be integrated by means of key actions was achieved by developing a chart where any key action is linked to all belonging or impacting / interfering services.

This step points out all the possible modalities in which services are connected, so that some set of services and/or processes have been highlighted as *markedly recurring* (Service for building functionality, Maintenance on failure, Planned Maintenance, Service for plants functionality - Planned Maintenance).

System of relations between services

The model representing relationships between services shows areas of greater and lesser impact of the key actions comparing them with all actions constituting processes; through a synoptic scheme, it is possible to extrapolate some actions paths, *named impact tracks*, throughout all service considered, in order to highlight some the strategic actions chain capable to be considered as enabler of an efficient control of all interactions among processes

The identification of key actions – defined as those actions that can determine effects on processes belonging to another service - was developed making a distinction between the *active* actions from *passive* ones suffering effects from actives actions.

So, as “key action” were indicated active actions and passive action, were defined as sensitive actions because their successful outcome is conditioned by the key actions outcome.

Furthermore, the study of impact tracks allowed to identify the "weight" of each key action thanks the identification of actions triggered by key actions. Essentially paths were highlighted linking a key chain on an issue of another process and so on as a kind of cascading effect. In this way it was possible to identify the potential role of a strategic key action on the basis of the number of processes that, sequentially, it can influence.

Identification of the relationship between services through key actions

The analysis of the relationships among services has been developed elaborating a services array, that allows to locate all possibile interchanges among processes: each place in the array identifies the correspondence between two processes (coordinates) and highlights what actions of the processes are related to others or could affect the services delivery. This matrix constitutes the services network map and helps in identifying *procedural areas* having greatest priority in control and management.

Propensity to services integration

The reading of the services integration propensity has been done considering the percentage of key actions and sensitive actions of each process; in fact, we considered that a process with a high percentage of key actions strongly affects the performance of the whole system and, therefore, could assume the role of "enabler" of the system integration. Similarly, a process consisting of a large number of sensitive actions is strongly influenced from the development of key actions. This approach to services for maintenance and management observation provides some initial information system on the processes that mostly could felt a greater impact from modelling key actions.

THE INTEGRATED MANAGEMENT SYSTEM CREATED FOR THE RUMMO HOSPITAL IN BENEVENTO

On the basis of the representation of organizational models of hospitals management services by mean of involved subjects, human actions and necessary information data, the SIGEM model for the optimized management of hospital buildings was realized.

Functionalities of the integrated management system have been defined following three key strategies, considered as able to optimize hospital services integration, thanks to their impact on effectiveness and efficiency of maintenance and safety processes. Integrated strategies are:

- maintenance strategies of plants/services for medical processes, able to introduce robustness in some critical devices monitoring and focusing on the malfunctioning detection for that components not monitored at the present;
- safety strategies for people in the neuro-intensive care department, preventing risk situations for both sanitary personnel and patients. These strategies are based on information integration coming from several plants belonging to independent services;
- optimizations strategies for energy saving, assuring the constant level of supplied services and their differentiation, according either law requirements either users needs.

The SIGEM system implementation at the Rummo Hospital in Benevento (Southern Italy) required the integration of the existing technological infrastructures with purposed sensors and actuators, easily interfaced by mean of automation gateways, respecting either architectural structures either the very strict law prescriptions to be respected in such type of sanitary department. Therefore,, the realization of SIGEM technical features for the on site experimentation was pursued taking into account the not-invasiveness of interventions, splitting the implemented strategies and selecting those components, belonging to different plant and services typologies, able to be fully integrated without significant modifications on existing structures .

The architecture of the SIGEM management system

The architectural model implemented for the SIGEM on site experimentation defines provided services, users involved as well as information and decision flows; it is based on web technology, working in ASP modality too. Basic components of the SIGEM architecture are:

- Level 3 – SIGEM DSS: integration of all the applications for the complex building management
- Level 2 – Service Node: monitoring, remote control, information integration
- Level 1 – Adapter: software system for communication with building automation structure
- Level 0 – Infrastructures: plants, automation gateway and building automation apparatus.

The implementation of the depicted architecture assumes that all the various components at level 0 are able to interface with and Automation Gateway directly or via a plant management device (e.g. a switchboard); it assumes also that plants providing services for sanitary activity are automated. As automation we intended that plants work without human being actions, except –of course- in activation, programming and maintenance phases. This means that SIGEM strategies act directly on plants, acquiring data on their working status by mean of specific sensors and modifying their working conditions by specific actuators.

The SIGEM Decision System Support integrates data coming from all components and, consequently, acts on the status of each considered plant, adjusting its performances according to the efficiency of the whole of integrated plants. Therefore, the remote control system, named Service Node, has a specific component for XML messages delivery to the DSS in case of events/alarms coming from plants. On the other hand, the DSS is able to receive and manage XML messages from service node. Obviously, DSS supports the defined strategies applying rules for both plants adjustment and/or other applications activation and generates meta-events to be sent to the service node.

The innovation in process optimization

One of the most innovative aspects in the presented research project is the possibility to test on site synergies of the maintenance process with other domains as safety management and energy saving. The SIGEM integration model improves either efficacy of each single process, evaluating all consequences and correlations of a specific event, either whole building efficiency, making possible the quick and correct task management and activation for any possible situation.

Moreover, the SIGEM model configuration in three possible connectivity typologies/levels with a wide range of devices/plants allows the SIGEM use in existing building or plants – even if they are not designed for remote control- with low impact and cost interventions. Also the firmware/software component, so-called “Adapter”, is a strongly innovative factor, since it allows the abstraction of the system from specificities of single devices or plants. In fact it standardizes processes and interfacing modalities using the “Automation Gateway” devices, which work independently on the specific producers.

For what concerns the building management domain, the availability of a service provider supplying services in ASP modality, in a dedicated service centre, is a quite original use of the common ASP existing technologies.

Finally, the Service Node has following characteristics, insuring its easy and flexible installation in a wide range of automated buildings:

- maximum variety of controllable equipments, thanks to a single system interface, accessing all the switchboards in the Automation Gateway;
- maximum variety of access channels, because the Service Node provides an uniform and multi-channel access to all –advanced and not advanced- Automation Gateways, with SMS (Short Message Service) and e-mail component for alerts notification and a labeling system for personnel access management;
- high security, due to the implementation of security features at the more sophisticated Service Node level, instead that at single Automation Gateways;
- maximum integration among business partners and business providers, thanks to a B2B integration allowing the information sharing (in XML format) among multiple and heterogeneous service providers (e.g. cleaning, security, safety, building maintenance, energy management, etc.);
- maximum customization in development and delivery of new services, thanks to modularity of the integrated system. In fact, the Service Node is built assembling a set of services devices, selected ad hoc from each single service, and consequently designing the new *integrated events* to be managed by the SIGEM system, in order to make the *integrated management tasks* fitting the specific building use and characteristics.
- user-friendly interface, allowing the control of several different plants and devices just using a single one interface.

CONCLUSIONS

SIGEM solution is able to give operational support for all subjects responsible of complex buildings management, providing interactive tools for synergic control of all integrated services by mean of Internet services. The SIGEM architecture represents a great opportunity for services provider companies to extend their services availability and, on the other hand, increases the service accessibility and integrability for building managers, which bring to a better efficiency, a resource cost reduction and a stronger customer satisfaction.

In this framework, actions and actors of each building process have been considered as key factors to merge so many flows, rules and resources in the most effective and efficient way. In fact, one of the most original aspects of the SIGEM project is the consideration of actions and tasks of all users as input for the data flow analysis, so that the integrated management system could provide a comfortable and efficient use of the hospital building for patients, visitors, medical personnel, cleaning, maintenance, security staff, accounting and technical personnel and also suppliers.

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REFERENCES

Attaianese E., Duca G., Fabbricatti K., C. Viscardi and Castagneto F., (2007) "Criteri innovativi per la sostenibilità della manutenzione edilizia nelle attività produttive", in Fiore V. (Ed) La cultura della manutenzione nel progetto edilizio e urbano – Proc. of National Conference, Lettreaventidue Editor, Siracusa, pp. 102-107.

De Joanna P. and Viscardi C. (2007) "Il sistema informativo per la gestione della manutenzione edilizia: Strumenti normativi ed esperienze applicative", Proc. of National Conference, Lettreaventidue Editor, Siracusa.

Caterina G., Attaianese E., Duca G. and De Margheriti G. (2006), "Participatory ergonomics in hospitals' renewal design oriented to humanization, in Meeting Diversity in Ergonomics", Proc. of International Ergonomics Association 2006 Congress, Elsevier.

De Joanna P. (2005) "Rilevanza del sistema funzionale rispetto alle strategie di manutenzione", "Criteri di classificazione degli spazi e delle attività" and "Costruzione del PCA (Piano di Classificazione delle Attività)" in Caterina G. (Ed) Per una cultura manutentiva. Percorsi didattici ed esperienze applicative del recupero edilizio ed urbano, Liguori Editor, Naples.

Caterina G., Fiore V., Attaianese E., De Joanna P., Bruno A. and Viscardi C. (2005) "Management and information maintenance plan for the new law court in naples" Proc. of First International Conference on Maintenance Management for Quality life, Safety and Productivity – Venezia 14/15 Aprile 2005, La Sapienza University Press, Rome.

Attaianese E., Caterina G. and Duca G. (2003) "A method to improve information design for building maintenance, in Quality of work and products in Enterprise of the future", Proc. of the Annual Spring Conference of te GfA and XVII Annual conference of the International Society for Occupational Ergonomics & Safety (ISOES), Munich, Germany, May 7-9 2003, Ed Ergonomia Verlag oHG, Stuttgart, pp. 175-178.

THE IMPACT OF CITY IMPROVEMENT DISTRICTS ON THE INFORMAL TRADING SECTOR

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ABSTRACT

This paper examines the impact the establishment of the Claremont Improvement District Company (CIDC) has had on the Informal Trading Sector in the Claremont urban precinct of Cape Town, South Africa. The study established that the informal trading sector is a prominent feature of the Claremont CBD. The various stakeholders in the study present conflicting perspectives in terms of the informal trading sector being accommodated in a collegial manner by the City of Cape Town. The negativity the Claremont Informal Trader Association's chairperson has towards these bodies, the fact that traders have very poor access to basic services, the poor interpersonal communication between traders and City officials in terms of traders rights, and the overwhelming unhappiness traders feel towards moving to a designated market is indicative that the Claremont Informal Traders have not been accommodated in a collegial manner by the City of Cape Town, the CIDC and "Big Business".

KEYWORDS: Improvement districts, informal sector, South Africa

INTRODUCTION

"Informal Trading" may be defined as the "economic activity undertaken by entrepreneurs who sell legal goods and services within a space deemed to be public property, within the informal sector" (Ukukhula Business Solutions, 2003:5). Informal economic activity is comprised of employees, employers, and self-employed persons who work for unregistered private sector enterprises which do not keep a record of accounts (Ukukhula Business Solutions, 2003). In addition, businesses in the informal sector can be defined as "micro", "small", "medium" or "large" scale enterprises (Jaffray et al., 2002). The South African informal trading sector (including "street trading" and "hawking") predominately comprises micro and small scale enterprises (Ruhiiga, 2000).

The City of Cape Town aims to develop its informal trading sector into a commercially feasible and dynamic economic sector, thereby contributing to local economic development and the promotion of the long term social sustainability of the City (Ukukhula Business Solutions, 2003). In a 2002 survey, it was established that 42% of informal traders in Cape Town were either unemployed or had been retrenched from the formal business sector (City of Cape Town, 2006). It was estimated that the informal sector in Cape Town generates 12% of the gross geographic product (GGP) for the Western Cape Province. The GGP of a particular area is defined as the "total income or payment received by the production factors - (land, labour, capital, and entrepreneurship) - for their participation in the production within a given area" (RSA, 2008). Furthermore, the informal sector in Cape Town employs 18% of the economically active individuals in the city (City of Cape Town, 2006). However, laws governing street trading have been developed controversially and without consultation with street trader organisations. The resource-constrained local authorities have tended to leave the day-to-day management of informal street trading to City Improvement District management structures (Lund et al., 2000). City Improvement Districts (CIDs) are "defined geographic areas within which property owners agree to pay for certain services to enhance the physical and social environment of the area" (Joburg Central, 2008). Such services are additional to those offered by the local authority, and typically include safety and security, pavement cleaning, litter collection, maintenance of public spaces and the removal of illegal posters; colloquially termed 'crime and grime'. This paper examines the impact the establishment of the Claremont Improvement District Company (CIDC) has had on the Informal Trading Sector in the Claremont urban precinct of Cape Town.

PURPOSE OF THE STUDY

The purpose of the study was to gain insight into the need for, the importance and extent of the informal trading sector in Claremont, a decentralised business district set in a Cape Town residential suburb. It also aimed to establish the Claremont Informal Traders' perspectives of The City of Cape Town, The Claremont Improvement District Company, formal sector businesses in the area, and their impact on the informal trading sector.

RESEARCH METHOD

A survey of informal traders and key stakeholders was conducted in the Claremont area in mid-2007. There are 60 informal traders in the Claremont area, managed by the City of Cape Towns Department of Business Areas Management. A random sample of 20 informal traders were selected and interviewed using a questionnaire survey. Many of the informal traders are not conversant with the English language. To facilitate understanding of the questions, each trader was interviewed at their stall and each question was explained to them in simple and easy to understand terms. Each interview took on average half an hour to an hour to complete. The survey was conducted during July 2007. Specific issues such as the impact of the Claremont Improvement District Company and "Big Business" on informal traders and the manner in which the City of Cape Town is currently regulating trading in the area could not adequately be covered by means of the survey alone. To obviate this, key role players were interviewed in order to achieve a more holistic view of the situation of traders in the Claremont area. Such role players included the Service Coordinator Manager of the Department of Business Area Management at the City of Cape Town (Interview 1); the chairperson of the Informal Traders Association (himself a historical trader) (Interview 2); a fellow historical trader (Interview 3); and the Informal Traders Area Coordinator (Interview 4). The richness of the complex issues inherent in the formulation of the Claremont Improvement District Company (CIDC) that emerged during the survey is discussed and conclusions drawn.

THE CLAREMONT CASE STUDY

Overview

Claremont is a dynamic, thriving decentralised business hub with a large and growing high density residential component. People are attracted to Claremont because of the Cavendish Square shopping centre (45000m^2), the train station, the transport network, and the numerous retail outlets. Claremont comprises a number of main travelling routes operating north to south. Claremont Main Road is the main arterial road of the area and is characterised by a large volume of vehicular and pedestrian traffic. The majority of the traders in Claremont are located on the pavements along “Main Road” because of its proximity to pedestrian flow. Lalthapersad-Pillay (2004), Chen et al. (2002), Lund et al. (2000), and Morris et al. (1996) have established that the main motivation behind informal sector businesses is personal survival. The Claremont survey supported this statement. More than 30% of traders in the area have been trading there for more than 11 years, indicative of the permanency of street trading as a sustainable economic activity.

Regulation of the Informal Trading Sector in Claremont

Informal trading in Claremont began in the early 1940’s with fruit and vegetable sellers. Prior to 1991, the City of Cape Town’s municipality had exclusive say about who could be granted a trading bay and where trading was permitted. This system was perceived to be one of unilateral dictatorship (Interview 1). Traders endured severe hardships during the *apartheid* era in that they could only trade in one place for a half hour at a time, had to wear white coats, and were prohibited from trading in Main Road. If they were in breach of the *apartheid* laws, their goods were confiscated (Interview 2). Many of the informal traders were born in Claremont, worked there in the formal retail sector, but were forced to leave the area when the Group Areas Act (RSA, 1968) was introduced. As a result, many of these traders lost their properties and formal businesses in Claremont and were forced to work in the informal trading sector (Interview 2).

The Claremont Informal Traders Association was established in the 1980s. The informal trading sector grew rapidly throughout the 1980s and, despite the difficulties, traders continued to conduct business along Main Road (Interview 2). In 1991, the Business Act (RSA, 1991) was promulgated. This Act allowed for the freedom of trade and as a result a somewhat “free for all” situation was permitted (Interview 1). However, conflict still existed between the traders and City officials. As a result of the new “free for all” approach, there were too many traders wanting to trade in Claremont which infuriated “Big Business” (Interview 2). Interviewee 1 went on to state that the informal sector took “complete advantage” of this opportunity.

The South African Property Owners Association (SAPOA), the Chamber of Commerce (COC), and a range of lobby groups placed a great deal of pressure on both the City of Cape Town and Parliament to amend the legislation. This amendment occurred in 1991 and resulted in the National Government no longer having sole control over the informal sector. This responsibility then fell to the Local Government. The plan devised by the City was to restrict informal trade to demarcated bays with a certain amount of trading bays allocated to each area. Traders agreed to this system and were free to operate in Main Road (Interview 2).

Until 1992 the Claremont CBD was extremely busy with traders. A small minority of traders were both acrimonious and confrontational and politicized the fact that they were only permitted to trade to demarcated areas. Property owners, through the COC and SAPOA, approached the City and threatened that if decisive action was not taken, they would boycott rates. At this juncture any effort made by the City to mediate between the informal traders and formal business to reach agreement resulted in hostility (Interview 1).

Informal Traders Business Plan Proposal

In 1997, in an attempt to resolve the problems in Claremont, the informal sector proposed a business plan to the City of Cape Town. The main objective of the plan was a partnership between the informal sector, formal sector, and the City, to jointly manage the informal trading sector. No response to the plan was ever received. Interviewee 2 believed that the City did in effect reply to the traders in respect of the business plan because the CIDC plan was to remove traders from Main Road and into trading markets. Interviewee 4 could not shed further light on the business plan, stating "I do have it; I just have to find it. The traders did make a proposal to the City but you will need to confirm with them". A follow up interview with Interviewee 1 confirmed that he was aware that, during communication between the Consultants and various trader bodies/groupings, a proposal was made which suggested that informal traders be self-regulated and self-managed. Neither the City nor the formal sector supported this proposal. Interviewee 2 added "I wanted a meeting with the manager responsible in the City of Cape Town, with our Association, and CIDC management. We wanted to debate this issue with regard to our rights, our future, the proposed plans we gave, how we lost Claremont, how we are still losing it up until today, and how they just want to remove us". Tensions clearly still exist between the parties.

Establishment of the CIDC

Initially the property owners, in partnership with the City, established the Claremont Business Forum. The informal sector was invited to be represented on this Forum. Interviewee 1 felt that there was a determined effort by the informal sector to take over the CBD's. He said that the Forum worked hard towards reaching a win-win situation. The agreements which were made and the issues which were resolved between the leadership of both informal and formal businesses were usually short-lived since the informal sector constantly violated the agreements. After about a year the City realised that it was not going to achieve a peaceful lasting agreement between the two parties. The City was happy with the proposal of having a CIDC. This proposal was approved via the required statutory process (Province of Western Cape, 2004). When it was advertised for public comment, the formal sector agreed to the proposal, but the informal sector appeared to object to it. Interviewee 1 believes that a "mafia" element was behind the disagreement and that the informal sector at large approved the proposal. The proposal was finally endorsed in 2000.

Informal Trading Policy

As a result of the formulation of the CIDC, the new Informal Trading Policy was implemented in 2003. The Policy suggested that street trading should be restricted and that there should be a move towards trading markets. As a result of the City's obligations in terms of the Policy, the City is currently developing a training and development programme for the traders. The City has prioritised the making of the traders "comfortable", with the intention of moving them to a market. According to Interviewee 2, the policy objective that traders can only have one trading bay per family and the objective of moving traders along a developmental continuum from micro-businesses to medium businesses is not an easy task. He feels that the City is making it very hard for the traders and that traders are eventually going to be phased out. The survey revealed that 60% of traders were operating on a survivalist basis and that only 40% traded on a profit basis. It should be noted that those who earned a profit felt that they could only make a very small profit which was saved to be spent during the winter months.

The Development of Trading Markets

According to Interviewee 4, traders in Claremont currently do not have any toilet facilities or proper structures. She says that, in terms of the proposed new market, traders will have access to formal structures, toilet facilities, water and other necessary amenities. Interviewee 4 stressed that the City will not simply move traders to the new market without their input. This move of traders to a market is consistent with the City's Informal Trading Policy and Interviewee 1 says that this is not a case of the CIDC wanting traders to be removed; the CIDC is only following what is stipulated in the Policy. The Policy makes it clear that, in tertiary economic centres, like Claremont, it is preferred that traders be located in pedestrian malls, designated open trading areas and markets. The survey established that only 25% of traders were pro the market, whilst the remainder would prefer to trade at their present locations along the pavement but in specific trading stalls. Their main reasons for this were that they were concerned that the pedestrian traffic past their stalls will drop, resulting in their businesses declining and eventually forcing them to leave. Quoting Interviewee 3, "I am not happy that they are going to move us out of the Main Road because I have been trading for over 50 years in the Main Road; we do not agree to this. I feel that the fruit and vegetable stands are like a show in the Main Road. I can't understand why we have to move out of the Main Road". Interviewee 2 shares a similar view; that moving traders to a market which is going to be behind buildings will only attract a certain number and type of customer, whereas in Main Road all different kinds of customers are found. He went on further to say "CIDC, along with the City of Cape Town, want Main Road for themselves, so that they can benefit from it; they don't actually care about us". Interviewee 4 empathises with these traders and has suggested that a few spaces along the Main Road should be identified for some traders to trade. She felt that not all traders should be removed from the Main Road.

Objections to the Informal Trading Policy

It is not clear if there were any objections *per se* to the Informal Trading Policy. Interviewee 4 did say that she would not allow traders to move to the market if they were not sure and comfortable with the move. Interviewee 2 said that all the traders across the Western Cape attended most of the workshops and challenged the City regarding the Informal Trading Policy; claiming that this policy document was based on the old *apartheid* system. He said that the 98% of Traders Associations did not agree to the Policy and yet the Policy was still approved. A fellow historical trader, Interviewee 3, said "When we attend the public meetings, they don't take note of what we have to say. The Trading Policy is wrong and we don't agree with it. The City of Cape Town must first speak to us and have a meeting so that we can understand and come to an agreement". Interviewee 2 shares this view. Interviewee 2 was quite adamant that he will not move out of Main Road to the market because the traders made no such agreement with the City of Cape Town. He said "They must show us proof that we agreed to the Policy document, because we objected in black and white; if they have no proof, we are not moving".

A follow-up interview with Interviewee 1 with regard to the matter of objections from traders revealed that he was not aware of the objection, and definitely does not support such a contention. According to him, the Draft Policy was advertised in local media and newspapers on the 25 August 2003. In addition, it was hand delivered to all key stakeholders in the Claremont area. Subsequently, public information sessions and hearings were held in September 2003. The majority of the comments which the City received related to the impact on flea and craft markets, with very few comments relating to the traditional street trading.

Informal Traders Views

Interviewee 2 was quite upset about the situation traders find themselves in at the moment and had "great" objections towards the Informal Trading Policy, the CIDC, "Big Business", and the City of Cape Town; especially with the redevelopment of Claremont underway.

Another historical trader, Interviewee 3, a fruit and vegetable trader, spoke about his trading experience in Claremont. He said “Over the last say 10 years since the CIDC has taken over, things are totally different. The big businesses just want to take over. They want to kill off the people with small businesses. They are not concerned with us. We struggled all the years and I think our situation in future is going to be worse now, even more so than in the *apartheid* times”. According to Interviewee 2, the main reason why traders left Claremont was due to the re-development process. He believes that “Big Business” and the CIDC, together with the City, view the informal traders as an eyesore in Claremont and that they are “in the way”. He believes the plan of big business is to Europeanise Claremont. He further believes that “big businesses” are only re-developing Claremont for their own benefits and that the underprivileged and traders will not benefit from this initiative.

CIDC View

Interviewee 1 stated that the main aim of the CIDC is “to make Claremont a better place for all” and that includes the informal sector. The CIDC is looking towards upgrading the urban space of Claremont as well as assisting in the management and control of crime and cleanliness in the area. The survey (ref?) revealed that more than half of the traders were aware of the primary objective of the CIDC in dealing with crime and grime. However, only 47% of the traders felt that the CIDC directly assists them in terms of security and crime control. Interviewee 1 felt that majority of traders had permits and obeyed the laws of trading. The survey verified this, as 95% of the traders agreed that they should have a permit.

Interview 1 considers that the greatest advantage of having a City Improvement District Company in Claremont is that they are not only concerned about their properties, their businesses and their income, but that they are aware of the social issues and hardships that traders are faced with. They view traders in a positive light and firmly believe that informal traders should remain. According to Interviewee 2, the CIDC and businesses will claim to view traders in a positive manner but that they believe they have the right to remove traders from the pavements. Interviewee 2 feels that traders should be free to trade as long as they are not contravening the by-laws. He further believes that the CIDC wants the City to create bylaws to restrict the activities of traders.

Interviewee 1 explained that the CIDC, together with the City, developed the “Claremont Vision” (CIDC Annual Report, 2006). This vision comprises a three-phase project development, entailing the upgrading of infrastructure feeding the area. Interviewee 2 agreed that it is a good idea to redevelop an area and make it more attractive, but feels that traders should be a part of such an undertaking. Interviewee 4 argues that the traders are seen as stakeholders in the area since they are paying for their permits. Interviewee 2 disagrees. He feels that informal traders have been totally excluded as stakeholders right from the start. According to him, all the other stakeholders in the area were “already on board” by the time the CIDC invited the informal traders to the meetings. Despite the alleged 98% objections from the informal traders, nothing has been done to alleviate the problem.

Formal Business View

Interviewee 2 believes that traders have a good relationship with formal businesses. He feels that the reason for this is that, together, the formal and informal businesses create the business vibe of Claremont. “We are not taking business away from them, we are giving them business as well. They are gaining from the public, the underprivileged, and from the traders; they are not losing anything”. Interviewee 4 believes otherwise, being of the opinion that some formal businesses are exploiting foreign traders by having traders sell their goods for them on a commission basis. Interviewee 4 reported that it was difficult to get traders to confess to this. According to Interviewee 4, certain traders were effectively blocking off entire shop windows, causing formal businesses to suffer.

According to Interviewee 1, traders have not left Claremont because of the establishment of the CIDC, but rather due to personal circumstances. Some have upgraded their businesses and are now managing small retail shops. According to Interviewee 4, she felt that many traders have left as a result of being displaced by the current building and refurbishment operations in the area. Two years ago there were evidently about 80 traders in Claremont. However, since the construction operations there are only about 60 left.

CONCLUSION

This paper has reported on a survey of stakeholder opinions regarding informal trading in the Claremont area. The findings indicate that informal traders feel disenfranchised, and entertain 'conspiracy theories' regarding the true motives of other stakeholders. The other stakeholders dispute this, being of the opinion that they are working together for the best interests of all. The proposal to move informal traders from the Main Road (their location of choice) to a designated market with a system of allocated and regulated stalls is unpopular with informal traders, despite the assertion of the other stakeholders that the traders were party to the agreement.

The number of informal traders in the area has diminished. Reasons for this include redevelopment in the area, coupled with a feeling on the part of traders of "fighting a loser battle". Many traders feel that mere lip-service is paid to their interests, and that the ultimate objective of the other stakeholders is to remove them from the area. The City, the CIDC, and formal business disagree. Traders see the CIDC initiative as detrimental to themselves.

The problem surrounding the nature, extent, location, and regulation of informal trading in the area remains unresolved. Poor communication between the parties is obviously an exacerbating factor. Clearly, there is a need for the City of Cape Town to conduct workshops with the Informal Traders, "Big Business" and the CIDC in order to achieve the best management option by means of incorporating all role players' inputs. Lastly, it is concluded that adopting a similar method of research, a comparison needs to be conducted between other City Improvement Districts in Cape Town in order to determine if the Claremont Informal Trading case is unique or whether the issues raised in this paper are prevalent in other areas of the city.

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REFERENCES

Chen, M.A., Jhabvala, R. and Lund, F. (2002), "Supporting Workers in the Informal Economy: A Policy Framework", International Labour Organisation, Geneva, available at: http://www.ilo.org/public/libdoc/ilo/2002/102B09_156_engl.pdf

City of Cape Town (2006), “Business Areas Management”, available at: http://www.capetown.gov.za/econdev/corebus/informaltrade.asp

CIDC Annual Report (2006), “CIDC Annual Report”, available at: http://www.claremontcentral.co.za/cidc-annual-report.html

Jaffray, J., Naidoo, R. and Neville, M. (2002), “Business support policy: promoting the growth of existing and new businesses”, available at: http://www.capetown.gov.za/econdev/downloads/bus_support_policy.pdf

Joburg Central (2008), “What is an Improvement District?” available at: http://www.joburgcentral.co.za/about_detail.php

Lalthapersad-Pillay, P. (2004), “A Socio-Economic Analysis of African Female Street Traders in the Johannesburg CBD”, SAJEMS NS, Vol. 7 No. 1, pp 22-25.

Lund, F., Nicholson, J. and Skinner, C. (2000), Street Trading, School of Development Studies, Durban.

Morris, M.H, Pitt, L.F and Berthon, P. (1996), “Entrepreneurial activity in the Third World informal sector: The view from Khayelitsha”, International Journal of Entrepreneurial Behaviour and Research, Vol. 2 No. 1, pp. 59-76.

Province of Western Cape (2004), “City Improvement District By-Law”, Provincial Gazette, Province of Western Cape Government Printers, Cape Town.

RSA (1968), “Group Areas Act no. 41 with amendments”, National Gazette, Republic of South Africa Government Printers, Pretoria.

RSA (1991), “Business Act”, National Gazette, Republic of South Africa Government Printers, Pretoria.

RSA (2008), “Gross Geographic Product Per Province’, Department of Environmental Affairs and Tourism, Republic of South Africa Government, available at: http://www.environment.gov.za/Enviro-Info/nat/ggp.htm

Ruhiiga, T.M. (2000), Management challenges of hawking in Phuthadithjaba, South Africa, Settlements Studies Unit, Qwaqwa.

Ukukhula Business Solutions (2003), “Informal trading policy and management framework”, available at: http://www.capetown.gov.za/policies/pdf/it_final_framework.pdf

A SYSTEMATIC FRAMEWORK FOR CORPORATE RELOCATION

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ABSTRACT

Corporate relocation projects represent a sizable portion of the workload of the service sector of the property and facilities management industry in most developed economies. However, the successful outcomes of such projects are often not guaranteed. This paper reports on a research project that examines project failures in corporate relocations with the objective of developing a systematic framework for evaluating the processes involved in corporate relocation projects. A literature review of factors affecting project failures classified problems encountered under four broad headings: general management, project management, finance and technology. Responses from a questionnaire survey of client and supplier organizations which had involvement with relocation projects (N=48) formed the basis of data analysis. The questionnaire covered respondents' details, motivation for initiating the relocation and a Likert scale ranking of statements covering the entire corporate relocation process from the feasibility study stage through to the post-move administration stage. The results of the questionnaire survey provided the basis for the development of a systematic framework for corporate relocation which was validated through three detailed case studies of completed relocation projects. The outcome from the research is a corporate relocation model in the form of a flowchart that acts as a checklist for monitoring corporate relocation projects.

KEYWORDS: Corporate relocation, project management, framework

INTRODUCTION

Corporate relocations can be defined as the geographical movements of corporations. The main reasons cited for relocating may vary from organisation to organisation, but can be summarised as one or a combination of the following: to reduce cost, to dispose of surplus property, to find more appropriate accommodation. However, with the pace of technological development in recent years, forces driving the need to relocate are increasingly driven by the increased use of IT, the adoption of new working practices, a restructuring of the business, downsizing or reducing the numbers of core employees within the business, business process re-engineering, or outsourcing of non-core activities.

Corporate relocation projects can be applied to small, medium or large sized corporations. The project scope often involves relocation of fixed assets, human resources, business operation and all related business activities. Risks are features of all projects and corporate relocations are no exceptions.

This research focuses on corporation relocation and major moves. The literature review carried out covered three areas associated with relocation projects: project risks, causes of project failures and factors contributing to project success. The outcome of the literature review provided a framework for classifying potential problems arising from corporate relocation projects. A questionnaire survey and case study evaluation were carried out to validate the classification framework. The classification framework then formed the basis for a review of requirements for project success and the development of a model process for corporate relocation. A Corporate Relocation Model is proposed incorporating a checklist of project implementation procedures aimed at avoiding common relocation problems encountered in corporate relocations.

THE MANAGEMENT OF RELOCATION PROJECTS

Workspace relocation projects are temporary activities with clear start and finish points. They therefore require organisations that are of a temporary nature, which brings particular problems to those responsible for managing them. An early step in arranging for the relocation to be carried out is the establishment of an appropriate project organisation. In large scale multi-sites businesses there may be a dedicated team who are assigned to handle relocations and churn. However for most businesses a relocation team will need to be assembled for each project. Some relocation projects can be carried out with a small group formed from within the resources of the facilities management team. Others may require large complex and multi-disciplinary teams to be formed where the relocation involves major construction, alterations or changes to services infrastructure. The appropriate composition of the relocation team will depend upon the specific project circumstances.

Like all projects, relocations need effective management, and experience has shown that this is often best achieved by the appointment of a single person as the relocation project manager. Depending upon the specific project circumstances the project manager may be internal (i.e. an employee within the client organisation) or external (i.e. a consultant or contractor engaged by the client for the particular project's duration). However all successful relocations are the result of the concerted effort of a team of people. The relocation project team is likely to include representation from business management and representatives of user departments, IT services, procurement and facilities management, all under the direction of the relocation project manager who, in many instances, may be the facilities manager.

The management of workspace relocation project, be it major or minor, has particular requirements which need to be addressed. The relocation could be a stand-alone exercise or more likely part of a larger project. One of the primary benefits of good project management is the co-ordination of activities of all the parties involved in the project and the issuing of clear definitions of responsibility and authority. In general, all relocation projects have five identifiable key components:

Defined objectives – a clear unambiguous statement of the business's objectives for the relocation as it forms the starting point for the subsequent development of the project, and would typically take the form of a brief;

Time limits – would include as a minimum, dates for commencement and completion, as well as any interim milestones and dependencies such as expiry of rent free periods, lease notice and termination dates;

Prescribed standards – these can take many forms including performance specifications, traditional specifications, drawings (schematic diagrams, layouts and detailed designs), descriptions, SLAs, instructions and contractual safeguards;

Cost limits – usually established as part of an initial appraisal or feasibility study and then progressively developed throughout the life of the project e.g. initial estimate, pre-move cost check, tender receipt and report, comparison with estimate and reconciliation, interim cost reports and final account;

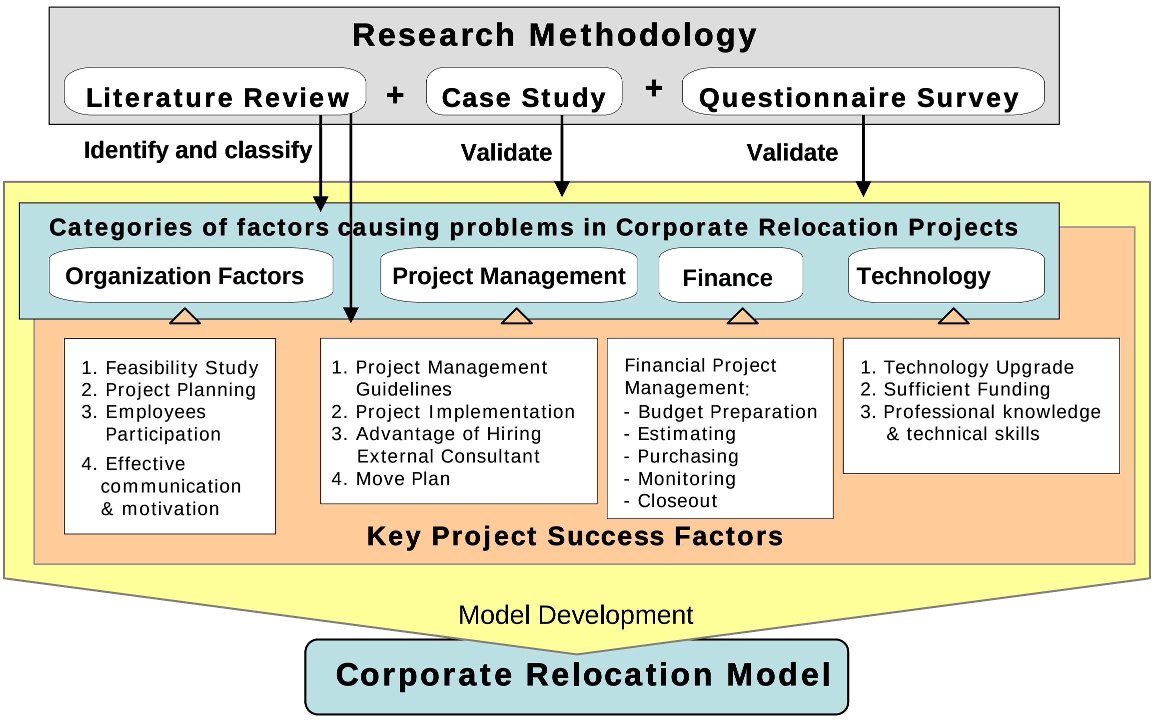
Resources – their requirements have to be determined, then appropriate types and quantities of resources obtained and applied to the project in line with a programmed sequence of events; typically they could include labour, plant and materials, fuel and energy, money, maintenance costs and materials, commissioning and decommissioning, acquisition and disposal.

Whilst the above components may seem obvious (McGregor and Then, 2001), the reality in practice is very often quite different because of the numerous variables that come into play in a project within an organisation setting.

RESEARCH OBJECTIVE AND METHODOLOGY

The main purpose of this research is to learn from problems that have arisen out of corporate relocation projects. The main objective is to develop a corporate relocation model that encapsulates the main stages of project managing a corporate relocation. The starting point of the research is to look at common problems that arose in corporate relocation projects from literature and practice. Figure 1 illustrates the context of the research methodology adopted in terms of the use of literature review, a case study review and the questionnaire survey conducted to identify, classify and validate the categories of factors that are causing problems in corporate relocation projects.

Figure 1: Research Methodology



The model development stage also included a review of factors that contributed to project successes and summarised the essential requirements under the four categories of factors (i.e.

Organisation factors, project management, finance and technology) designed to prevent similar problems occurring in corporate relocation projects.

Literature Review

A review and analysis of published literature relating to risks and problems associated to corporate relocation projects led to a classification framework comprising of four categories of factors: Organisational factors; Project Management, Technology and Financial factors. (Rondeau et al, 2006; Scarcello et al, 2005; Bajab, 2003; Blyth and Worthington, 2001; McGregor, 2000; Katz and Borden, 1999; Farren, 1999; Willet and Green, 1997; Owen, 1993; Binder, 1992 and Saphier, 1978).

Organisational factors: This category of factors relate to issues that are directly concern with how relocation projects are organised and directed within the organisation. Whatever the motivation for the move, senior management sponsorship and moral support and in terms of making resources available are crucial. The temporary nature of such projects calls for careful considerations of an appropriate project organisation that will avoid disruption to business operations. The size, scale and complexity of the relocation project may influence the procurement approach as to whether external expertise is required. (Roman, 2006: Kaya, 2004: Laframboise et al, 2003; Chessier, 2001; Flynn, 1999; Attwood, 1996 and O'Connor et al, 1995)

Project Management: This category of factors relates to overall process of managing the relocation project. The coverage of issues would include adequacies in various aspects of project management including competencies in risk assessment, communication, people skills, process tools, monitoring and control systems. (Moore, 2007; Greenwood, 2002; Murray et al, 2001; Stevens, 2001; Webster, 1999; Katz and Borden, 1999; PMI, 1996 and Ingrey-Counter et al, 1994)

Technology: The technology of the buildings and workplace continues to develop at a phenomenal speed. Technological changes, particularly the convergence of information and communication technologies, have impacted on the economics of location and workplace design in terms of the way workplace is designed and equipped to support its users. Hence, understanding the role of technology and how it will service the users in the workplace now and in the future (upgrades) are critical in any large relocation project. The rapid pace of technological development place a demand on keeping up with the latest, in making design decisions, in implementation and ongoing maintenance of systems requirements. (Bjorson, 2006; Gill, 2006; Levin, 2005; Robertson, 2000; Tablaba, 2004 and McGregor and Then, 2001)

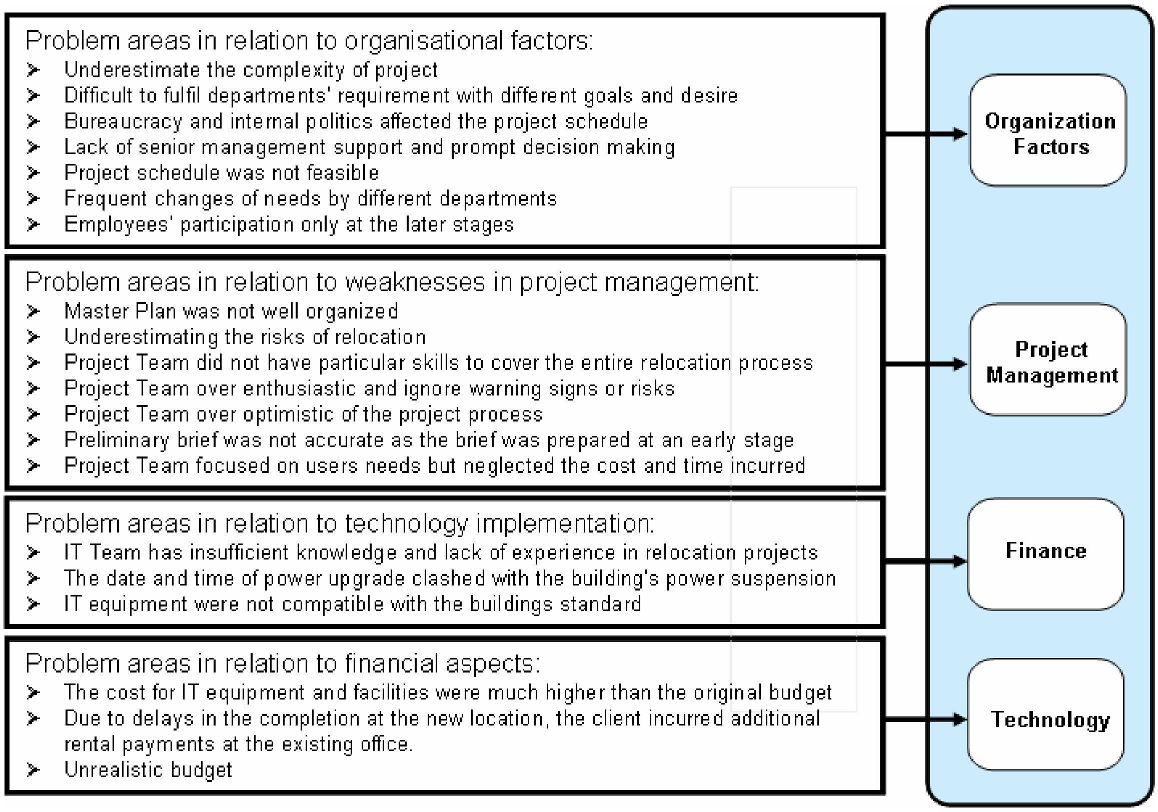
Finance: The financial planning and control of relocation provisions/budgets are clearly a critical component of any successful projects. Having a realistic budget that caters for all aspects of the relocation from start to end is a basic requirement in effective financial planning. Conversely, an inexperience project team may result in omissions that may have a disruptive impact on the project schedule, leading to delays and extra costs. (Hilker, 2006; Langston, 2003; Scarcello et al, 2005; Neldon, 2000; Lewis, 1994 and Stevens, 1999)

Case Study Analysis

The case study was used to validate the *Four-factor Classification Framework* derived from the literature review. The case study was a corporate relocation project of a worldwide financial institution regional office in a grade "A" intelligent building in the Central District of Hong Kong. The analysis of the case study tracked the project from the start to completion, covering an area of about 40,000 sq. ft., over a period of nine months. The project started with an in-house team which faced many problems relating to fitting-out work and technical issues. A consultant designer and project manager was engaged mid-way through the project to redress potential delays and to resolve technical issues. The project completion was delayed by a month.

The results of the case study analysis (see Figure 2) indicated that the classification framework derived from the literature review was adequate as a tool in grouping problem issues that arose in corporate relocations.

Figure 2: Summary of Findings from Case Study Analysis



Questionnaire Survey

The case study analysis confirms a general view that corporate relocation projects can be complex and complicated which require strong professional skills and technical knowledge to manage the projects. In order to further validate the robustness of the classifying framework, a questionnaire survey aimed at clients' organisations in Hong Kong was carried out. The questionnaire was designed to focus on identifying relocation problems in corporate moves.

The questionnaire was structured in two parts. Part I consisted of two multiple-choice questions that dealt with the organization of the relocation process and main reasons for relocating. Part II consisted of sixty-eight (68) questions relating to potential relocation problems. For questions in Part II, respondents were asked to indicate their ranking to statements on a Likert scale from "strongly agree", "agree", "neutral", "disagree", "strongly disagree" to "not applicable".

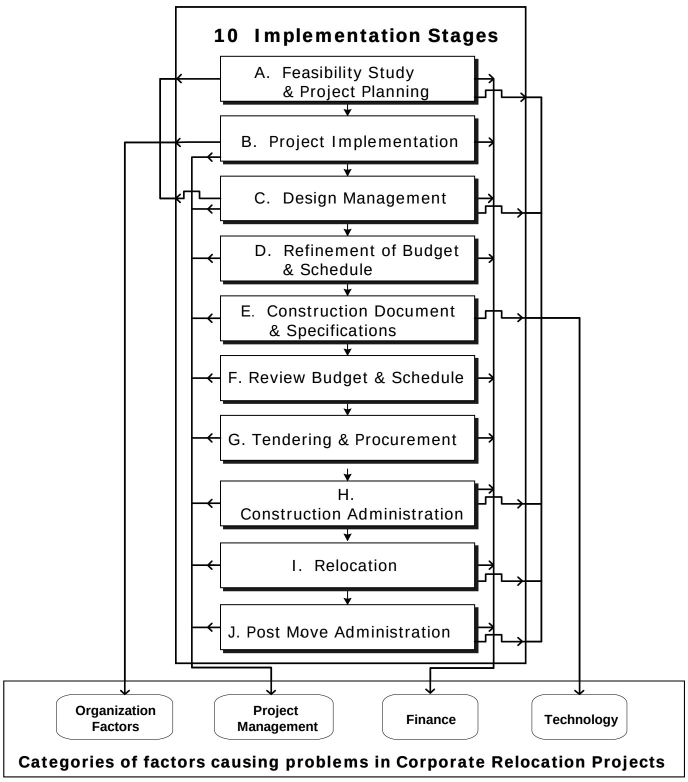
The questionnaire was sent to 110 clients' organizations in Hong Kong. Thirty-seven organisations responded to the questionnaire representing a response rate of 33.6%. The majority of the respondents were in senior positions (Director/Associate Director, Financial Controller/Adviser, Finance and Administrative Director/Manager, Project Manager, Facilities/Senior Engineer) with more than 5 years experience (97%) and have handled at least three relocation projects (76%).

The results of the feedback from the respondents are illustrated in Figure 2. The questionnaire survey results largely supported the basis of the classification framework in categorising problems that were encountered in corporate projects.

Model Development

The model development process builds on the findings of the questionnaire survey together with requirements of project success (see Figure 1). Following a review of a number of project processes (Farren, 1999; Owen, 1993, McGregor and Then, 1991) and incorporating the practical experience of the authors from numerous relocation projects in Hong Kong and mainland China, a 10-stage Project Implementation Framework was developed.

Figure 3: Model Development



The 10-stage Project Implementation Framework is then integrated with the *Four-factor Classification Framework* as shown in Figure 3. The combined integrated framework provides the relevant linkages to consider or even anticipate potential problems that may arise at each of the implementation stages.

Figure 3: Results of Questionnaire Survey

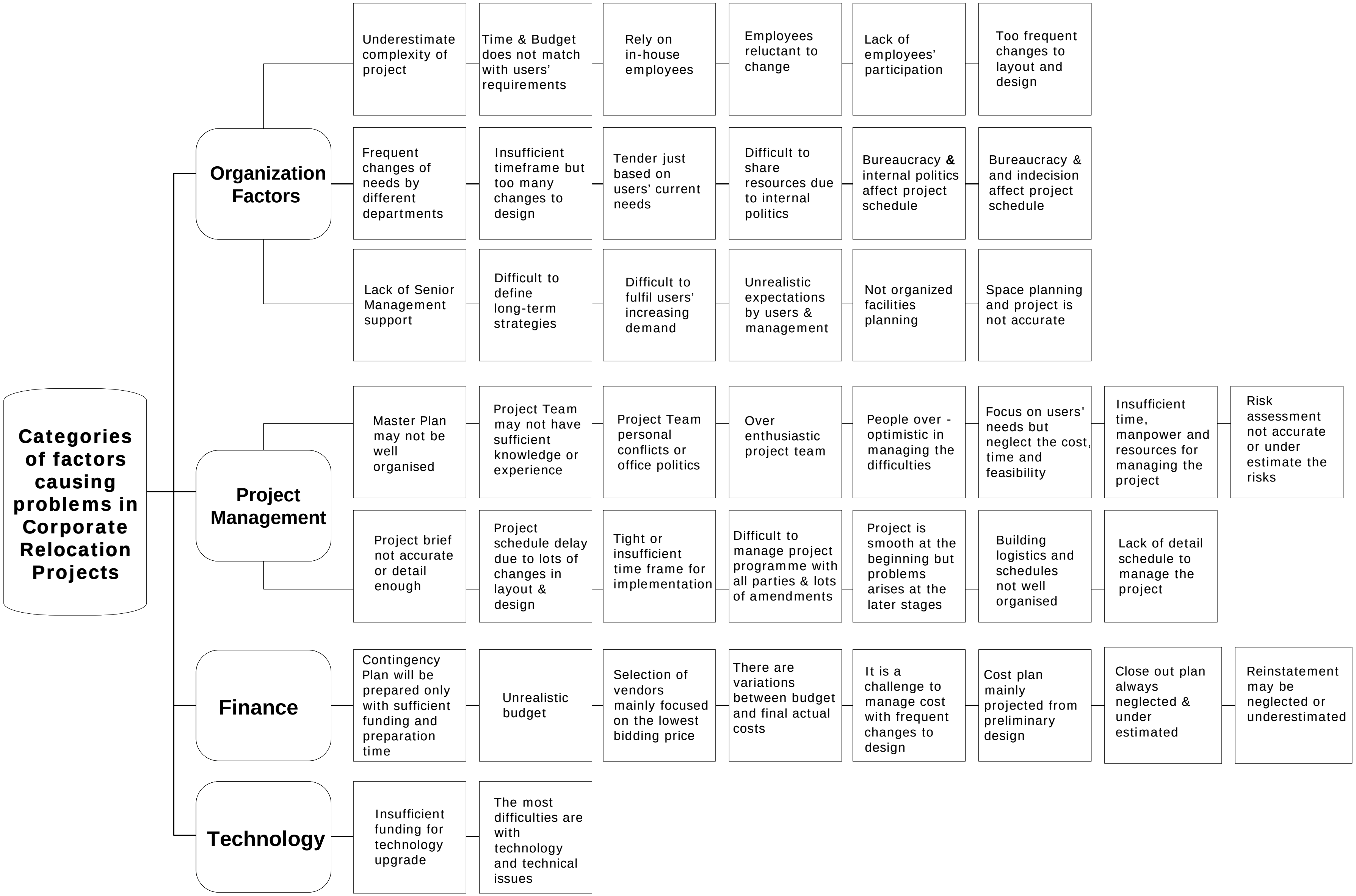


Figure 4 illustrates the complete flowchart model of the proposed Corporate Relocation Model. The vertical dimension of the model comprises the ten implementation stages, while the horizontal dimension describes a three-level procedure for each of the stages. Project managers can apply the procedures to overcome particular relocation problems related to each of the stages from *Feasibility Study and Project Planning* to *Post-move Administration.*

CONCLUSIONS

An analysis of key factors causing relocation problems and factors contributing to project success factors formed the basis of the development of a systematic framework for a corporate relocation model. The proposed model will track through a 10-step project implementation stages designed to overcome potential problems that may arise from issues relating to organisational, technological, financial or project-related factors. The Corporate Relocation Model is proposed as a guide for corporations and facility management professionals to manage relocation projects.

REFERENCES

Attwood, D.A. (1996), The Office Relocation Sourcebook, A Guide to Managing Staff Through the Move. John Wiley & Sons Inc.,

Bajaj, D. (2003), "Risk Management." In *Workplace Strategies and Facilities Management –Building in Value.* Best, R., Langston, C. & De Valence, G. Ed. Part 2: Key Facilities Management Issues, Chapter 8 - Risk Management. pp. 128-145. Butterworth-Heinemann.

Bjorson, K.D. (2006) "Smooth Moves: Start early, Leverage resources, Lead Teams", Area Development Site and Facility Planning, 40, 6, p.22.

Blyth, A. & Worthington, J. (2001), Managing the Brief for Better Design. Spon Press. Part One: Briefing Explained. Chapters 1-3. pp.3-30.

Capasso, A.M. (2003), "The art of the successful organizational move". Journal of Facilities Management, Vol 2, Iss 1, p.35.

Chessler, K.E. (2001), Office Relocation Planner, 3rd Edition, Vision Publications,

Farren, C.E. (1999), Planning & Managing Interior Projects. 2nd Edition. Kingston: R.S. Means Company Inc.

Flynn, M.J. (1999), "Moving out?" Facilities Design & Management, Feb 1999, 18, 2.

Gill, T. J. (2006) "Workplace continuity: how risk and technology will affect facilities strategy," Journal of Facilities Management, Vol.4 No.2, pp110-125.

Greenwood, M. (2002), "The management of project." in *Best Value in Construction*, Kelly, J., Morledge, R. & Wilkinson, S, Ed. Blackwell Publishing. Chapter 12. pp.222-239.

Hilker, J.M. (1996), "Corporate Relocation - The Devil is in the Details". Facilities Design & Management, Vol. 15, No.8, pp.52.

Ingrey-Counter, I. and Biles, M. (1994), "Successful relocation using consultant support". *Facilities*, Vol 12, Iss 3, p.21.

Kaya, S., (2004), "Relating building attributes to end user's needs: the owners-designers-end users equation". Facilities, Vol 22, 9/10; p.247-252.

Katz, E. and Borden, K. (1999), Commercial Relocation, A Comprehensive Guide for Industry for Professionals and Service Buyers, Franklin Sarrett Publishers, Ch.12.

Laframboise, D., Nelson, L. Rodney, S., Jason, (2003), “Managing resistance to change in workplace accommodation projects”. Journal of Facilities Management, Vo 1, Iss 4, p.306.

Langston, G. (2003), “Financial Management.” In *Workplace Strategies and Facilities Management –Building in Value.* Best, R., Langston, C. & De Valence, G. Ed. Part 2: Key Facilities Management Issues, Chapter 10 - Financial Management. pp. 164-176. Butterworth-Heinemann.

Levin, A. C. (2005), “Changing the role of the workplace design within the business organization: A model for linking workplace design solutions to business strategies”. *Journal of Facilities Management*, Vol.3 No.4 pp.99-311

Lewis, C. H. (1994), “The Facility Manager’s Move Survival Kit, IFMA ’94, FM: The force behind the business strategy”. Proceedings of IFMA 15th Annual Conference & Exposition on Facility Management, St. Louis, Missouri, Texas, pp.359-368.

McGregor, W. (2000) “Preparing for an uncertain future”. Facilities, Vol 18, Iss 10/11/12, p.402.

McGregor, W. and Then, D.S.S. (2001), Facility Management and the Business of Space. Butterworth-Heinemann, Chapter 6, 7 & 8.

Murray, M. and Langford, D. (2004), *Architect’s Handbook of Construction Project Management*. London: RIBA Enterprises Ltd.

Neldon, C.H. (2000), “Financial Project Planning – Five Steps for Success”, Proceedings of IFMA World Workplace 2000 Conference, Vol.1, As the workplace evolves, so should you. Texas, pp.231-248.

O’Connor, M. and Sutler, J. (1995), “Organization Relocation: Planning a Phased Move”. Facilities Design & Management. Vol. 14, No.5.

Owen, D. (1993), Facilities Planning & Relocation. Kingston: R.S. Means Company Inc.

Project Management Institute, PMI, (1996), *Project Management Body of Knowledge*. (pmbok guide)

Robertson, K. (2000) “Work Transformation: Integrating people, space and technology”. Facilities, Vol 18. No.10/11/12. pp.376-382.

Roman, S.R. (2006) Employee Satisfaction: the Relocation Process, BR Anchor Publishing, (http://www.branchor.com/newsletter.htm

Rondeau, E.P., Brown, R.K. and Lapides, P.D. (2006), Facility Management, 2nd Edition, John Wiley & Sons Inc, Ch.5-9.

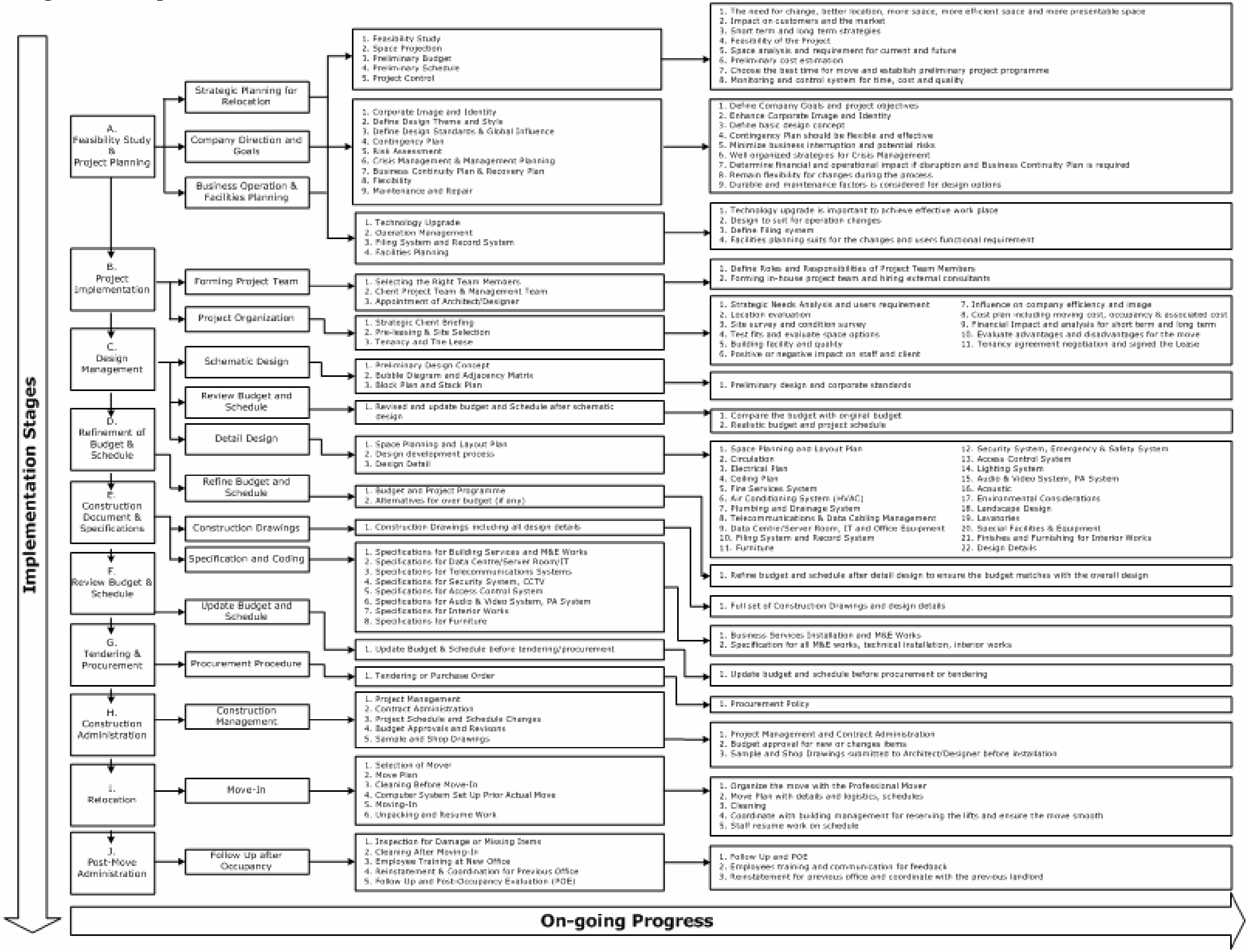
Scarcello, H.H., Burrough, M.R. and Dennis, H. (2005), It’s Your Move: How to Avoid Costly Relocation Problems, Proceedings of IFMA World Workplace Conference & Expo, Vol 1, p.35-41. Texas.

Stevens, M.M.Sr. (2001), “Simplifying Corporate Facility Relocations”. Facility Management Journal, January/February..

Tablada, S. (2004), “Using Technology to Reduce Real Estate Costs”, *Corporate Real Estate Leader*, May 2004, pp44-46, 2004

Willett, B, and Green, R.(1997) “The changing face of relocation management”. Facilities, Vol 15, Iss 5/6, p.150.

Figure 4: Corporate Relocation Model



A SYSTEMS VIEW OF CORPORATE FACILITIES

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ABSTRACT

The experience of corporate facility management in Brazil has shown that FM activities are regarded in different ways by people working in this field. In this paper corporate facilities are presented as a socio-technical system composed of both deterministic/mechanical systems and purposeful system working together. Recognizing the importance of understanding the ends to define actions to be done, the authors show that systems approach to FM is a useful tool. All facilities systems are viewed in terms of Functions, Structures and Process acting to achieve Purposes. Systems view is the basis of performance concept in FM and to commissioning buildings in a superior level of facilities quality. Facilities performance management is also discussed from a systems perspective.

KEYWORDS: CREM/FM, systems, facilities, performance.

INTRODUCTION

Facility Management (FM) is not a new activity as many people think, as for the individuals and the organizations use means and somehow manage them, for a long time. What's new is the importance that means have today in the business context as factor of production, demanding improved efficiency and effectiveness in the operations of FM for support of the core-business. Today it is possible that FM can contribute in a significant way to the business results, collaborating for the reduction of costs and risks, for the improvement of the atmosphere and the quality of work life, for the improvement of the individual productivity and of the work group, as well as in the intervention for assuring the economical, social and environmental sustainability. It is the authors' opinion that the accomplishment of FM in a higher level of performance depends more on the vision from the point of view of all kind of users and on solidly established concepts, than on the methods and tools used. It is not uncommon to find, in Brazil, the adoption of brilliant solutions for the wrong problems. In this sense, the success in FM would depend more on the understanding and definition of the problems than properly of the adopted solutions. In this work, the authors try to evidence the importance of the appropriate formulation of purposes, presenting a systemic and teleological vision of FM.

Facilities and use

Architecture and engineering have had a great role in the development of the construction business in the last century, and this progress was significant and accelerated. The conception of corporate buildings has been made traditionally for some decades based in different hypotheses, generating different results. One can identify along the time, different priorities in the focus of building construction:

- Inputs (materials)
- Construction processes
- Differentiated products and systems
- Adaptation to the market
- Operational cost reduction
- Diversity of functions

In general, the users' needs have been overlooked in reason of technicalities and mistaken reasoning of costs. As so, the construction industry in Brazil has been producing buildings of different types, being conceived from different points of view, resulting from technical challenges according to the practice of the industry in different moments. This reveals an analytical and praxiological view in the treatment of the subject, with different approaches. The consequence of this behavior is that the majority of the buildings built until the 90's demanded adaptation to the users' real needs.

Buildings are means that should assist specific purposes of the interested parties. The identification of the users' needs gains greater importance for the creation of facilities that are, in fact, efficient means for the accomplishment of the business activities. Appropriate facilities must be adequate to the actual conditions of use and never limit the user by inconvenient facilities. This is only possible through the change of the FM approach, definitively given priority to the use and so, developing efficient and collaborative methods for the definition of the actual users' purposes.

The search of efficient means is only justified when the purposes of what is planned are well known. Therefore, when in the planning of the means and of the Corporate Facility Management (CFM) system, it should be recognized the complexity and nature of the considering systems, which demands appropriate methodology of approach. In first place it is necessary to organize ideas and then, the actions. The urgency and the anxiety are, usually, great enemies of the success in FM turning, frequently, *doing* more important than *planning*, resulting in excessively reactives FM operations, and focused just on the daily issues. It is important to put out "fires", but it is better that they don't happen. It is better to prevent than to remedy! This is made with planning, and the essence of the planning is the definition of ends and of the efficient ways to reach them. In this sense, the effective Facility Performance Management system is only made possible if starting from clear and objective definition of desirable references.

Effectiveness *versus* Cost of the space

The traditional approach in CFM has been the administration of the cost of the space, instead of focusing at the effectiveness of the use. There is need to enlarge and to modernize the vision of the role of CFM in the business context as lever and support of the core business. New concepts have been used in this sense:

- Appling systems approach in facilities planning
- Understanding the dynamics of the systems along the time (life cycle)
- Users' characterization and permanent identification of their needs
- Clear definition of the role of the facilities as factor of production
- Alignment of FM with the business strategy
- Incorporate FM concepts in normative, strategic, tactical and operational levels.
- Use of appropriate tools for the administration of the activities
- Continuous improvement of the services operations
- Minimization of the used inputs without quality loss
- Administration of facilities performance
- Definition of performance indicators
- Establishment of a Performance Measurement System

CFM can be well performed measuring the results of the accomplished activities and confronting them with users' expectations. However, without the correct definition of *expectations*, the actual performance of the system cannot be known. This process should be initiated before the conception phase, settling down general orientation documents, such as:

- SoR- Statement of Requirements
- OPR - Owner's Project Requirements
- BoD - Basis of Design
- KPI - Key Performance Indicators
- SLA - Service Level Agreements

The Total Building Commissioning process (TBC) presents itself as an appropriate tool for quality assuring of facilities along the pre-design, design, construction, and also in the facilities operation. It is emphasized at this point that the formulation of users' purposes, in several levels, assumes vital importance for construction and effective operation of facilities, because it turns possible the evaluation of facilities attributes, such as:

Comissionability	Maintainability
Serviceability	Productivity
Functionality	Accessibility
Safety	Sustainability
Operability	Reliability

Manageability: (costs, times, cycles, quality, conformity, satisfaction, performance, people, contracts.)

For that, it is convenient the application of the systems concept in the context of FM, as follows.

SOCIO-TECHNICAL SYSTEMS

The systems approach has been shown useful in countless applications in FM. In this work it is not intended to be exhausting in the treatment of the subject, but just to show the application of the concept of systems in the in the field of FM, particularly those related to purposes

The modern society is characterized by the coexistence, not always peaceful, involving objects and people, because almost everything that we do involves something produced by the man. It is common to use the term *man-machine system* where the mutual dependence accomplishes any action, which it is not possible of being accomplished for just one of the elements. It is like this, for instance, driving a Formula 1 car, where the performance of the group depends so much of the quality and of the performance of the vehicle as of the pilot's ability. The work of FM happens to the similarity of the Formula 1 teams, following up the performance of the group and acting readily when necessary. The performance depends on the action in the development phases, project, construction, test and operation, always seeking the joint performance of the object together with the individual.

Social-technical systems are systems in which people interact with objects, in a way to produce actions (work and communication) transforming matter, energy or information, in certain space, along the time. In this sense, Facilities and Organizations can be here understood as social-technical systems.

Facilities (man-building system) = Building (including FFE) + Services (Operational)
Organization (man-facilities system) = Services (Core business) + Facilities

Therefore, in the modern organizations it is impossible to dissociate the building and their equipments of the individuals that use them daily, without loss of efficiency and effectiveness. Every day the dependence of the objects increases, which requires the adoption of more consequent FM systems and a responsible and broader understanding of the managed systems. The knowledge regarding systems dynamics, as they are the socio-technical ones, can be obtained through the study of the following perspectives:

- Environmental (context of the system)
- Structural (elements of the system)
- Behavioral (process of the system)
- Functional (product of the system)
- Teleological (purpose of the user of the product of the system)

So that the knowledge is comprehensive and for the proper operation of the systems, there is need to identify and to harmonize environment, structure, process, function and purpose for all FM systems. In this work, the teleological perspective of the systems is emphasized, that, for its subjective nature and variety, brings more difficulty for the obtaining of success at FM operations.

SYSTEMS AND PURPOSES

In the organizations, as already said, objects and people interact continually. There is need to identify with more detail the objects and the people, while systems, seeking the appropriate formulation of purposes.

When the understanding is not just looked for ‘what’ composes a system and of ‘how’ a system behaves, but of the ‘reason’ of this behavior, a teleological study, or a study of the system purposes, is been made. The concept of *purpose* implies the possibility of choice, in other words, for a system to have purpose, it is necessary that the same has conditions of doing choices as much of means as of ends, in different environments. This choice depends on [i] cultural, [ii] rational and [iii] emotional aspects, being evident, therefore, the need of the existence of *people* in the system, so that the same can have *purposes*. As so, through choices, the systems with purpose can modify their ends, therefore elapsing the choice of the necessary ways for obtaining of these ends.

Once the existence or no of purpose in the parts of a system and in its whole is considered, a hierarchy of models of systems can be established (fig 01), according to the work of Ackoff, R. L. (1999). Once it is role of the facility manager the proposition of appropriate solutions for service of people purposes, it is essential that the same ones have an appropriate vision of each sub-system that composes the socio technical system of which makes part, their functions or purposes, establishing the appropriate treatment (means) for each problem depending on its nature.

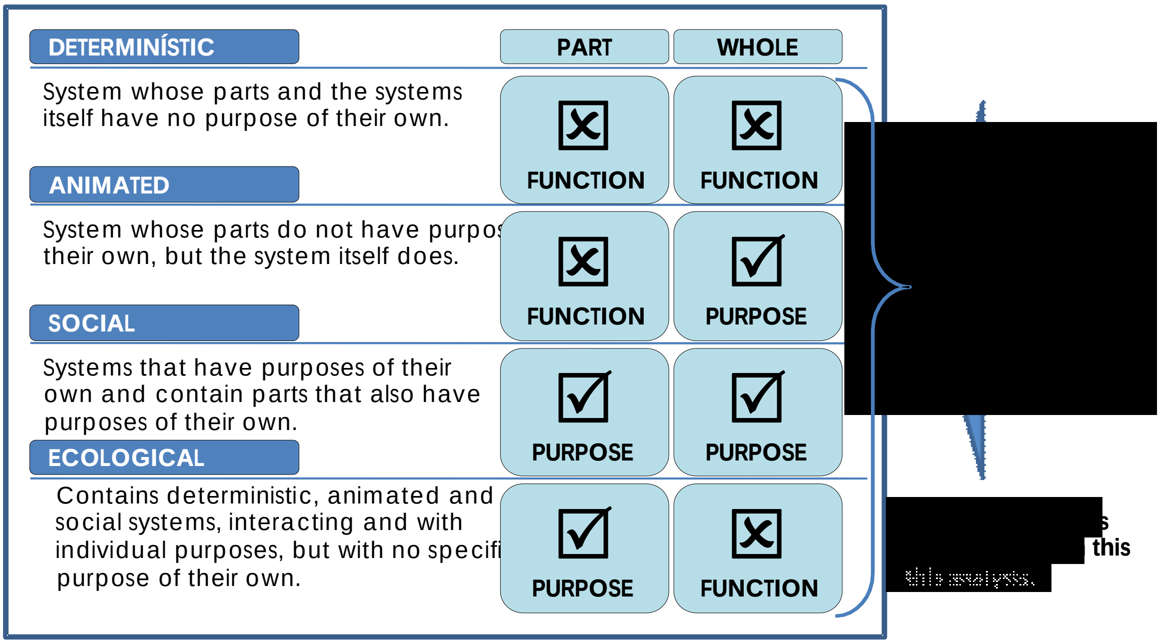

Figure 01. Teleological analysis of FM systems

The socio-technical systems represented by the organizations and their facilities evolved in such way that the use of deterministic models' solutions doesn't produce efficient results. The facility manager erroneously consider, and usually do it, that each component of the socio technical system is a simple mechanism without purpose and usually tries to obtain the expected behavior starting from their parts, not from the whole view. This inadequate posture can be the origin of several problems experienced by FM professionals. It is of great importance therefore, that the FM professional makes a teleological study of the systems that the organization is composed.

Deterministic

In CFM, the systems considered deterministic are, essentially objects (buildings, machines and equipments), as well as the elements and pieces that compose them. These objects present certain and expected behavior (function), independent of choice, and they assist to the purpose of external systems. In this sense, the role of the facility manager should be to establish specifications for these systems and to control the operation in use, in agreement with standards and procedures. A typical example of this situation is the programming and control of the maintenance of the building systems and equipments according to standards and technical specifications.

Animated

The animated systems are organisms, whose parts just carry out functions (i.e. heart), and the whole has purposes (an individual). Like this, in the extent of CFM, the consideration on animated systems concerns the service of the individuals' functions (biological, physiologic, ergonomic), as for the service of these same individuals' purposes. For so much, it can be used the theory developed by Abraham Maslow, according to which the needs of the individuals to be satisfied are hierarchy-ordered from the most pressing to the least one. A person will try to satisfy the most important needs, first. Later, the next one and so on. In their pressing order, those needs are:

- physiological needs
- safety needs
- social needs
- esteem needs
- self-actualization needs

The facility manager owes, in this case, to identify the needs of the people while individuals, and to look for appropriate solutions for satisfying them. For that, it is convenient that similar groups of individuals with the same needs, such as same gender, age (child, elder) and special needs persons were identified in such way to facilitate the identification of the needs peculiar needs of each individual.

Social

A social system is composed by parts that have specific purposes (people) and the whole, in other words, the defined social groups in the organization, also have purposes. Like this, in this case, unlike the individual needs of people, the needs of the groups are identified in agreement with its purpose in the organization. The organizational purposes usually can be grouped in 4 levels:

- Normative
- Strategic
- Tactical
- Operational

Accordingly with these purposes, to the people (individuals) are allocated positions that identify them inside as a specific group of the organization, such as: shareholders, CEO & executives, managers, technical, administrative, staff. Therefore, studying purposes of each group, the facility manager should plan the appropriate means to satisfy those needs.

Ecological

The ecological system class regards systems whose parts present purposes or functions; however the group doesn't present a purpose by itself. Like this, it is treated as a larger system in which the deterministic, animated and social systems are integrated, however without assisting to a specific purpose. In this case, the facility manager can use the sustainability concept to study the organization, and to identify specific needs that should be satisfied, in the environmental, economical and community perspectives.

It is obvious the appearance, in an international extent, of standards and evaluation systems of the sustainability of the built environment and space, developed in the sense of minimizing the current environmental impacts of the facilities operations. However, it should be emphasized that such standards still privilege the environmental perspective of the sustainability, being usually given less attention to the economical and community perspectives. Regarding the economical perspective, the FM professional possesses a vast instrumental to calculate economic and financial indicators for the operation, which should be used as reference for monitoring and controlling their operations. As for the community's' perspective, it is necessary to previously identify the organizational objectives regarding the community; the corporate image, vision and mission, and the way that the relationship of the organization with other external organizations is sensed.

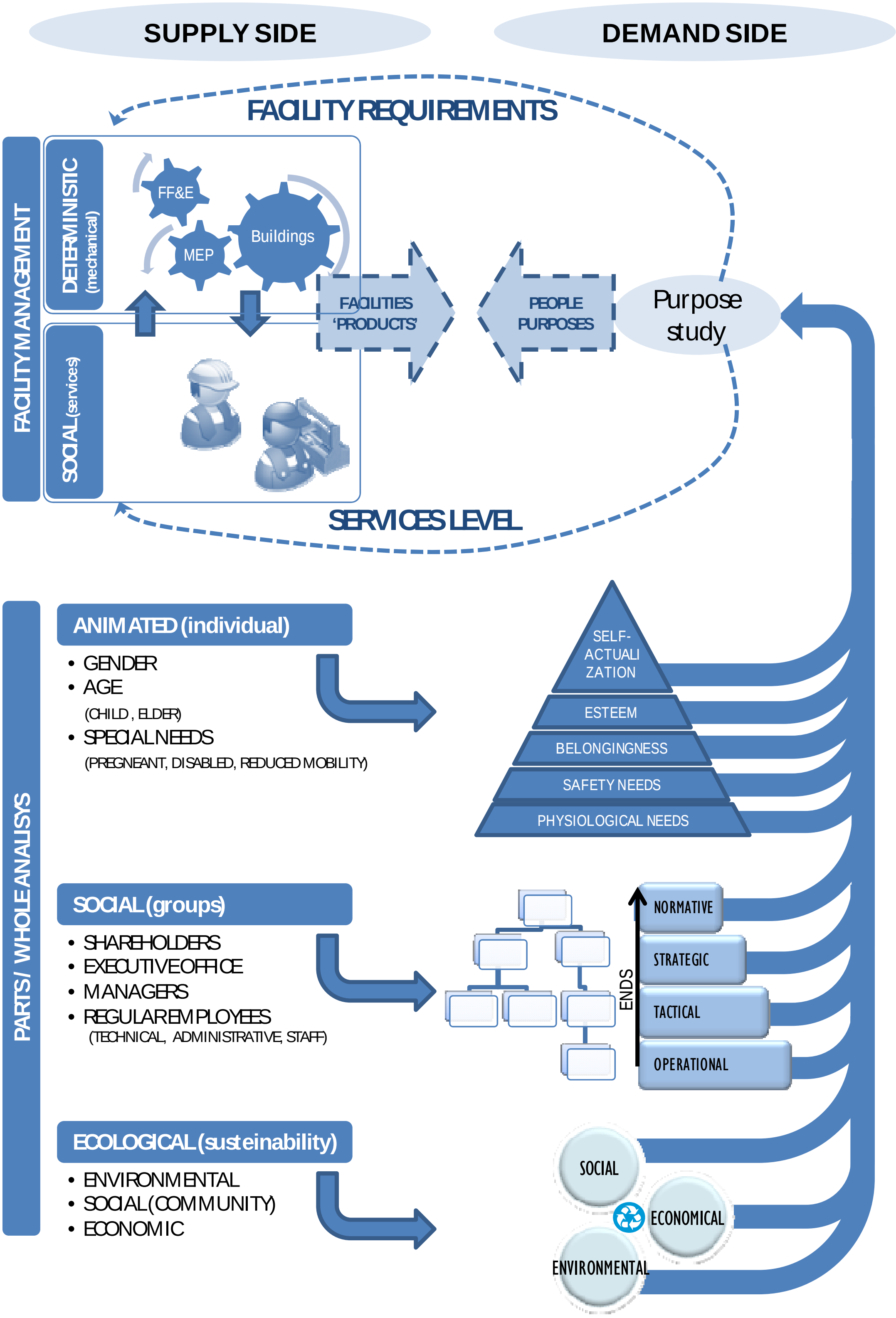

Figure 02. Teleological analysis: FM purpose identification and fulfillment

SYSTEMS MODEL OF CORPORATE FACILITY MANAGEMENT

The quality of CFM depends directly on the specification of the purposes and of the subsequent definition of the means to reach them. This strategic study defines the appropriate model of Facility Management to be implemented, as the definition of the purposes will serve as reference for the decision process for the solution.

This could be interpreted as *ends planning* and *means planning*. As ends planning, it is important to explain that, for Corporate Facility Management, the three types of organizational ends (ideals, objectives and goals) are needed, as for to get an accurate purpose identification and definition. Bad definition of purposes implies in inadequate facilities. Therefore, a systems view of the purposes of the system is very much needed.

Ends

After the identification of the systems elements and definition of the purposes, and only after that, the facility manager can efficiently plan the means to fulfill those purposes, or to attend the needs identified. Therefore, means planning involves the development of the plans needed to reduce de gaps between what the facility actually offers and the organizational needs. For that, and more specifically for the building and its parts (or the deterministic systems of corporate facilities), it can be used the serviceability concept (understood as the capacity of the means of a certain organization, for them to carry out the function or purpose for which they were designed or intended).

Functions

As for the *functions* of this system, one can use different criteria for classify all the different activities performed under the FM scope, but there are four categories that are commonly used for that: Technical Facility Management (hard FM), Support Services Management (soft FM), Commercial (managerial) Services, and Space Management.

Processes

The FM discipline involves a number of different functions, and one can understand it as a purposeful, information bounded system. Once the functions are established and categorized, with each scope defined, it is time to draw on the processes that should be used to provide those functions. Those processes can be *throughput processes* (directly related to the deployment of the FM services), and *organizational processes* (related to the alignment, integration and synergy among the systems' elements)

Structure

Finally, once the functions are defined and processes established, it is time to look at the structure that will give support to all of this. For that, a *multidimensional design* is best employed, as for it gives a clear view of the organization, the hierarchical relationship of authority and also the functions performed by the elements of the system.

Environment

The definition of ends, functions, processes and structure makes sense after an accurate diagnosis of the environment of the CFM system. This can be done before the ends definition but, it was not the authors' intent to discuss environmental issues in this paper.

CONCLUSION

Corporate Facilities Management system design is considered by the authors as the basis for good performance and purposes achievement, and this is very important to the success of a facility management operation. Adopting systems approach as a method to think about facility management is very useful, because it disciplines the thinking and creates a holistic view of the system considering all of its parts and its environment. The systems approach gives to the designer a complete knowledge of the system, and this imply in better facilities performance. The knowledge of the system is the basis to the establishment of good metrics, as a way to control and improve performance every day. A good metrics system needs also a computer system and a well defined process to assure that indicators are consistent and reliable.

The systems approach in facility management is the key to implement good operations that must be improved through continuously monitoring of the environment, the purposes, the functions, the processes and the applied resources, through good metrics and measurement systems.

Finally, to recognize the complexity and velocity of change of world affairs, and its effects in corporate real estate management, as well as use new concepts and modern methods to improve whole organizations performance, is the main objective of the responsible facility professional.

REFERENCES

Ackoff, R. L. (1999), Re-creating the Corporation, Oxford University, New York, NY.

Hierarchical approach to managing risks of large-scale construction projects

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ABSTRACT

The main purpose of the study is to develop an integrated framework for managing risks of large-scale construction projects. Conventional project risk management frameworks emphasize on managing business risks and often ignore operational risks. There are instances of project failure due to operational risks (e.g. failure of project leadership, contractors' and suppliers' incapability, technical complexities etc.). A hierarchical approach deals with such shortcomings by analyzing risks in different levels (e.g. project, work package and activity). It helps identify the least risky project alternative through project level risk analysis and subsequent work package and activity level risk analysis to help identify both business and operational risks. The proposed framework has been applied to a 17000 km long oil pipeline construction project in India in order to demonstrate its effectiveness.

Key Words: Project risk management, analytic hierarchy process, hierarchical approach, oil pipeline construction

Introduction

Although today's organizations appreciate the benefits of managing risks in construction projects, formal risk analysis and management techniques are rarely used due to lack of knowledge and to doubts on the suitability of these techniques for construction industry activities (Akintoye and Macleod, 1997). Managing risks is one of the most important tasks for the construction industry as it affects project outcomes. Today's project managers believe that a conventional approach to project management is not sufficient, as it does not enable the project management team to establish an adequate relationship among all phases of the project, to forecast project achievement for building confidence of the project team, to make decisions objectively with the help of an available database, to provide adequate information for effective project management and to establish close co-operation among project team members.

The current literature on construction risk management consists of empirical researches on risk management practices of the construction industry and conceptual frameworks of risk management using various tools and techniques. The Project Management Body of Knowledge (PMBoK, 2004) introduces a six step method of risk management. Although, these steps are very generic and act as a guide line for managing the risk of projects, they fail to provide a risk management framework for a specific project. The conventional project risk management approaches in the project feasibility stage emphasize on managing business risks and often ignore operational risks. However, there are instances of project failures due to operational risks such as technical complexities, contractors' and suppliers' incapability, Government red tape etc., which remain unidentified until they occur. Dey (2001) reported time overrun due to implementation issues of a river crossing section for cross-country oil pipelines in the Eastern part of India. Ogunlana et al (1996) reported cost overrun in high rise building projects in Thailand due to contractor's failure. Social and environmental issues caused prolonged postponement of the Chand-Cameroon oil pipelines (Ndumbe, 2002). Several projects in the Vietnam oil industry were delayed due to Government approval (Thuyet et al. 2007). Risk management approaches in the feasibility stage, although helping to mitigate business risks (external in nature), however fail to identify operational risks. Although they are valuable to identify the least risky project, but fail to provide a framework for managing every risk across various levels of the project. The integrated hierarchical approach to risk management not only combines the risk management processes (identification, analysis and development of responses) in an analytical framework, but also integrates the risk management processes in every level of the projects that helps identifying all the possible risks in the early planning phase of the project enabling the project team to make decisions on their responses.

The objective of this study is to develop a framework for managing the risk of large construction projects using an integrated hierarchical framework with the active involvement of the concerned stakeholders.

There are two approaches to construction risk management – project level risk analysis and work package level risk analysis, which are carried out during the feasibility analysis and implementation phases respectively. Both the approaches have limitations. The project level risk analysis reveals mostly the business risks, which are external in nature covering market, economical and political factors. Although it helps identify the least risky project, it fails to identify operational risk factors. On the other hand work package level risk analysis reveals operational issues, which in many cases are too late to address and the responses are constrained by the business risks. Moreover, the current literatures demonstrate applications of various tools and techniques in managing project risk, but none of the research reports risk analysis across various levels, which help identify the least risky project alternative, critical work packages and activities along with the associated risks during the early project phase. Therefore, the contemporary approaches to risk analysis lack establishing an integrated risk management framework covering every level of the project, which helps to manage the project effectively. This study is for bridging this gap.

Proposed risk management framework

The proposed risk management framework has the following steps:

1. Identifying the alternative projects
2. Analyzing project level risks and selecting the least risky project
3. Developing the work breakdown structure of the selected project
4. Analyzing work package level risks
5. Developing risk responses
6. Analyzing activity level risks, and
7. Developing risk responses.

This study uses the analytic hierarchy process (Saaty, 1980) for analyzing risks in the project, work package and activity levels.

Application

The proposed framework has been applied to a newly conceived cross-country oil pipeline transportation project in the Western part of India. A typical oil pipeline project consists of laying oil pipelines, constructing pumping and delivery stations, constructing tank farms, constructing communication and a cathodic protection infrastructure. A risk management group consisting of nine executives with more than 15 years of project experience was formed. They performed the following steps to analyze risk of the project under study.

Step 1: Identifying the alternative projects

In the oil pipeline industry, alternative projects are identified through feasible routes. The geological information system helped identify a few alternative feasible routes.

Step 2: Analyzing project level risks and selecting the least risky project

The risk management group in a brainstorming session first identified project level risks. They were market, financial, economical, environmental, technological and political risks. A few subfactors were also identified against each factor. The likelihoods of the risks were then derived using the analytic hierarchy process (first, the likelihood of risk factors and subfactors were determined through pair wise comparison at each level using the verbal scale (Saaty, 1980). Second, the likelihood of failure of each alternative with respect to each risk subfactor was determined by pair wise comparison and subsequently, the results were synthesized across the hierarchy to determine the overall risk of each work package). Figure 1 shows the project level risk analysis in an AHP framework. The analysis revealed that the likelihoods of environmental and technological risks were very high and the project with pipeline route 2 was the least risky. However, the selected route (2) was vulnerable from both environmental and technological risks. The group decided to mitigate the project level social and environmental risk by acquiring statutory approval from relevant government authorities and technological risk by communicating with the concerned contractors and consultants. The group decided to further analyze in order to mitigate the risks of the selected pipeline option.

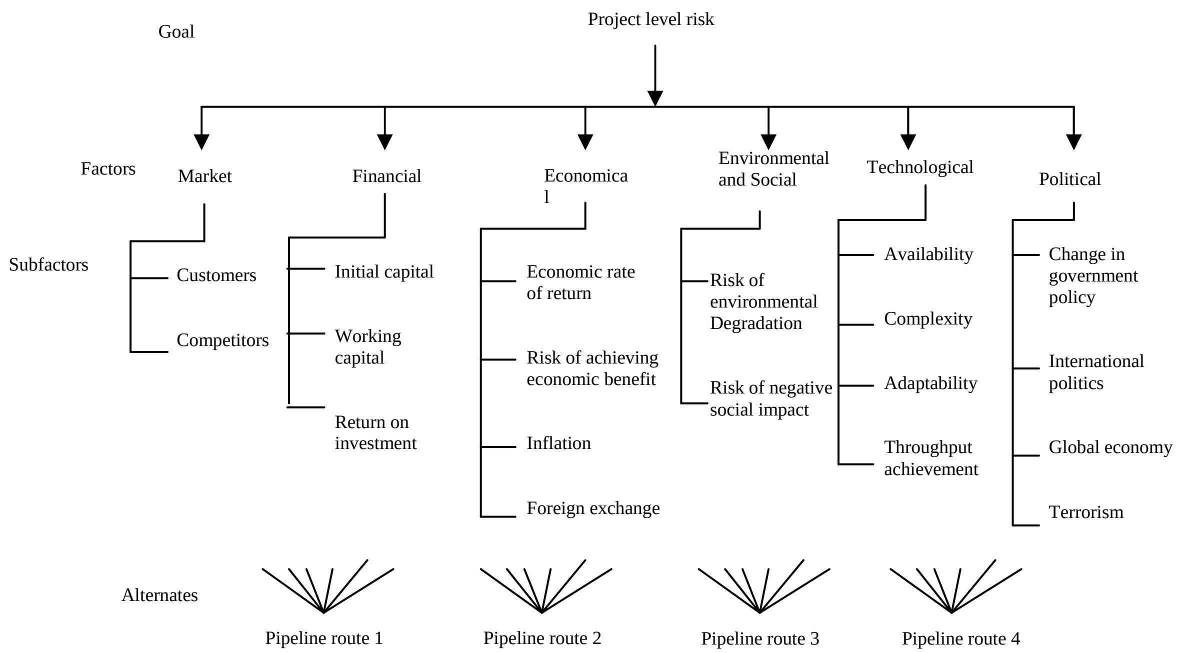

Figure 1 Project level risk analysis using AHP

Step 3: Developing the work breakdown structure of selected project

The entire project had been hierarchically classified to form a work breakdown structure (WBS). Figure 2 shows the WBS of the project under study.

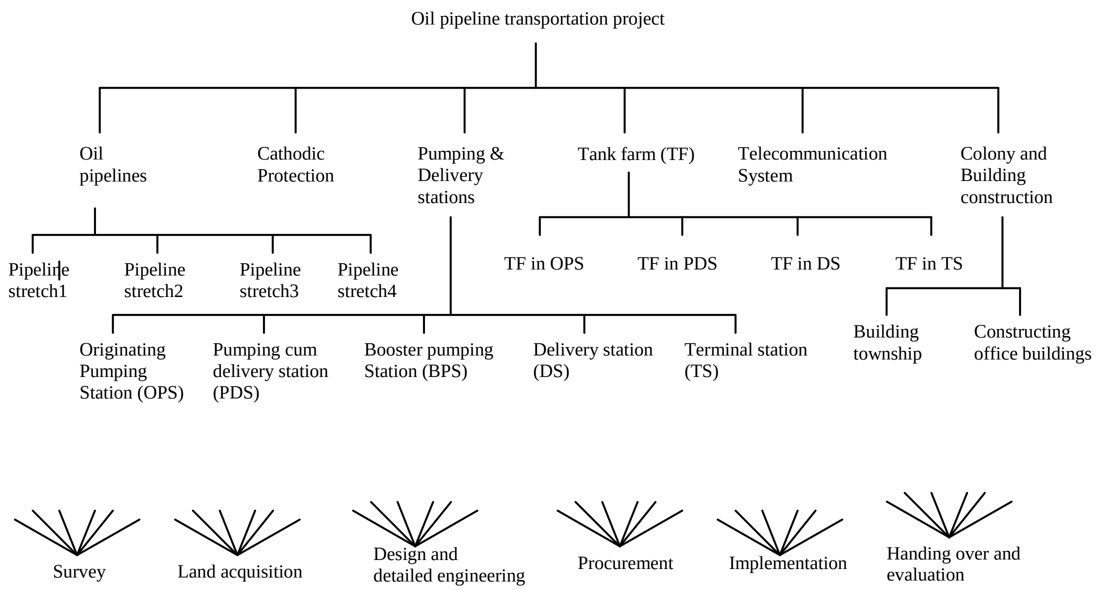

Figure 2 Work Breakdown Structure of oil pipeline construction project

Step 4: Analyzing work package level risks

The risk management group decided to analyze only pipeline laying, station construction and the tank farm work package risk after a short brainstorming session. They identified various technical, organization and environmental risks. Risks related to selection of appropriate technology, site selection, implementation methodology selection, information and communication technology selection, and operational risk were identified under technical risk. Similarly, risk created by project team, operating team, consultant, contractors, suppliers and communication framework were considered as organizational risk and environmental damages during implementation and operations, negative impact on society during implementation and operations and statutory clearance for implementation and operations were identified as environmental risk. Figure 3 shows the work package level risk analysis in an AHP framework. Firstly, the likelihood of the risks was derived by pair wise comparison in factor and subfactor levels using the verbal scale. Secondly, the likelihood of failure of each package with respect to each subfactor was derived through pair wise using same verbal scale. Finally, the results were synthesized to determine the overall risk of the work package. The analysis revealed that the pipeline stretches had the highest risk followed by tank farm and stations. Technical and environmental risks were more likely to happen compared to organizational risk. In the subfactor level, risk related to implementation method selection, environmental damages and negative impact on society were most likely.

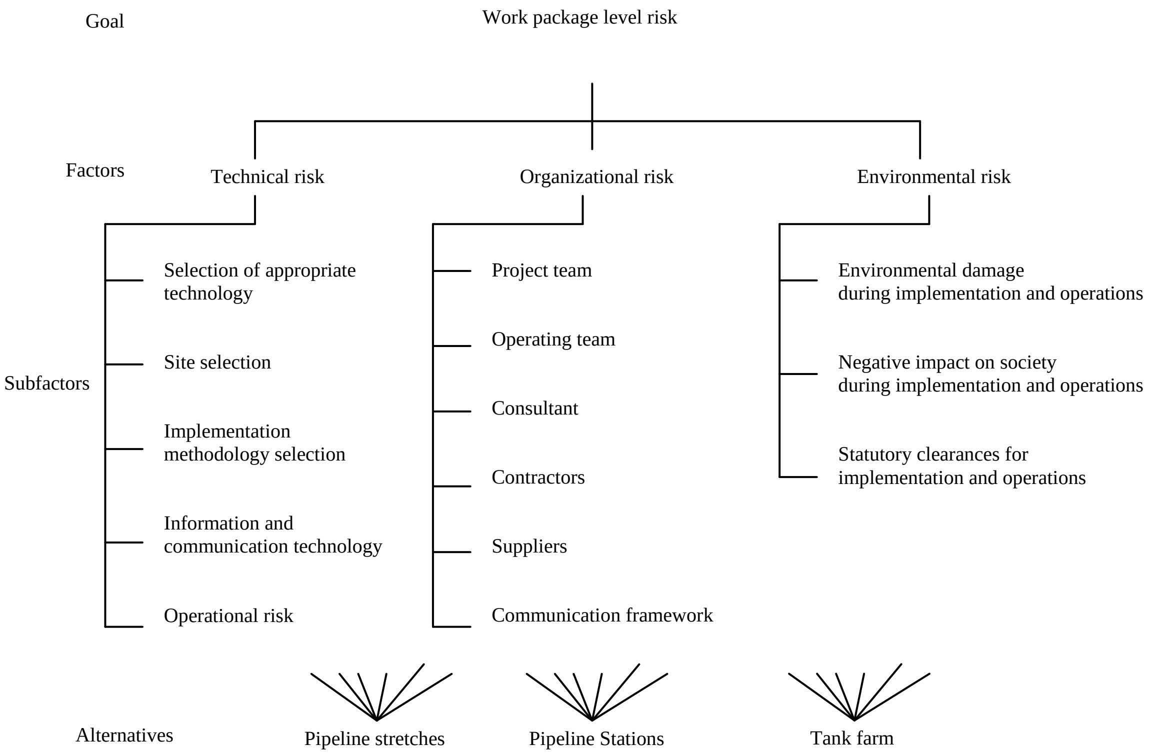

Figure 3 Work package level risk

Step 5: Developing risk responses in work package level

The group decided to take the following responses to mitigate work package level risks. They were selection of quality contractors for each work package, selection of appropriate implementation methodology for every pipeline section, appropriate environmental impact assessment and social impact assessment of pipelines package and dynamic operational risk analysis of stations package.

Step 6: Analyzing activity level risk

The risk management group decided to further analyze risk of pipeline work package by classifying it to four stretches. They identified four major risks in this level. They were design risk (design quality and communication framework), procurement risk (procurement method, quality consultants, contractors and suppliers, and communication framework), implementation risk (specification, organization, natural hazards, environmental and social impact, and communication framework) and operations risk (throughput, inspection, maintenance, environmental and social impact and communication framework). Subsequently, they derived the riskiness of each factor and subfactor and calculated the likelihood of failure of each pipeline stretch using the AHP framework (as demonstrated in step 2 and 4). Figure 4 shows the risk structure for activity level risk analysis. The analysis revealed that implementation risk was most likely followed by procurement risk and pipeline stretch 3 is the most vulnerable. As pipeline stretch 3 was routed through the most difficult terrain, it was likely to experience risks in relation to procurement method selection and possible poor performance of consultants, contractors and suppliers. Additionally, this stretch was vulnerable from poor implementation method specification and organizational issues for implementation. Pipeline stretch 1 was vulnerable from environmental and social impact as it mostly traversed through normal terrain. The pipeline stretch 4 was exposed to mainly operational risk as it was connected to an offshore terminal.

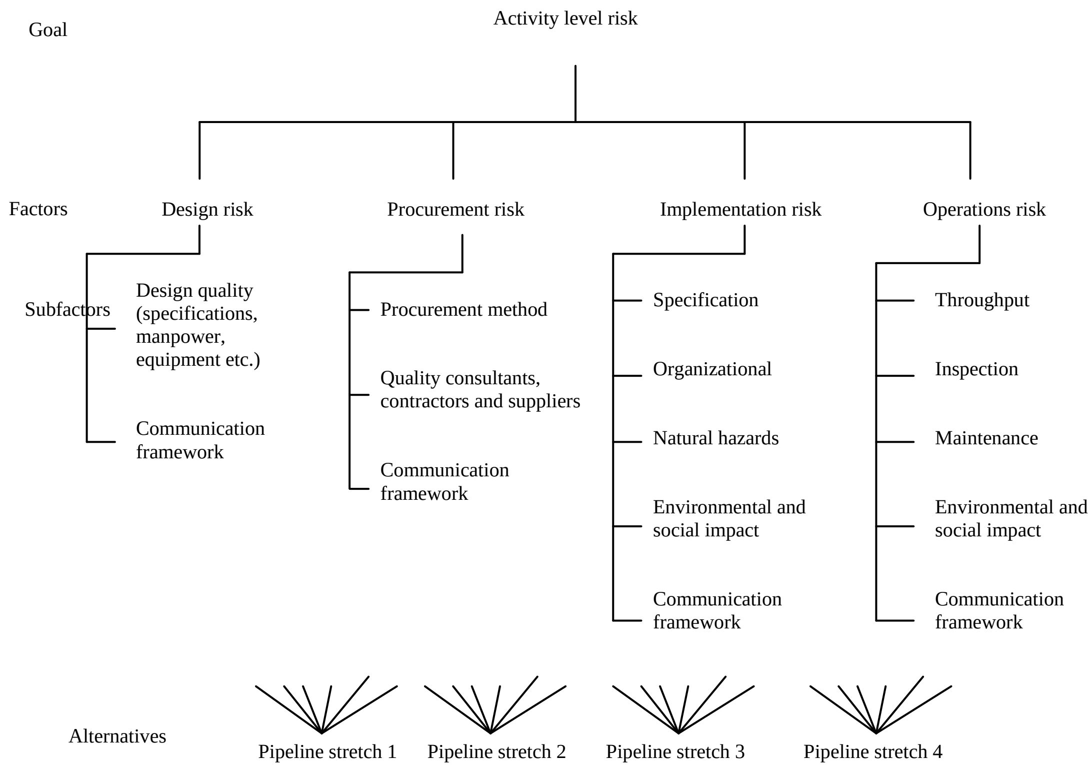

Figure 4 Activity level risk

Step 7: Developing risk responses in activity level

The risk management group through brainstorming developed the following responses (Table 1) for each stretch.

Table 1 Risk responses in activity level

Activity	Risk factor	Responses
Pipeline stretch 1	Environmental and social impact during implementation	Thorough impact assessment with the involvement of the project affected people
	Environmental and social impact during operations	Monitoring environmental and social parameters throughout the services life
Pipeline stretch 2	Environmental and social impact during implementation	Thorough impact assessment with the involvement of the project affected people
	Environmental and social impact during operations	Monitoring environmental and social parameters throughout the services life
Pipeline stretch 3	Procurement method and stakeholders' performance	Consultants, contractors and suppliers selection on performance basis and selecting contract type, which enhances quality
	Implementation specification and organizing the implementation	Involving contractor to develop specification for implementation method
Pipeline stretch 4	Throughput non-achievement	Hi-tech instrument control to avoid operational error

Discussion and conclusion

Construction projects often fail because of wrong technology selection, poor environmental management plan, political red tape, poor design specification, wrong implementation methods, poor performance of contractors, and lack of maintaining materials delivery schedule by the suppliers along with many other reasons. The causes of failure could be classified into business risks (external) and operational risks (internal). Unless they are addressed in the early project-planning phase and adequate responses are planned and implemented, projects inevitably fail to achieve their objectives. In the conventional approaches to project appraisal and planning, quite often only business risks are addressed in order to justify the investment. Therefore, as the projects progress with added learning, there is need for additional resources and knowledge in order to accomplish project outcomes as planned, which become impossible in many cases. Analyzing project risks hierarchically helps prioritize activities, which are vulnerable for not achieving time, cost and quality. Thereby it helps achieving successful completion of the work packages and in turn projects. Additionally, it helps identifying risk in each level (project, work package and activity). Analysis of project level risk helps identify the least risky project alternative and calls for additional planning for mitigating the risks that are present in the selected project option. Work package level risk analysis firstly, identifies the risky work packages and prioritizes work packages on the basis of risk vulnerability for additional planning. Secondly, it analyzes risk factors associated with each work package and derives the mitigating measures for each risky work package. Activity level risk analysis on one hand identifies the risky activities within the risky work packages and on the other hand, identifies risk factors, analyzes them and derives responses. Risk analysis using a hierarchical approach not only justifies additional planning and resource requirement at the early project phase, but also helps achieving project schedule, budget and specification. This study reveals that the project level is affected by external risks, work package level is affected by both external and internal risks and activity level is affected by internal risks.

The proposed risk management framework using the analytic hierarchy process helps project executives to make decisions dynamically during the project-planning phase with the involvement of the project stakeholders. This provides an effective monitoring and control mechanism of projects across various levels of management of the organization. The proposed framework uses Expert Choice to analyze the decision situation. Additionally, the sensitivity utility of AHP provides an opportunity to the risk management group to observe the nature of the model outcome in different alternative decision situations.

References

1. Akintoye, A. S. and MacLeod, M. J., (1997), Risk analysis and management in construction, International journal of project management, Vol. 15, No. 1, pp 31 – 38.
2. Dey, P K, (2001) Decision support system for risk management: a case study, Management Decision, Vol. 39 No. 8. 634 – 648.
3. Ndumbe, J.A., (2002), The Chad–Cameroon oil pipeline—hope for poverty reduction?. *Mediterranean Quarterly*, 13 (4), pp. 74–87
4. Ogunlana, S O, Promkuntong, H, Jearkjirn, V. (1996), Construction delays in a fast growing economy: comparing Thailand with other economies, International journal of project management
5. PMBOK (2004), A guide to project management body of knowledge, Project management institute, USA
6. Saaty, T L, (1980), The Analytic Hierarchy Process McGraw-Hill, USA.
7. Thuyet, N V, Ogunlana, S O and Dey, P K (2007), Risk management in oil and gas construction projects in Vietnam, International journal of energy sector management, Vol. 1 (3)

POST-OCCUPANCY EVALUATION OF A NEW OFFICE CONCEPT IN AN EDUCATIONAL SETTING

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ABSTRACT
At the end of 2006, Avans Hogeschool (a Dutch Institute of Higher Education) moved a number of previously dispersed departments to a new building. This move was taken as an opportunity to introduce new workplace strategies with desk-sharing and desk-rotating in a transparent setting. This paper presents the results of a post-occupancy evaluation of the new development. Staff was found to be satisfied with the modern architecture, the advanced IT facilities and the openness of the building that supports communication and social interaction. However, many complained of a lack of privacy, conditions that hampered concentration on one's work and insufficient facilitation of the interaction between teachers and students. Seven years ago, Delft University of Technology introduced an innovative office concept in one of its faculty buildings. Evaluation of user satisfaction showed that desk sharing was generally regarded as one step too far at that time. But the improved openness, the extra space for display of research work and increased opportunities for students to work in the research area were highly appreciated. In this paper the Avans results are discussed and compared with the findings of the case study at Delft University of Technology.

KEYWORDS: new workplace strategy; post-occupancy evaluation; educational setting

NEW OFFICES FOR AVANS HOGESCHOOL

Worldwide, both public and private organizations are applying new office concepts such as desk sharing and desk rotation in a variety of activity-related workspaces, with the general aims of facilitating communication and concentration, increasing employee satisfaction, improving productivity and reducing facility costs (Duffy, 1996; Balkin et al, 2001; Becker, 2004). 'Non-territorial' offices can be found in particular in banks, accountants' offices, insurance companies and the like, and are beginning to be implemented in educational settings (Watson, 2007). An interesting question is, whether such new workplace strategies are suitable for use in an educational setting. The move of a number of previously dispersed departments of Avans Hogeschool in Breda (in English: Avans University of Applied Sciences) to a new building with a new office concept offered an opportunity to investigate how teachers and administrative staff experience new ways of working. The management of the Hogeschool took the move as an opportunity to rethink its educational and accommodation policies. After due deliberation, they opted for the concept of activity-related workspaces: ARW. No one has a fixed personal desk – with the exception of members of staff who are dependent on special facilities and receptionists and helpdesk staff. Each member of staff chooses a type of workplace that suits his or her current activities: open worksites to support communication, cockpits for tasks requiring a high level of concentration, conference rooms and spaces for less formal get-togethers, classrooms etc.

Office facilities such as printers and copiers, fax machines and stores of office supplies are provided at central locations. Certain rules apply to the use of these worksites, such as a ‘clean desk’ policy.

Before implementation of the ARW concept, Avans management formulated the following core objectives: 1) The new working methods should support communication and promote cooperation; 2) They should contribute to staff welfare and work quality; 3) Floor area usage should be reduced, thus boosting efficiency; 4) The new working methods should support cultural change by making staff more result- and customer-oriented. Apart from these qualitative objectives, it was stipulated that 80% of all staff involved should have a positive or neutral attitude to ARW at the moment of delivery, and that 80% of all employees should be satisfied with the work environment six months after occupancy.

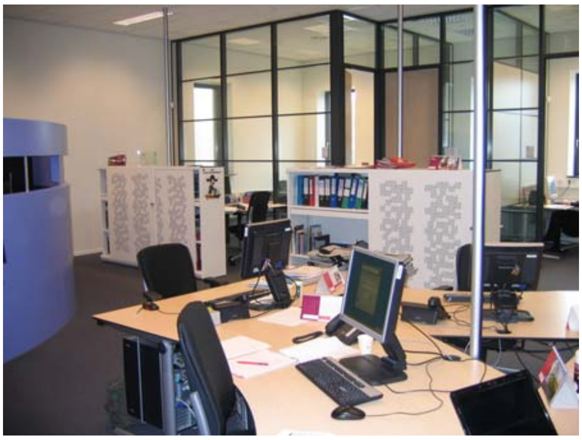

Figure 1: Avans Hogeschool
Left: workplaces in open settings and cockpits. Right: students at work in the new learning centre

At the request of Avans, the Center for People and Buildings carried out a study of the use and user perception of the new office concept in the summer of 2007. At that moment, the first group of employees had been in the building for 3-4 months. The management hoped that the results of this study would provide valuable insights that could be used in the next phases of the move. The focus was on the perception of the concept by employees, i.e. the teaching staff and the staff providing administrative and management-support services. The way students used and perceived the new concept fell outside the scope of the present study.

RESEARCH QUESTIONS

The research questions were formulated in consultation with the ARW project-leader:

1. How does the first group of users experience the ARW concept? How does the concept work? Are the users satisfied with it?
2. Does the ARW environment meet the objectives and expectations formulated in advance?
3. What lessons can be learnt from the experience gained so far?
4. How can the results of this study be incorporated in the preparations for the subsequent phases of the move?

RESEARCH PROCEDURES AND METHODS

The study comprised the following components:

1. An introductory talk, during which the members of the research team were informed of the objectives of the move of Avans Hogeschool.
2. Collection and study of documents and other information on the previous accommodation and the new accommodation (location, floor plans, m2 gross and net floor space, use), mode of communication concerning the study etc.
3. Sending of a digital questionnaire to all users via Avans-Intranet. The questionnaire measures user satisfaction or dissatisfaction with 19 aspects of the work environment (Volker & Maarleveld, 2007). These issues were found in previous studies to be of more than average relevance for employee satisfaction and perceived productivity (Barber, 2001; Brill and Weidemann, 2001; Pinder et al, 2003). Apart from scoring all aspects on a 5-point scale, six aspects were given an overall rating on a 10-point scale familiar to people from its use in marking work at schools (where 5 is a 'fail', 6 is a 'pass', 8 is 'very good' and 10 is 'exceptional'). A few additional questions were included concerning the gender, age, education and training and job description of the respondent, the amount of time spent on various office activities and the way the worksite was used.
4. Analysis of the study data with the SPSS statistical and data management package.
5. Feedback in two group discussions with users of the findings and interim conclusions.
6. Preparation of the final report and making of agreements about communication of the results of the research and the conclusions and recommendations.

RESEARCH FINDINGS

A total of 114 questionnaires were filled in and returned. This represents a response rate of about 40%.The users estimated that on average they spent roughly half (52%) of their time on "desk work", 7% of the time on phoning and another 7% on reading for more than half an hour at a time. An average of 21% of the time was spent on planned and unplanned consultation, and 7% on filing and document processing. The spread of these values is high. When asked where they usually worked, respondents estimated that they spent 61% of their working time at a desk in an open worksite and 19% at a workplace arranged for concentrated work. These figures add up to 80% of their time spent behind a desk. This is appreciably higher than the above-mentioned 52%. However, phoning, filing and part of informal communication also occurs at ones desk, so if one adds up the above-mentioned 52% + 3 x 7% + 10% (nearly half of 21%) for consultation, one arrives at a total of 83%. This is very close to the 61 + 19 = 80% referred to above.

Overall appraisal

Respondents were asked to rate six aspects of the social and physical work environment on the 10-point scale (Table 1). The extent to which the work environment supported productivity got the lowest score: a mean of 5.1, corresponding to the qualitative appraisal 'unsatisfactory'. Both the extent to which the work environment was perceived as agreeable and the accommodation concept scored about 5.5, while the organization and facilities scored about 6 (recognized as a 'pass'). Work/work-process was the only aspect with a mean score corresponding to a good pass (6.6), though all other aspects received also scores of 7 or 8 from individual respondents.

Table 1: Overall appraisal of six aspects of Breda work environment on a 10-point scale

	≤ 5	6	≥ 7	Mean
Organization	28%	32%	40%	5.9
Work and work process	17%	19%	64%	6.6
Facilities	30%	19%	52%	6.1
Extent to which work environment is perceived as agreeable	37%	25%	38%	5.7
Extent to which work environment supports productivity	48%	27%	26%	5.1
Accommodation concept	45%	19%	35%	5.5

Appraisal of the building as a whole

The appraisals of the distinctive aspects are summarized in Table 2. The architectural appearance of the building gets the highest score, with 58% satisfied and 25% highly satisfied. Opinions were divided on the location of the work sites: 27% of respondents were neutral, 43% satisfied and 22% dissatisfied. Only 5% and 3% ticked the “highly satisfied” and “highly dissatisfied” boxes respectively. Opinions were also strongly divided on the number, diversity and functionality of the workspaces in the immediate vicinity of the worksite. Views on the spatial configuration of the work spaces and the openness and transparency of the work environment were fairly positive. The survey found 46% and 54% respectively of the respondents to be satisfied or highly satisfied on these aspects. At the same time, an appreciable minority (25% and 30% respectively) were dissatisfied or highly dissatisfied with these aspects. All other respondents scored “neutral”. The internal climate including lighting and acoustics got the highest level of criticism. No fewer than 36% were dissatisfied with this, while another 33% were highly dissatisfied. Only 16% were satisfied, and 1% highly satisfied. Respondents complained that they were not allowed to open a window, because this would interfere with the operation of the climate control system.

Appraisal of the new office concept

There was a lot of criticism about the privacy of the work environment. No fewer than 37% of the respondents were dissatisfied with this aspect, and 23% were highly dissatisfied. Only 1% was highly satisfied, 18% were satisfied and 21% were neutral. One of the problems mentioned was the lack of privacy for a confidential talk between a lecturer or a tutor and a student, who may be quite upset about a particular issue and who may moreover have to walk through an office landscape where people are working to get to the interview room.
Similar levels of criticism were found concerning the extent to which the work environment allowed people to concentrate on a particular task: 56% were dissatisfied or highly dissatisfied with this, as compared with only 26% who were satisfied or highly satisfied. There were also reports of a high level of ambient noise, and complaints about the difficulty of making an undisturbed phone call. Respondents were on the other hand quite pleased with the scope offered for communication and social interaction: 55% were satisfied and 11% were highly satisfied, as compared with only 10% dissatisfied and 11% highly dissatisfied.

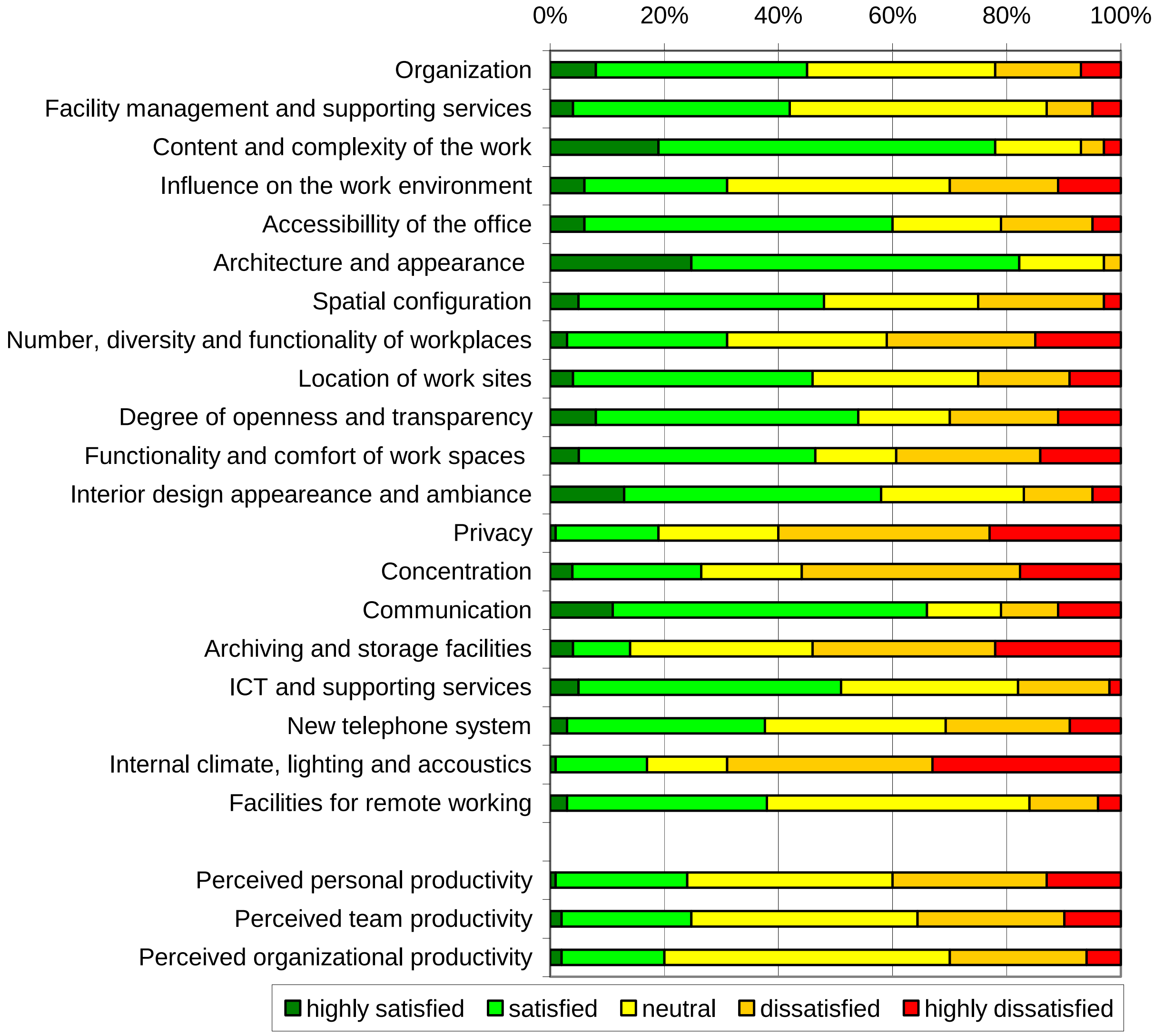

Table 2: Percentages of employees satisfied and dissatisfied with specific aspects (N = 114)

Respondents were not very happy with the filing and storage facilities. The project designers had tried to make the whole set-up much more professional in this respect, with a clear separation between central archives for documents that were not consulted very often and local filing facilities for documents that were needed frequently. The general opinion among respondents, however, was that 1 metre of shelf space for each employee’s personal files was inadequate. Some set up extra bookcases at home to store their papers from work. The IT and ancillary services were much better received: 52% were satisfied or highly satisfied, as compared with 16% dissatisfied and only 2% highly dissatisfied; 31% had a neutral opinion.

There was little difference between respondents’ assessment of the degree to which the work environment supported their own perceived productivity and that of the team in which they worked. In both cases, about 40% had a neutral opinion, a quarter were positive and 40% were negative, in particular due to problems with concentration and distraction.

Aspects of the work environment perceived as most important

Respondents were also given a list of 17 aspects of the work environment, and asked to tick the three they considered most important. Functionality and comfort came top of the list (ticked by 57 respondents i.e. by 52% of the respondents). Internal climate, lighting and acoustics came second (41 x, 38%) and support for concentration on particular tasks third (35x, 32%). The number, diversity and functionality of the work spaces and the support offered for communication received 28 and 26 votes respectively. It is noteworthy that the architecture of the building (which was highly praised) received only 12 votes, and also privacy (strongly criticized by the respondents) got only 12 votes. These last-mentioned aspects are apparently considered to be relatively less important than functionality, an agreeable internal climate and conditions that lend themselves to concentration and to communication, depending on which is called for at a given moment.

Feedback from final group discussion

The participants of the workshops mentioned that generally speaking the present building offers a much more pleasant work environment than the former one. The architecture of the present building was much appreciated, as was its openness which promoted social interaction and encounters – as opposed to the old building where everyone "was hidden away in his or her own little box". The IT facilities (hardware, software, backup services) were also praised. The rule for use of the cockpits (closing the door of the cockpit means DO NOT ENTER) worked well. But the openness of the building also had drawbacks. The transparency and the access of all staff to all work spaces made it difficult to store confidential documents and hold confidential talks. Managers were particularly bothered by this aspect, though the respondents did not perceive separate rooms for managers an option as well. Since doors cannot be locked, users had to be extra careful not to leave valuables lying around. The provisions for concentrated work were seen as inadequate, despite the availability of the cockpits. According to one participant, the cockpits were too small, and were often all occupied. The same applied to other workplaces, so that employees sometimes had the feeling that "they had nowhere to go". It may be remarked, however, that this feeling was not confirmed by the overall workplace occupancy rate throughout the building, which is low. People have to get used to the idea that the whole building is there to be worked in, not just the work sites in what one considers to be one's own domain.

Comparison with targets of Avans Hogeschool

The survey shows that a few months after some of the staff had moved into the new building, many targets have not yet been reached. The building does indeed promote communication, and the architecture contributes to the well-being of the staff. There were few complaints about the flexi-work approach. The intended reduction in floor area had also been achieved. However, the building does not meet the wishes of the staff in a number of important respects, in particular the internal climate, the telephone system, the filing and storage facilities and the provisions for student-teacher contact. Users were not always able to find the conditions that allowed them to concentrate on a demanding task.

A PILOT STUDY AT TU DELFT

In 1999, a pilot study was carried out in the Faculty of Civil Engineering and Geoscience (CiTG) of Delft University of Technology in order to gain experience in the use of a more transparent, dynamic study and work environment (Van der Voordt, 1999). The old situation was characterized by a double-corridor system with long, straight corridors, sanitary facilities and other services in the central core and mainly 1- and 2-person rooms round the outside. The massive walls gave the whole set-up a quiet but boring look. The lay-out was not conducive to creative work or contact between members of staff. In consultation with the Board of the Faculty, one of the wings of the main CiTG building was designated by the department of Real Estate Management of TU Delft as the site for a pilot study of the implementation of innovative concepts in the layout of an office/teaching/research environment. The pilot site had a gross floor area of 2050 m2. The original infill was completely demolished, and a new interior created that was characterized by more openness and smaller rooms, together with more shared space for meetings, spots for individual study, central filing systems and the display of the products of research projects. Since the sections housed on the pilot site were mainly concerned with research rather than teaching (any teaching activities being mainly restricted to one-to-one tutoring), the rooms in the new lay-out were still mainly 1- and 2-person offices. Glass walls gave the desired openness, while a strip of frosted glass at eye level ensured a degree of privacy. Since practically everyone concerned worked here on a full-time basis it was decided to continue the use of fixed personal desks, apart from the student research assistants. Some of the users were moved to another part of the building. The space released in this way was used to construct a new microlab for the study of concrete techniques. Integration of this laboratory in the office environment created an exciting, instructive blend of research and administration.

Evaluation of this pilot project showed, that the new look and feel of the department were highly appreciated (Van der Voordt and De Puy, 1999). A majority of respondents praised the work ambiance, the comfort offered by the furniture, the use of light colours and the transparency (lots of glass). Respondents found the work environment to meet the requirements of day-to-day work reasonably well, and to be equally suited to research and teaching activities. The new work environment seemed to appeal both to students and to new members of staff. The face-lift has improved the image of the department. The assessment of the functionality of the new set-up was ambivalent. The amount of space for formal and informal consultation and the provision of audiovisual aids in the conference room were appreciated. However, many users were dissatisfied with the internal climate, the limited scope for regulating the climate oneself and the lack of visual privacy. Despite the installation of overhead cooling and protection against incident solar radiation, it could get very hot and sticky in the building in the summer.
The mean overall satisfaction rating was 7.7 on a 10-point scale if two negative outliers were left out of consideration. The old situation got more or less the same satisfaction score, however, so in essence things had not really changed much. The unfavourable aspects of the new set-up would seem to have seriously tempered the enthusiastic response to the attractive new working ambiance, the transparency and the ample provision of aids to communication and cooperation. It may be noted in conclusion that a majority of staff found that the new work environment did lead to a slight improvement in their productivity.

DISCUSSION

The 1999 pilot project at CiTG dated from the early days of innovative office concepts like combi-offices and hot-desking. Evaluation of the project indicated that hot-desking was a step too far for the academic users. While it is true that the preparations for the use of activity-related work sites at Avans Hogeschool did not start much later, there was still plenty of time during the preparatory phase to take on board the experience in the use of flexible office concepts gained elsewhere. This gave the Executive Board of Avans the confidence to proceed with this innovative project. The main difference between these two cases was the use to which the space in question was put. At CiTG, the space was primarily used for research, while at Avans it is chiefly for the administrative support of teaching activities and the individual supervision of students. This last-mentioned point has been found to give rise to some difficulties in the new set-up. The spatial provisions for the interaction between members of the teaching staff and students are not yet satisfactory. The mix of “private space (‘staff only’), “public” spaces where students are allowed to come, and a joint “semi-private” staff zone is not facilitated on a satisfactory level. Supervisions often take place in the cockpits. Lecturers characterize the old situation, where each one had his/her own room, as much more acceptable. Students were able to find them more easily, and the door of the room could be closed to ensure sufficient privacy. The high level of transparency in the new situation is less suitable for a confidential or sometimes even quite emotional conversation. The new situation is also experienced as less convenient for the storage of personal documents, including the lecturer’s own books and students’ project papers. It would be advisable to take these findings into consideration during the preparations for the next phase of the Avans move and to think carefully - in consultation with the staff and certainly also the students! - about the best way to facilitate contacts between teaching staff and students.

Considerations concerning the research methodology used

Any measurement of user satisfaction is a snapshot taken during a continuous process. When considering the results of the Avans Hogeschool study, it should be borne in mind that the measurements were made shortly after the first group of users moved into the new building, when a number of important elements of the new work environment such as the planned Grand Café were not yet in place. The project bureau is still waiting for the permits for the seating to be installed in the (wide) corridors, which could help to provide more space for the supervision of students. It also took some time to get the internal climate control properly regulated. Unpleasant experiences on hot days stick in the memory for a long time, and clearly influenced user evaluation of the quality of the internal climate.

The use of a digital questionnaire for the survey had the advantage of ensuring that all users could be contacted quickly and efficiently, and that data could be rapidly made available in tabular and graphical form. A risk of this approach is the potentially low response rate. It also proved to be difficult to get enough users to participate in the group discussions. The disadvantage of small numbers is balanced by the two in-depth group discussions that made it possible to ask respondents about the reasons “behind their answers”. A combination of questionnaire and group discussion would seem to be a highly effective means of gaining a sufficiently reliable and valid picture of user perception of the new work environment.

It might be possible, however, to use quite different investigative methods in future research. In particular with respect to cultural changes, anthropology is a discipline that might contribute to building up a body of knowledge about experience and use of work environments by participant observation and phenomenological approaches such as interviews-in-depth and asking users to keep a diary or to tell narratives about their working environment. Observations and stories to grasp their native point of view may help to improve our understanding of peoples' behaviour in such new settings. What kind of interventions occur as a consequence of people's resistance? *Why* do people behave as they do? What is the impact of type of business, organizational culture, social roles, group dynamics, attitudes and habits? What are short term and long term effects of a new work environment? Does the period of measurement – for instance in hectic periods with time pressure of teaching duties versus more quiet periods – make a difference? Unfortunately disciplines such as anthropology, environmental psychology, business administration and facility management seem to be hardly connected at all. We still have a long way to go.

REFERENCES

Balkin, D.B., Tremblay, M. and Westerman, J. (2001), "Workplace innovations in large, unionized Canadian organizations", Journal of Business and Psychology (15) no. 3.

Barber, C. (2001), "The 21st-Century Workplace", In: Kaczmarczyk et al, People and the Workplace. GSA Office of Governmentwide Policy, Washington DC.

Becker, F. (2004), Offices at work, Jossey-Bass, San Francisco, USA.

Brill, M., and Weidemann, S. (2001), Disproving widespread myths about workplace design, Kimball International, Jasper, USA.

Duffy, F., with Powell, K. (1996), The New Office, Conran Octopus, London.

Volker, L. and Maarleveld, M. (2007), Wodi-Light ontwikkeling en gebruikhandleiding, Center for People and Buildings, Delft. [WODI-Light, development and user guide].

Pinder, J., Price, I., Wilkinson, S.J.and Demack, S. (2003), "A method for evaluating workplace utility", Property Management Vol. 21 No. 4, 218-229.

Voordt, D.J.M. van der (1999), Universitair vastgoed: leer- en werkomgeving. Delftse Universitaire Pers. [University Real Estate, an evaluation of two poilots].

Voordt, D.J.M. van der (2007), Activiteitgerelateerde Werkomgevingen bij Avans, Center for People and Buildings, Delft. [Activity Related Workplaces at Avans].

Voordt, D.J.M. van der, and de Puy, L. (2000), Evaluatie pilot Civiele Techniek, Faculteit Bouwkunde TU Delft, Delft. [Post-Occupancy Evaluation of the CiTG-pilot].

Watson, L. (2007), "Building the Future of Learning", European Journal of Education, Vol. 42, no. 2, 255-263.

FUTURE WORKPLACE: RAISING AWARENESS OF THE POTENTIALS AND THE NEEDS OF AN AGEING LABOR FORCE.

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ABSTRACT

Unless there are changes in migration patterns or fertility trends, employers across the world could be facing dramatic work force or "seasoned talent" shortages. This is particularly true in those sectors that are either planning for significant growth or sectors that are already experiencing difficulties attracting and retaining competent workers. According to Merriam-Webster Online, flexibility can be "characterized by a ready capability to adapt to new, different, or changing requirements". A flexible workplace, then, might be one that is able to adapt to the new requirements of an ageing workforce. It might offer choices with regard to which the numbers of hours an employee can work and the choices concerning the tasks assigned to the job. Such a workplace should also offer the potential for work redesign that takes into consideration the older workers experiences abilities and preferences. The location (telecommuting or alternate work locations) or the layouts of the offices where the employee can work are of particular importance to FM. It is expected, then, that new type of infrastructure will be needed to accommodate an ever increasing ageing workforce. The aim of this paper is to present a conceptualization of the management of facilities addressing the issues of an ageing workforce.

KEYWORDS: ageing society, workplace, conceptualization

INTRODUCTION

In the report entitled "Strategic Business Risk: 2008 - The Top 10 Risks for Global Business", Ernst & Young in collaboration with Oxford Analytica sought the views of more than 70 analysts from around the world within more than 20 disciplines. Although the empirical apperception -in its Kantian sense- nature of the study, the ageing society and ageing workforce phenomenon has been listed in the five top tens threats. Significantly enough, they focused on the strategic risks facing 12 of the world's larger sectors: asset management, automotive, banking & capital markets, biotechnology, consumer products, insurance, media & entertainment, oil & gas, pharmaceuticals, real estate, telecommunications and utilities. They further divided the threats in three groups –macro threats, sector threats and operational threats. They noted that due to the growing group of older consumers, sectors such as asset management and insurance are experiencing dramatic shifts in demand. Other strategic challenge posed by an ageing society is the ageing workforce. In the automotive sector, for example, companies are facing severe competitive challenges as a result of their ageing workforces. Sectors, like those of the oil & gas or banking, are already experiencing a talent shortage.

In recent demographic studies in the United States, it is estimated that the percentage of people age 65 and over will increase from 12.4% in 2000 to 20.7% by 2050, whereas the percentage of the workforce between the ages of 20 and 64 will decline from 59.0% in 2000 to 53.4% by 2050 (U.S. Census Bureau, 2004). These statistics imply that people over 65 will gradually take up a higher proportion of the workforce. Moreover, as people live longer, they will be more likely to want to remain in the workforce for longer. Dynamic demographic changes and increasing variations in people's lifestyles will increase the need to broaden the diversity of the workforce, to include senior people and people with disabilities (Saito Y., 2006).

KNOWLEDGE-BASED RESOURCES

There is a growing awareness that knowledge is the main driver in business and that knowledge creation among employees of a company or a team is critical to sustain and increase competitiveness (von Krogh, 1998). All the systems and processes of an organization that deliver value to the business have a knowledge dimension.

Nowadays, organizations do not rely solely on traditional assets such as labour, land, capital, materials, and machinery to create wealth and drive economic success. It is now recognized that through collective knowledge and abilities, knowledge-based resources can enhance existing products or processes, or develop new products and processes that were previously unknown. By cultivating its knowledge-based resources, it is possible for an organization to offer customers value and maintain a competitive advantage (Fong, 2007a).

Tacit knowledge is that which an individual is not fully aware of and which is difficult or impossible to articulate in written form (Nelson and Winter, 1982). Explicit knowledge, on the other hand, is more tangible and observable and can be conveyed orally or in writing (Kogut and Zander, 1992). Although the distinction between tacit and explicit knowledge is important, it is not necessary to provide examples of completely tacit or completely explicit knowledge. In effect there is a knowledge continuum which ranges from explicit to tacit (Inkpen and Dinur, 1998).

OLDER LABOR FORCE PROFILE

In the introduction, I have argued that some evidences indicate that older workers are expected to be on the job over the next 20 or more years and that the workplaces and working relationships they face are changing. I now turn attention to the profile of older worker. First I must try to find an answer to the following question. How old is an older worker?

There is no consensus about who is and who is not an older worker. Ideally, the definition of an older worker should be functional rather than annual. Not surprisingly, policy makers, business leaders, academics, and older adults tend to calibrate the age of older workers in different ways -"…the age at which one becomes an older worker seems not to be related to biological age but instead to concerns faced by workers at various points in their lifespans." (Rocco, Stein & Lee, June 2003). Thus, if age, aside from non age related personal qualifications, is a significant hindrance to employment and income, then a worker faces the older worker problem regardless of his precise age in years. The definition varies across historical periods and industrial sectors and perhaps by role and is not as linked to chronological age as it once was. The differences are most clearly drawn across occupations. Professionals and self-employed should be differentiated from manual workers. But even within one of these occupations, some workers at the age of 50 are inferior to others at the age of 60 or 70 years old. Nevertheless, a distinction should be drawn between the problems of workers in the 45-65 age category and those over 65 years of age. Whereas those over 65 have passed the normal retirement age, those in the 45-65 age braquet are potentially active members of the work force.

Which physical and cognitive resources of older workers are likely to match or impede the matching of older workers and the working environment? I should focus on the characteristics that predict which older workers are most likely to work most productively and on the best incentives and methods to encourage and enable the most productive workers to stay. However, we must first examines these age-related differences in function, capacity, and vulnerability, investigating the physical, psychological, and social characteristics that distinguish older from younger workers and how they affect differences in function, capacity, and vulnerability.

Understanding the health of a given cohort of older workers is aided by important gerontological theory. Particularly important is the life course perspective on aging (Baltes, 1997). The life course perspective suggests that biological, social, and environmental factors that occur in child and adult development, beginning from conception, all play important roles in the nature and trajectory of aging. It is likely that among the most important determinants of health and aging for older workers are the prior work experiences. In turn, they are related to the levels of environmental exposures as well as the social and health care opportunities created by work with their effect on overall socioeconomic status, which is an extremely powerful determinant of the future occurrence of diseases, illnesses or disorders, disability, and death (Adler and Newman, 2002). Many important age-related changes may begin in youth or midlife. Regardless of the causes of these early changes, early physiological abnormalities can predict later dysfunction and disease (Whetstone et al., 2001). However, not all age-related changes occur in slow, continuous decrements, but also with the rapid emergence of chronic diseases such as cancer, heart disease, and stroke (Ferrucci et al., 1996). This highlights the role of clinical disease prevention in deterring what might in populations be seen as age-related functional decline (Wegman and McGee, 2004).

So, what physical changes occur, in general, as a person ages and how can this affect their work? People reach full physical maturity or development at around the age of 25 years. Then after a period of relative stability, our bodies begin to show signs of aging. Most of these changes are first noticed at ages 40 or 50, but changes can occur (or start) as early as 20 or 25. Among the almost noticeable changes include:

- *Maximum muscular strength and range of joint movement*, in general, people lose 15 to 20% of their strength from the ages of 20 to 60. However, every person is different and there is a large range between individuals. Older employees may be able to perform the same tasks as a younger worker, but they may be working closer to their maximum level. For example, highly repetitive motions -- doing the same thing, over and over again -- can cause physical problems at any age. However, as we age, the body loses some flexibility. Being less flexible or able to reach could cause problems in some unpredictable situations that require unusual movements.

- *Regulation of posture and balance*, people may find it harder to maintain good posture and balance. When seated or standing still, this may not be a problem. However, accidents that happen because someone loses their balance do happen more often with age.

- *Sleep regulation*, older people can't regulate sleep as well as they used to. How long a person sleeps, and how well they sleep, can be disrupted by changing work hours or by light and noise. The impact on employees is especially a concern for older shift or night workers. They might need more recovery time between shifts or extended workdays.

- *Thermoregulation of body temperature*, our bodies are less able to maintain internal temperatures as well as less able to adjust to changes in external temperature or due to physical activity. This change means that older workers may find heat or cold more difficult to deal with than when they were younger.

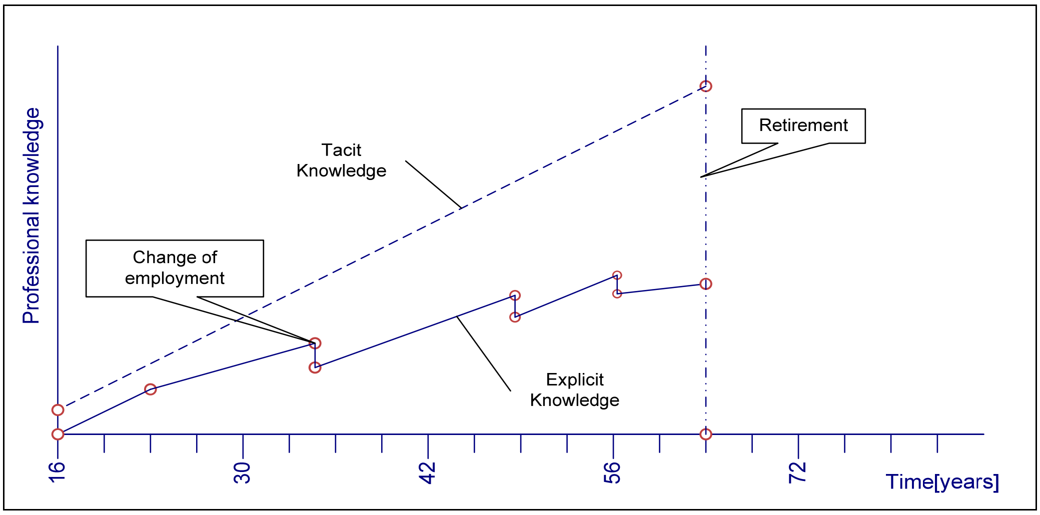
- *Vision disabilities*, we will notice we cannot see or read from certain distances as well as we used to. This reduction in the "amplitude of accommodation" (the ability to see or adjust focus in certain distance ranges) is normally corrected with prescription glasses. Changes also occur in the peripheral visual field (how well you can see in the areas to the side of you, that you're not directly looking at), visual acuity (how exact, clear things appear), depth perception, resistance to glare and light transmission. These changes are normally not noticed by a person unless there is poor lighting or there are sources of glare. Someone might also notice that they can't see as well when they're reading something when text size is small, or when there is poor contrast between the text and the background. Brighter lighting (that is suitable for the task) and well laid-out documents which avoid small print are important.

- *Auditory disabilities*, we may not be able to hear as well at higher frequencies (high pitch sounds). Most often, this change is noticed as the inability to listen to a particular voice or sound in a noisy environment. As well, people who work with a lot of background or noise may have difficulty hearing verbal instructions.

The cognitive capabilities, fluid intelligence such as inductive reasoning, selective attention, dual-task activities, and information processing, declines with age while verbal tasks and vocabulary (talking and expressing themselves) remain constant or improve. Tasks that depend on short-term memory usually take longer. Older workers tend to use experience and expertise when working and may find it hard to work with complex or confusing stimuli. This means they might find it hard to do tasks in which they have to do (or think) a different things quickly or at one time. In a busy environment, they may find difficult to work and may be less able to focus attention only on information relevant to the task at hand, especially in "new" situations. This means, because of the surrounding and especially in new situations, they aren't sure what to prioritize, what to pay attention to, and what to ignore.

In the previous section, I settled my discourse on the importance of knowledge aspects in the today’s economy. The older worker excellence will be potentially lost at the time of the older workforce retirement. I also noted that both tacit and explicit knowledge are involved. So how could be the evolution of the knowledge during the entire life? Figure 1 depicts the simple assumption I made about the evolution of the tacit and explicit knowledge during the whole life of a professional. Two observations can be made: the abrupt end of the work-life and the significant gap between the tacit and the explicit knowledge.

Figure 1. Current Situation: Professional Knowledge creation thorough life



ORGANISATION AND LEARNING

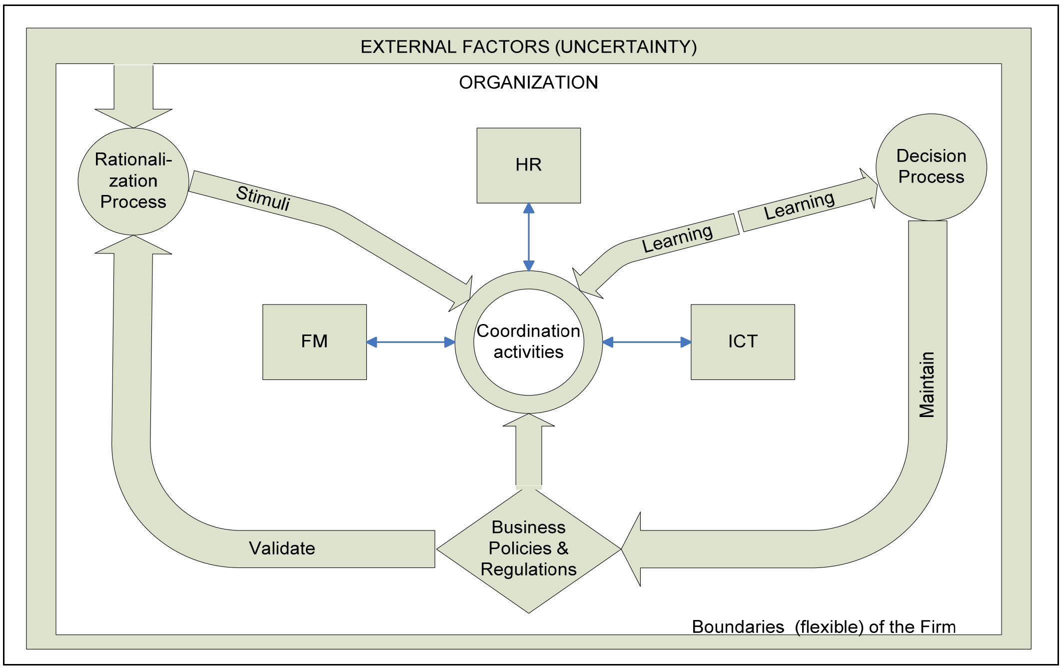
In today's digital economy, a major determinant of Information Processing Capability defined as "*its ability of the organization to capture, store, process and utilize information for the coordination of production and decision-making*", ICT would have a significant impact on the ways institution organize and interact. Hence, Information Management and Knowledge Management practice are implemented by ICT in a cost effective manner. It allows the production of relevant information at a reasonable cost. It should also sort out and dispatch it to the right places. The right places means where it will be used in a profitable way.

Hatchuel (2001) found two important elements in understanding what characterizes the modern firm. Recalling Weber's argument according to which a strong relationship exists between the nature of collective organizations and the rationality of those, he sets the following propositions:

- We should be aware of the existence of different forms of collective organizations and of their permanent reconstruction over time since the beginning of the nineteenth century;
- These reconstructions are stimulated by permanently renewed rationalization schemes, the nature of which is to be explored;
- Each of these schemes stimulates new learning processes embodied in the formulation of new rules and new actions

Hatchuel defines rationalization as a fundamental driver of organizational changes and emphasizes the interconnection between organization and learning. Moreover, the objective of integration is to coordinate the innovation process and the firm's adaptation. Integration requires the implementation of information systems and incentive schemes. One important function of incentive schemes is to create some form of congruence between the firm and its members. Congruence simply means the firm tries to conceive situations in which different parties have a common interest in participating. Thus, when one employee has made specific investment and proves that she has certain qualities, the firm should be able to offer her a job which is good for the firm and interesting for her.

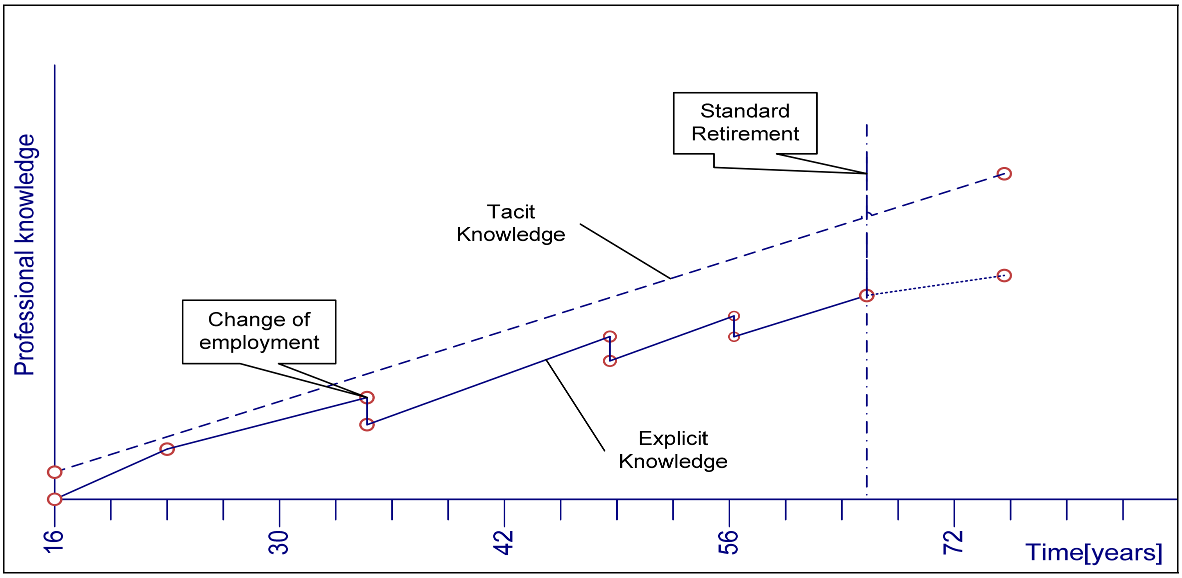
Figure 2. Concept of the integrated firm adapted to Facilities Management



As shown in figure 2, the knowledge is created through the continuous interaction between the decision and the coordination processes where learning is the vehicle. Moreover, the external world affects the boundaries of the firm and as a consequence to modify the rationalization process. (Dettwiler, 2008)

By identifying the potential gaps and knowledge transfer needs, an organization could better make a profit of the knowledge from the older worker. From the previous *current situation* of the person's knowledge, we can draw now the assumed *ideal situation* represented in the figure 3.

Figure 3. Ideal Situation: Professional Knowledge creation thorough life



CONCLUSION AND FURTHER RESEARCH

This paper has discussed the need for maintaining older workforce in working life for extended time periods. This is primarily necessary due to (1) demographic reasons and (2) competitive reasons for companies and organisation that to a larger extent can take advantage of the long life accumulated tacit knowledge among elderly workforce.

If we are serious about retaining the intellectual capital of older workers, countries will have to develop policies and tools for knowledge transfer among elderly workforce. They will gain competitive advantage compared to countries that do not make such process.

Much greater integration of public policies toward older workers with policies of businesses will enhance their engagement. Too few middle size or larger industries have undertaken demographic audits and will be in the need to plan the labour force. For example, everyone has a generalized knowledge of the greying of the workforce but few of us can be specific. Some questions arise like: “How old are managers in business organisations?”, or “What is the impact on succession planning?”.

Training offered in the context of job and career development for mature worker are some of the measure that will improve the retention of talent and enhance the phased retirement. Which impact such program will have on facilities and services?

An active field of research will be the adaptation of facilities design to major and minor disabilities. Media stereotypes about older people and older workers need to be actively challenged. Rather than developing special schemes, it is better to put greater emphasis on removing age barriers by developing universally designed environments and tools. As universal design is a broader concept than inclusive or barrier-free design, it is expected that facilities will have to be designed with a broader scope. Health, wellness, security and comfort will almost have impact on facilities implementation and maintenance. Because group and individual solution will be required, Facilities managers will have to be strongly coordinated with Human Resource managers and tools developers to provide an integrated infrastructure.

It is expected that flexibility in working arrangements is for an older worker as much important as it is for younger workers. How facilities management will contribute to the implementation of such arrangements? Working schedule, job redesign, and so on is pertaining to the toolset of the HR manager. Those changes imply that FM contribution will be far beyond their actual capability. The paradigm of service oriented architecture will help facilities and services provision that follow the continuous change of users and corporate needs.

REFERENCES

Adler N.E. and Newman, K. (2002), “Socioeconomic disparities in health: Pathways and policies. Inequality in education, income, and occupation exacerbates the gaps between the health “haves” and “have-nots.””, Health Affairs, Vol. 21 No. 2, pp. 60-76

Baltes, P.B. (1997), “On the incomplete architecture of human ontogeny. Selection, optimization, and compensation as foundation of developmental theory”, American Psychologist, Vol. 52 No. 4, pp. 366-380.

Center for Universal Design (1997), The Principles of Universal Design, Ver. 2.0, North Carolina State University, Raleigh, NC.

Dettwiler, P. (2008), "Virtual and Real Boundaries of Growth Firms: Office Space and Implications of Outsourcing and Mergers & Acquisition", Working paper.

Ferrucci, L., Guralnik, J.M., Simonsick, E., Salive, M.E., Corti, C., and Langlois, J. (1996), "Progressive versus catastrophic disability: A longitudinal view of the disablement process", Journals of Gerontology Series A-Biological Sciences and Medical Sciences, Vol. 51 No. 3, pp. 123-130.

Fong, P.S.W. (2007a), "Dynamic Knowledge Creation through Value Management Teams", Journal of Management in Engineering, Vol. 1, pp. 40 – 49.

Hatchuel, A. (2001), Journal of Management & Governance, Vol. 5 No. 3-4; pp. 260

Inkpen, A. C. and Dinur, A. (1998), "Knowledge management processes and international joint ventures", Org. Sci., Vol. 9 No. 4, pp. 454–468.

Kogut, B. and Zander, U. (1992), "Knowledge of the firm, combinative capabilities, and the replication of technology", Org. Sci., Vol. 3 No. 3, pp. 383–397.

Mace, R.L. (1985), "Universal design: barrier free environments for everyone", Designers West, Vol. 33 No. 1, pp. 147, 148, 150, 152.

Nelson, R. R. and Winter, S. G. (1982), An evolutionary theory of economic change, Belknap Press, Cambridge, Mass.

Ostroff, E. (2001), "Universal design: the new paradigm", in W.F.E. Preiser, E. Ostrof: Universal Design Handbook, pp. 1.3–1.12, McGraw-Hill, New York, NY.

Rocco, T., Stein, D. and Lee, C. (June 2003), "An exploratory examination of the literature on age and HRD policy development", Human Resource Development Review, Vol. 2 No. 2, pp. 155-180.

Saito, Y. (2006), "Awareness of universal design among facility managers in Japan and the United States", Automation in Construction, Vol. 15, pp. 462 – 478.

U.S. Census Bureau (March 2004), "U.S. Interim Projections by Age, Sex, Race, and Hispanic Origin.", available at: http://www.census.gov/ipc/www/usinterimproj/.

von Krogh, G. (1998), "Care in knowledge creation", California Management Review, Vol. 40 No. 3, pp. 133–153.

Wegman, D. H. and McGee, J. P. (2004), Heath and safety needs for older workers, The National Academy Press, Washington, D.C.

Whetstone, L.M., Fozard, J.L., Metter, E.J., Hiscock, B.S., Burke, R., Gittings, N. and Fried, L.P. (2001), "The physical functioning inventory: A procedure for assessing physical function in adults", Journal of Aging and Health, Vol. 13 No. 4, pp. 467-493.

CITY SPACE MODELS IN OFFICE DESIGN

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ABSTRACT

Amongst the many studies in the field of designing creative human office interiors, one can note a distinctive tendency in organizing work office space based upon a metaphor for the city. However, it is difficult to find an answer to which city model could be considered as providing the optimum in usefulness when designing work space.

The aim of this paper is to evaluate the various spatial arrangement possibilities which could be utilized as reflected in the office interior blueprints from ancient, medieval, and Renaissance cities.

Based upon the spatial models presented, each will then be subject to a two-part evaluation. In the first part, aspects of spatial legibility, the accessibility to facilities, and the capability to generate interpersonal interactions will be subjected to analysis. The other part of the evaluation will concern itself with the potential use of the presented models in various types of buildings.

The results of this research paper may provide to be a helpful tool during strategic decision-making processes when considering the functionality and shape of both newly-designed and modernized office buildings.

KEYWORDS: urban design, alternative workplace strategies, creative environment

INTRODUCTION

The last twenty years of the 20th century was host to a period of both intensive IT development and the introduction of new organizational methods toward work. This was also a period of research on the nature of office work, with the creation of new – as alternatives to traditional solutions- workplace design strategies.

In the industrial era, the configuration of office space was, to a large extent, a derivative of the command-and-control type hierarchical management system, or the result of adapting personnel worksites in an arrangement that efficiently channelled the flow of paper documents. Today the office is treated as just a part of a complex, interdependent system that is divided between three main characteristics, compromising of: work processes (WP), information technology (IT) and the physical settings and furniture (PS). Such an approach, described by Becker as organizational ecology, takes into consideration the interdependencies occurring between, WP, IT, and PS, which provide for such issues as: organizational behaviour (eg. organizational structure, formal and informal communication, corporate culture); human factors (eg. air quality, level of noise, light) architectural and interior design issues (eg. space allocation, materials, finishes); and industrial engineering (eg. supporting work processes through the workplace layout). [Becker, p.13-14]

One of the results of such a multifaceted approach to the problems affecting the shape and development of offices was the inception of new office space concepts based upon the allegory of a city. Belonging to these is the „Office like a city" model (proposed by John Worthington) - underlining the necessity of creating multifunction office structures; an example of the „Total Office" design (presented by Franklin Becker and Fritz Steel) - treating the office space as set of places with different functions connected in such a way that can generate the maximum amount of interpersonal contacts; and based on a similar principle, the concept of the „neighbourly" office (as defined by Myerson and Ross).

The purpose of the present article is to illustrate the common features in the advancements of industrial and post-industrial era offices with the development process in the formation of Medieval and Renaissance cities. Through analysis in the development of the characteristic features of office systems and their corresponding municipal plans, we will try to find the optimum-spatial examples that equalize the need between order and disorder – keeping in mind which factors favourably influence the development of space for intellectual work. The presented article is part of a greater analytical program in pursuing varying methods in urban-planning in office design headed by the Faculty of Architecture at the Wroclaw University of Technology.

COMPARING CITY SYSTEMS WITH THE SPATIAL SYSTEMS OF OFFICES

Street systems

In the history of constructing cities, street systems were treated as a „primal" characteristic model more for town-settlements which, as time went by, climbed to the rank of cities. Within the limits of this rather simple definition, we can distinguish three key distinctions regarding the manner of the location of public city services. [fig. 1]
In designing offices, the image of street systems is transposed into corridor/hallway systems, known as „cells". This spatial example, used for the first time in the Gallerie Uffizi project, became in the 20th century one of only two significant office models used in the industrial era. Amongst buildings built up in such way, we can distinguish several types of shaped projections. The basic differences between them are the number and the width of paths and the way vertical transportation routes are located. [fig.2]

Orthogonal systems with regular street networks

The origin of the orthogonal city space system is tied in with the adaptation of the city structure in order to meet the geometrized needs of an army camp (lat. castrum). This was combined with the adaptation of simple and modular-plan solutions to meet the functional requirements of the city. [Książek, p.15] With the development, or a rather renewed birth, of this spatial model were the cities of the late Middle Ages. At this time, the configuration of city space was largely influence from legal regulations that determined the location of new cities. [fig. 3]

In the history of office buildings, an image of the orthogonal example can be seen in the multi-spatial model of the office hall – defined in current research papers as a „hive". This model was developed alongside the rising growth in the number of tasks carried out in offices and relevant to this, an increase in employment, taking place in the first years of the 20th century. This concept differentiates itself from the European (corridor/hallway) office

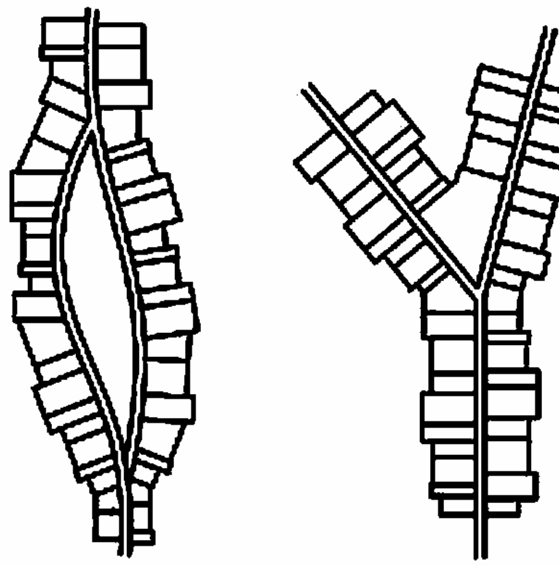

Fig. 1. Primary "street" patterns.

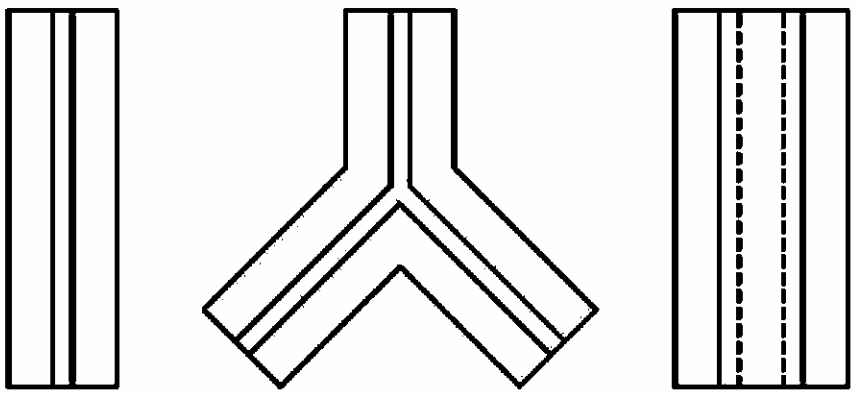

Fig. 2.Various types of corridor offices.

structure model as it originated with no traditional connection; instead it arrived from the highly valued, effective solutions of American society. It was adapted from the development of the writer's room in merchant exchange offices, which gradually enlarged, first from the big hall room, to the large spatial hall interiors in the first decade of 21st century [Złowodzki, p.77]. Later, the single large interiors were isolated into single worksites in the form of so-called box offices (eg. cubicles). [fig. 4]

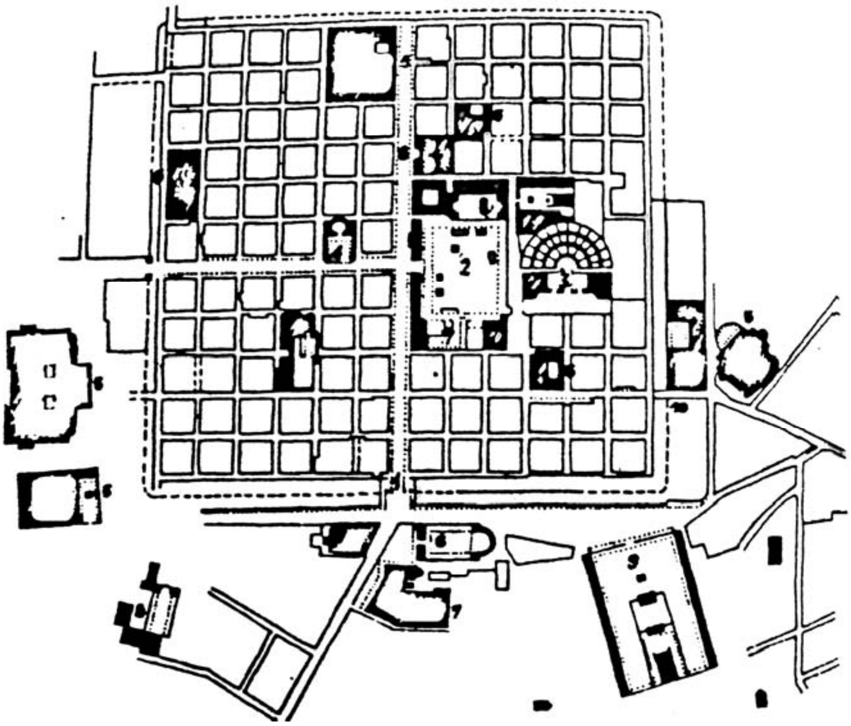

Fig. 3.Blueprint of ancient roman city – Timgad

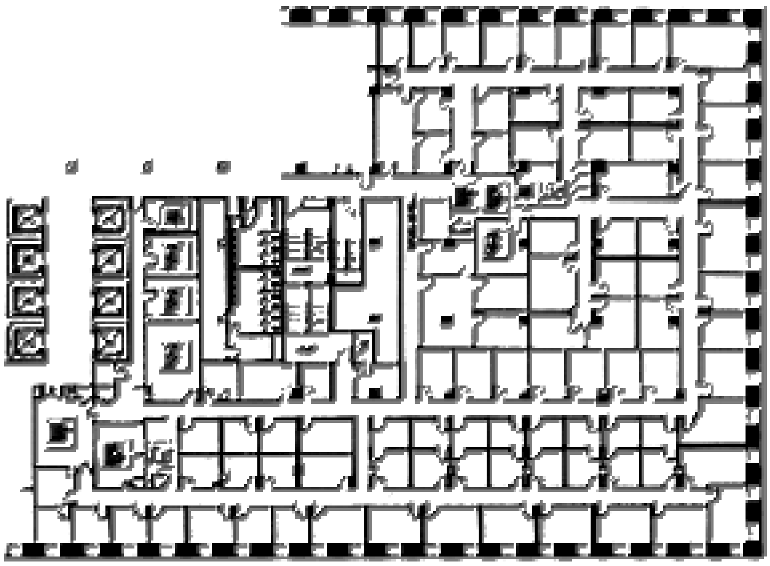

Fig. 4.Large scale office interior divided into boxes.

Organic systems

The early formations of cities were created from loosely related structural units (the castle, the settlement outside castle walls, neighbouring settlements). Concurrently with the development of this model the tendency to centralize these kinds of systems became visible. [fig. 5] The discretionary and fragmented choices in the localization of city urban elements were replaced over time towards the tendency of joining city components into a rational, integrated structure. [Ostrowski, p.91]

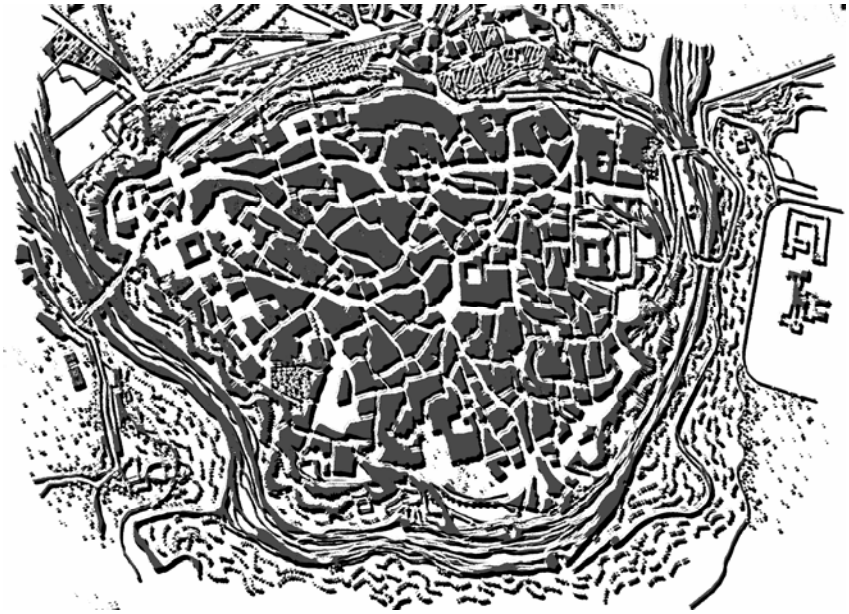

Fig. 5.Blueprint of early middle age city - Toledo.

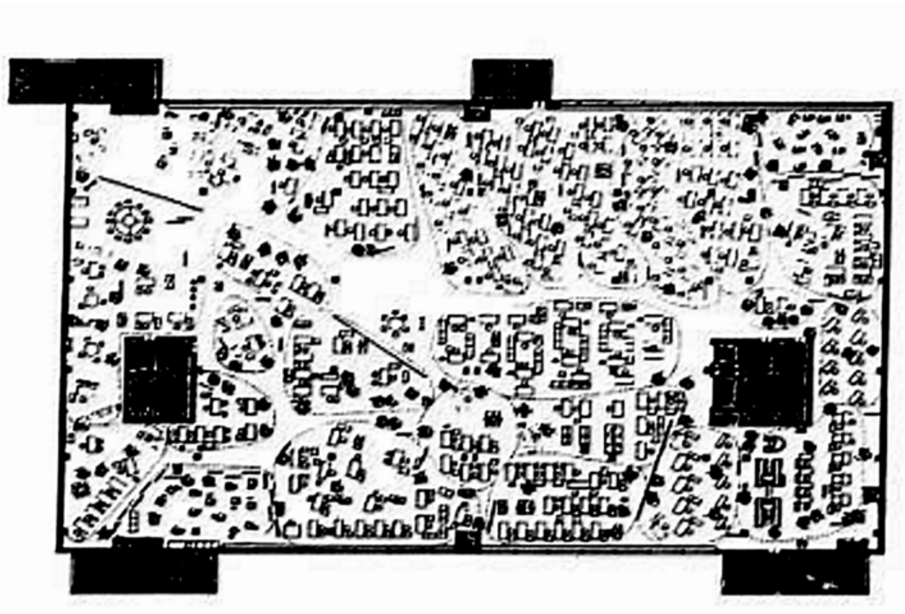

Fig. 6.Example of office landscape – Germany 1961.

A counterpart to the organic example in office design is the office landscape model. A characteristic feature of this kind of solution is the reflection of the spatial system character in the work processes and document flow within offices. Grouped workplaces are arranged in different angles in geometrical areas isolated by walls, screens and green plants. Vertical transportation points and sanitary and technical rooms are separated into columns – the so called „stable points”. By keeping advantageous work conditions, it is possible to simultaneously create spatial frames for the pipelined organization of work. [fig. 6]

Hybrid systems

Early forms of combined model appeared in ancient Greek city-states. Around an open 'place of assembly' called Agora (which was a center for citizen's gathering) orthogonally shaped living districts were freely located. [fig. 7]

During the Renaissance, this kind of the city structural model was developed – by consolidating the advantages of both the organic and orthogonal systems – an integrated concept called the ideal city (lat. citta ideale) was born. New urban planning solutions emerged due to both changing social and economic conditions and also new technical achievements. This development naturally led to congruent changes in cities design, it was tied together with the intensive development of the humanities, sciences, and technical subjects, which stemmed from political and class transformations. The leading initiative behind the rise of Renaissance cities was therefore combining the advantages of both the organic system (closely situating cooperative structural units, segregation from the surrounding area, and safety) and the orthogonal system (system readability, good spatial orientation) into one principle sphere. Within the grounds of these new city layouts, there is a visible tendency by Renaissance era designers to create numerous related city squares in various shapes [Ostrowski, p. 396] in order to determine specific social activity centers. In such communication design construction, the various general city functions were located in such a way that they reflected their purpose in the city's operation. [fig. 8]

A characteristic feature in modern offices concepts shaped on the likeliness of Renaissance cities is the alternation of work zones with social, auxiliary and supplementary spaces (Neighbourly Office, Total Office, Office Like a City). The purpose of this kind of arrangement is to insure to its users a favourable working environment; the archetype of a small city is used to reinforce and establish social relationships. Similar to the ideal city design, we can distinguish three important stages in the designing of offices on a likeliness to cities. The first stage is based on the creation of a readable internal communications system, where the center is the „plaza” („agora”) or „main street” from which small streets radiate outward, each leading to an individual structural zone. The second stage of this concept depends on he creation and correct placement of so-called atractors; these can be defined as groups of social spaces placed in the most important sections of a city, as defined through an interpersonal communications viewpoint. Atractor clusters also serve as orientation landmarks, facilitating way-finding; they are often placed close to intersections of key transportation routes. The third stage in this kind of office space design consists in the placing of individual, group, and team worksites. Temporary workplaces are usually located close to the main communication routes; they differentiate themselves from fulltime workplaces, which could be located further away from the central work-spheres and situated in more quiet places in the building. [fig. 9]

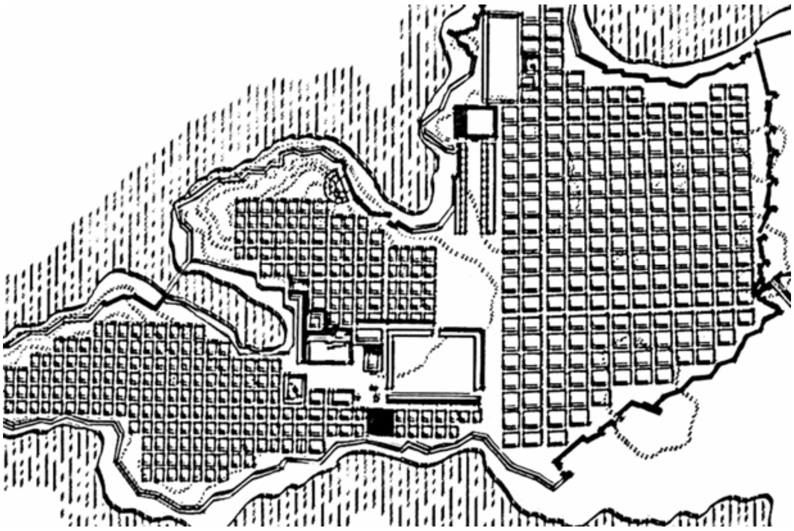

Fig. 7. Blueprint of ancient Greek city – Milet V bc.

Fig. 8. Schemes of ideal cities according to Francesco di Giorgio Martini XV c.

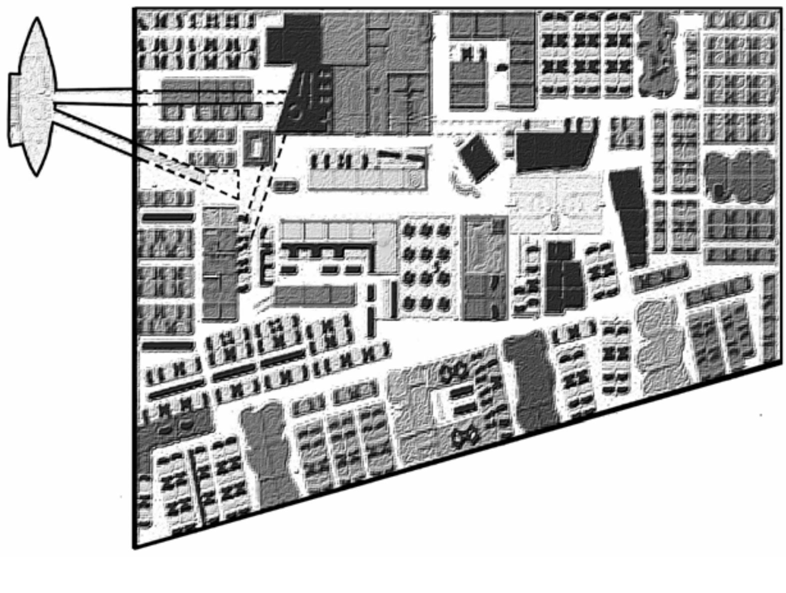

Fig. 9.Example of contemporary “neibourghly office” – USA 1999

SUMMARY

In analyzing the similarities between the apparently distinct disciplines of urban design and space planning, similar trends were found that influenced the development of these subjects through different time periods. The comparisons carried out between the arrangement of primal (street) medieval cities (orthogonal and organic) and Renaissance cities with the cities of the Industrial era (hallways, multi-spatial, and scenic) as well as the Post-Industrial („neighbourly", „total Office" and „Office like a city") revealed many similarities. Based upon the conclusions reached, we can be permitted to assume that the use of city models newer then 16th century solutions can allow us to widen research in office design planning. This kind of research is also useful in the case of large-scale office building modernization, since the existing interior permits a diversified arrangement which enables it to match the latest, alternating demands in office work organization.

REFERENCES

Becker, F., Steele, F, Workplace by Design. Mapping the High Performance Workscape., Joosey-Bass Publishers, San Francisco, 1995

Cunliffe, R., Raymond, S., Tommorrow's Office. Creating effective and humane interiors., E&FN SPON, London, 1997

Książek, M., Materiały pomocnicze do studiów w zakresie historii urbanistyki : pomoc dydaktyczna, WPK, Cracow, 1994

Myerson, J., Ross, P. (2003), The 21st Century Office, Laurence King Publishing, London.

Norbert Schultz, C. (1999), Meaning In Western Architecture, Murator, Warsaw.

Ostrowski, W. (2001), Wprowadzenie do historii budowy miast. Ludzie i środowisko OWPW, Warsaw.

Price, I., (2007) "The Complex Adaptative Workplace: A Theoretical Link between Office Design and Productivity" available at: www.ifm.eng.cam.ac.uk/mcn/pdf_files/part5_4.pdf

Worthington, J. (2004), "Distributed Work in the Networked City", Proceedings of EuroFM, Kopenhaga, A1.pdf.

Złowodzki, M., (1997), Technologiczne i środowiskowe projektowanie architektury biur., WPK, Cracow, str. 77

WORK SPACE PLANNING AND AMENITY AREAS

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ABSTRACT

The traditional approach to workplace strategies are increasingly becoming inappropriate to emerging patterns of work and are encroaching on workers performance. Facilities managers need to be in a position to distinguish the needs of their employees and to ensure that the working conditions are fully responsive to these needs. This paper reports on a case study of the single largest office park in Cape Town. The purpose of the study was to establish the extent to which the modification of their amenity areas is changing employees' usage patterns. The research concluded that the modification of the workplace environment has had an overall positive impact on the organisation when implemented appropriately and the key lesson of which is to focus the priority on the employees and their work process.

KEYWORDS: Work space planning, amenity areas, South Africa

INTRODUCTION

This paper reports on a case study of the single largest office park in Cape Town. The purpose of the investigation was to establish the extent to which the modification of their amenity areas is changing employees' usage patterns. Work is done differently from the way it was done a decade ago, using different methods of work and equipment and this resulted in the needs in the workplace changing. According to Grimshaw and Fielder (2003) workplaces have over the years been modified, renewed and reshaped to suit the needs and expectations of the staff. Motivating people to work has always been a concern for managers over the years and still is (Grimshaw and Fielder, 2003). Schriefer (2005) argues that rapid innovation is essential to an organisation's survival in the 21st century competitive business environment. Furthermore, a new breed of worker is emerging who demand an environment that attracts them, satisfies their needs, and provides them with an incentive to stay. Work environments that organisations have provided historically are increasingly becoming inappropriate to emerging patterns of work and are restricting workers from performing to their full potential.

Steiner (2005) describes space planning as a continuous process resulting from dynamic organisational growth and churn as well as the emerging new work styles in modern economy. More and more organisations are adopting innovative measures to enhance competitive advantage within the workplace to in order to improve productivity. Puybaraud (2004) argues that the key to success in the workplace is through the creation of an environment that stimulates productivity and performance and establishing the right balance between working patterns. Casual business conversations are as effective as formal meetings and also results in high productivity. Morris (1999) argues that informal communication improves the possibility of doing something new and innovative. This mode of communicating also tends to stimulate employees' working capacity and make them more productive as they are engaging in a manner which they are most comfortable with.

Although advanced technology enables knowledge to be shared and disseminated more widely and rapidly, it reduces the social aspects of communication associated with working together and increases the reliance on remote leadership (Cartwright, 2003). Communication between workers via electronic media limits the collaboration and brainstorming which is perceived to be essential in non-manufacturing industries to attain productivity. Organisations embarking in this innovation of flexible working will further need to build their corporate culture of enterprise, motivation and loyalty across the various multi locations, venues and time working arrangements (Nutt, 2000). The increase in popularity of employee collaboration within the organisations has ultimately translated into increased diversity of group spaces. Corporate facilities must provide the right mix of collaboration spaces and support virtual interaction with teams of colleagues and partners (Schriefer, 2005). Modern workplace designs are encompassing more shared space and less private meeting rooms that accommodate the need for privacy or a quiet area for certain tasks (Steiner, 2005). Schriefer (2005) suggested that corporate offices should provide a variety of activity settings to meet various needs, which will allow workers to move to the appropriate spaces throughout the day. Organisations need to adjust to modern trends and lifestyle in order to attract and retain staff.

THE CASE STUDY

Descriptive Data of the Mutual Park Amenity Case Study

Old Mutual is the largest and most well-established financial service provider in Southern Africa. Mutual Park in Pinelands consists of a prestigious facility which houses the national head office of Old Mutual. This facility extends over 166 000m^2 of commercial office accommodation and incorporates a large sports facility, landscape grounds and a covered and open parking facility. Inside the building at Old Mutual is a combination of workspaces and breakaway areas known as amenity areas. The Corporate Space Design team at Mutual Park established that the revamp of the amenity areas was long overdue as they had not been renovated in twenty five years. It was pin pointed that the minimal success and utilization of these areas could be attributed to their appearance.

The Corporate Space Design team identified the amenity areas as spaces that could be upgraded to keep with the general enhancement of the work environment that would resemble their marketing strategy of “Mutual 2008, a great place to work.” Old Mutual was also seeking an outcome that would result in a system that would be beneficial to their staff as a way of retaining and attracting skills to the organisation. Moreover, Old Mutual was aiming to provide their employees with a wider variety of choice within the workplace as a way of giving back to them and showing an appreciation for their loyalty. To establish the needs of the employees, a survey was conducted in the amenity areas. The survey was done through observation of staff behaviour and asking open ended questions. These were done to establish the frequency and usage patterns of these areas as a course of action to improve these areas.

It was therefore resolved that four of the amenity areas would be renovated to suit modern trends to encourage a more interactive atmosphere for employees. The amenity areas are designed as open plan, interactive and collaborative areas to enhance communication for staff use throughout the day. The deliberate location of these spaces on the working floors provides a variety of collaboration settings and brings continuity throughout the floors. The four renovated amenity areas were designed differently in feel and visually distinctive to have their own identity. The renovations were also intentionally conducted in varying locations of the building in order to identify the one providing the most desirable outcome. Two of the renovated amenities are within workstations whereas the other two are along the smoking balconies. The objective of renovating the amenity areas is to provide places of destination in contrast to the workplace, which resembles leaving ones desk and going to an external commercial café. The amenity areas are intended to be destinations of activities and a point where planned and unplanned meetings take place. This upgrade was targeted at all employees of Mutual Park as the nature of work is predominately team work based.

A survey was initially conducted on all the twenty three (23) amenity areas to establish their strengths and weaknesses and to ascertain how they could be improved. As previously discussed, the basis of any workplace strategy is an understanding of business processes through surveys, interviews and observation of employees combined with profound knowledge of industry trends and practices (Puybaraud, 2004). It was accordingly decided that four (4) amenity areas would be renovated as testing grounds to ascertain the success of the modification. The motive of modifying the amenity areas was to create multiple use of space of getting refreshments and meeting colleagues and clients. The new amenity areas provided a self service and more private environment in response to employees' demands. The new environment also provides a modern, friendly environment with more flexible, functional and comfortable furniture. What is advantageous about these new environments is their convenient operational hours. Big screen televisions are placed at each of these amenity areas to broadcast in-house products and messages from senior management in other branches. The new revamped amenity areas are fitted with wireless technology as a means of encouraging multi-purpose and convenient use.

Limitations of the Survey

This study was limited in that it only incorporated the opinions of those who utilised the amenity areas and not the entire staff population as the surveys was conducted in the amenity areas. The surveys were conducted over a period of a week and hence excluded participants who were not present at work (Muslim staff as it was conducted during Ramadan, or those who were on leave) or were not utilising the facility over that period. It was established while conducting the post-renovation survey that there were different participants from those that were initially surveyed for the pre-renovation survey utilising the amenity areas. As a result, participants were orally requested to state whether their usage pattern was affected by the revamp of the environment. This is perceived to be a limitation in that the surveys were based on both observation approach and direct questioning of explicit information and relied to a great extent on what the participant articulated which could lead to misrepresentation of options. The post-renovation surveys were conducted immediately after the amenity areas were renovated so participants could either have not yet been familiar with the new environment or hesitant about making use of it. The only results that were presented were of those participants whose usage patterns were documented for both the pre-renovation and post-renovation survey. The total number of participants in the pre-renovation survey was thirty two (32) and similarly for the post-renovation survey.

Results of the pre-renovation survey

This section presents the results and analysis of the pre-renovation survey conducted before the refurbishment of the amenity areas. Three questions were presented in both sections of the survey. The first question was aimed at gathering information regarding the participant's current frequency of visits to the amenity area. Table 1 presents the results to this question.

Table1. How many times do respondents utilise the amenity area on a daily basis?

Frequency	Hourly	More than four times	Less than three times
Number of people	8	10	14
Percentage	25%	31%	44%

The majority of the respondents who utilise the amenity area on hourly basis or more than four times a day are heavy smokers and hence visit the amenity area on their way to or from the smoking balconies. Interestingly, the majority of the respondents prefer to utilise the amenity area only three times a day, i.e., in the morning, during their lunch break and tea break. The minimal usage patterns could suggest that employees are not satisfied with the environment.

The second question was included to establish the participant's length of stay in the amenity areas, which would reveal their comfort and satisfaction with the environment. The percentage response to this question is presented in Table 2.

Table 2. How long do participants stay in the amenity area?

Duration	Less than 10 minutes	More than 10 minutes
Number of people	24	8
Percentage	75%	25%

The results illustrate an interesting finding that the majority of respondents under utilise the amenity area. It was established that most people come to the amenity area on their way to the smoking balconies or to get their refreshments and return to their workstations.

The third question was incorporated to reveal the activity that the respondents embark on in the amenity areas. The last question asked of participants to indicate what activity they engage in when visiting the amenity area. Table 3 presents the results of this question.

Table 3. What activity do participants engage in while in the amenity area?

Activity	Take refreshments and leave/smoke	Sit and chat on a social basis	Sit and discuss work
Number of people	26	4	2
Percentage	81%	13%	6%

These results confirmed the Corporate Design Team's assertion that the amenity areas were being under-utilised and not fulfilling their intended use of providing a multi-purpose social and collaborative space to enhance communication.

Results of the post-renovation survey

This section presents the results of the post-renovation surveys after strategic and interior design took place at the amenity areas in Mutual Park. This section is also comprised of the three questions used in the first section of the survey. It was established while conducting the post-renovation surveys that majority of the respondents did not take part in the initial survey. This reflects the fact that different people are making use of the amenity area and the possibility that these areas are attracting more people. In response to the first question that dealt with the frequency with which respondents visit the amenity area, it is clear from Table 4 that there is an overall increase in the use of the amenity areas (72% in total) as compared to the usage patterns before the renovations. Respondents showed a positive response to the modified environment.

Table 4. How many times do respondents utilise the amenity area on a daily basis?

Frequency	Hourly	More than four times	Less than three times	Seldom
Number of people	5	18	7	2
Percentage	16%	56%	22%	6%

A notable difference was detected in the results to the second question on how long the respondents stay in the amenity area. The results of the usage pattern and duration of the stay in the amenity areas on the internal floor (1st and 2nd floor) differed from those in the amenity areas along the smoking balconies (3rd and 7th floor). Therefore to best represent the results, the responses from these floors were dealt with separately and are depicted in the Table 5 and Table 6 respectively.

Table 5. How long do participants stay in the amenity areas on the 1st and 2nd floor?

Duration	Less than ten (10) minutes	More than ten (10) minutes
Number of participants	2	14
Percentage	12%	88%

The results illustrate an interesting finding that majority respondents seem to favour the modified environment. Previous studies by Morris (1999) have demonstrated similar results. The fact that more and more people are making their way to these social spaces and actually staying there for some time allows for unanticipated conversations which permit creative idea sparking opportunities which would have otherwise not occurred efficiently in other workspace environments. This point is further emphasised by Morris (1999) in stating that informal communication improves the possibility of doing something new and innovative.

With reference to Table 6 (3rd and 7th floor amenity areas along the smoking balconies), it is clear that these amenity areas are the most under utilised of all amenity areas even after the renovations. This is in contrast to what was reported in the literature by Morris (1999) that new performance work environments support more frequent and more spontaneous interactions that lasted three times longer and occurred twice as frequently as those in traditional environments. Employees find amenity areas in these locations unwelcoming and unsuitable for relaxation. Non-smokers find environments of this nature unbearable because of the smoke.

Table 6. How long do participants stay in the amenity areas on the 3rd and 7th floors?

Duration	Less than ten (10) minutes	More than ten (10) minutes
Number of participants	10	8
Percentage	56%	44%

Once again a notable difference was observed in the activities undertaken by the respondents from the amenity areas on the internal workspace and those along the smoking balconies. The modified amenity areas on the internal working spaces are arguably the most successful in terms of encouraging collaboration as opposed to just taking refreshments and leaving. Participants were observed to be collaborating with colleagues on both a social and business level. The literature supported this finding in suggesting that revamping communal areas appeals to employees to an extent that they spend more time collaborating with colleagues as opposed to taking their refreshments and going back to their respective workstations (Wanjek, 2005). It is also worth noting that the two participants who reported "taking their refreshments and leaving" stated that they did so because their work demands did not permit them to take long times away from the desk. Participants were also observed to be taking advantage of the wireless internet connections placed in these areas. The modified areas are also conducive to entertaining clients and conducting semi-formal meetings as the open-plan workspaces available to these employees do not offer the same degree of privacy that is available in these areas.

CONCLUSION

There is a radical shift in the usage patterns between these two surveys. The activities conducted in these areas have almost reciprocally swapped. The results suggest that the modified amenity areas are attracting more people than they were before the revamp. It was also apparent that people are utilising the amenity areas more frequently. It is clear from the results of the post-renovation survey that the Corporate Space design team's task of creating an interactive environment where employees interact as opposed to just obtaining their refreshments and returning to their respective workstations was achieved. There is a sharp shift in the duration of time spent by the participants in the amenity areas before renovation and that spent in the amenity areas on the internal workspaces. This suggests that participants are more comfortable and motivated to stay in the amenity area for a longer period of time. It can be concluded that the modified environment provides an improved work-life balance needed in corporate buildings.

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REFERENCES

Cartwright, S. (2003), “New forms of work organization: issues and challenges”, Leadership and Organizational Development Journal, Vol. 24 No 3. pp 121-122.

Grimshaw, B., and Fielder, I. (2003) Flexible Working UK Survey 2003. Faculty of the Built Environment, University of the West of England, available at: http://www.environment.uwe.ac.uk/fi/.

Morris, L. (1999), “The Link Between Facility Design, Organization Design and Corporate Design”, New York.

Nutt, B. and McLennan, P. (2000), “Facilities Management Risk and Opportunities”, Blackwell, Oxford.

Puybaraud, M. (2006), “The Flexible Working Survey 2005 Four Years of Learning Summary Document”, Facilities Innovation Programme, University of England, available at: http://www.facilitiesinnovation.co.uk.

Schriefer, A. (2005), “Workplace Strategy: What it is and why you should care”, Journal of Corporate Real Estate, Vol. 7 No 3, pp. 222-233.

Steiner, J. (2005), “The art of space management: Planning flexible workspaces for people”, Journal of Facilities Management, Vol. 4 No. 1, pp. 6-22.

Wanjek, C. (2005), “Workplace solutions for malnutrition, obesity and chronic diseases”, International Labour Office, Switzerland, pp448.

OPEN PLAN AND ACADEME: PRE- AND POST-HOC CONVERSATIONS

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ABSTRACT

There now exists a strong body of evidence that creative workplaces can, in certain circumstances, exert beneficial influences on organisational cultures and outputs. Academia tends to resist such spaces and faculty buildings. The reasons are explored but the reactions of staff are not found to be different from those reported in the literature on general creative spaces. The success or failure of team oriented workspaces is in large part a socially constructed perception influenced by the manner of implementation and management. As elsewhere new workplaces are about new conversations. The cases studied lead to a model of the tensions inherent in workplace redesign.

KEYWORDS: workplaces, academia, change, case study

NOTE TO READERS

This paper is abridged from a longer manuscript reviewed for the conference but not reproducible within the constraints of the conference proceedings. A full text version can be obtained from the authors.

INTRODUCTION

The term 'open-plan' covers a considerable range of workplace designs from the rectilinear grids of high walled 'Dilbert' cubicles to a variety of more creative, flexible spaces. There are cases where the latter at least have been shown not only to be more efficient – to consume less physical resource per person accommodated – but also to be more effective with a significant difference in perceived productivity or occupant satisfaction and in some cases to tangible and intangible organizational outcomes. Other studies report the opposite; increased stress and turnover and less saving of space than anticipated as utilization efficiency deteriorates. (references below). For many office based workers in the UK the *'State Of The Office*' (Nathan and Doyle, 2002) remains poor. The potential contribution to business outcomes is not appreciated by the management concerned. People simply settle into their workplace. Most office buildings remain inefficiently occupied; at a direct cost to the economy of several billion pounds (Bootle and Kalyan, 2002).

Bootle and Kalyan contrasted average occupation densities of 15 m^2 or more Net Internal Area[2] (NIA) per full time staff member (FTE) working from an office with the upper quartile

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[2] It is important to consider buildings as a whole to include shared areas, meeting spaces and other amenities, rather than to look at templates for individual workstations.

of UK corporate offices. Those achieve densities of 10 to 12.5 m^2 per FTE; a figure which unpublished data held by FMGC suggest is conservative even in head office environments. Equivalent data in university environments are harder to come by. The sector as a whole suffers from the prevailing FM, and property supply industry, emphasis on measuring cost per unit area of space rather than seeking evidence of effectiveness and outputs. Current research in FMGC (Matzdorf and Price, in progress) is seeking to overcome this barrier by applying Lean Asset™ (Price, 2007) to benchmarking comparable departments. The concept derives from an argument that businesses of various types need to consider what is produced from the space they utilise rather than simply what is consumed to provide that space. Occupation densities and user satisfaction provide such measures (Pinder and Price, 2005) and universities or particular departments can also be compared on the income they generate per unit area of NIA[3]. Preliminary data suggest that even Business Schools, which tend to earn higher incomes per m2 than more space consuming subject areas do not achieve overall occupation efficiencies approaching those of the best corporate or governmental office buildings. To date 20m^2 per FTE[4] is a good relative figure. At least part of the explanation is likely to result from the persistence in academic departments with cellular office designs and a high proportion of individual offices.

The current study sets out to examine why that relative inefficiency might exist and to see whether it is inevitable, or indeed justifiable. We begin by examining the general literature on workplace designs and productivity then summarise otherwise unpublished research in HE environments drawn from dissertations by MBA students working in FM at various universities. We then test examples of more innovative space use in academic and none academic environments within one institution, Sheffield Hallam University (SHU).

The study was commissioned by the university's own Facilities Directorate and was intended to inform the future development of space management practice within the institution. It was however a condition of the study that it be conducted with due academic independence and rigour and be submitted for publication via peer review. The university has achieved a reputation within the sector for efficient space utilisation (Anon, 2006). Research into undergraduates' choice of where to study (Price et al. 2004) suggests factors related to SHU have a higher than usual impact on that choice and income per m^2 calculations (Pinder and Price 2005) also reveal a performance that is 'better' than many other comparable 'new' universities. This study seeks to contrast its space provision with what is revealed from research in other 'knowledge-based' organisations.

LITERATURE REVIEW

The review covers the following but has been abridged to major conclusion.

Surprisingly there is no absolute consensus in the literature as to where the boundary should be drawn between enclosed or cellular offices and 'open plans'.

[3] Data Envelope Analysis is used to allow a weighting to different income streams.

[4] Excluding centrally timetabled space

Figure 1 View of typical Burolandschaft Office (Sundstrom, 1986). Note the desk and chairs for visitors

Figure 2.6. A typical *Burolandschaft. Source*: Photograph courtesy of Frank J. Carberry, managing director, Office Landscape Users Group, Philadelphia.

In both the USA and the UK the cellular office came to be a symbol of status or organizational power (Vischer, 2005) with nuances that were often finely drawn and rigidly enforced. An early challenge to such post war cellular designs arose with the *Burolandschaft* movement of the1960s which sought to introduce openness and landscaping. Despite such a claim a striking feature of such designs is that the desk, or at least the executive desk, is treated as a station which visitors would approach. The signs can be overt (Figure 1). Privacy crept back in and the 'organic landscape' evolved to the rectilinear open plan (Sundstrom, 1986). The combi office, a series of equally sized cells spaced around a shared core area, was originally introduced in Scandinavia as an early exercise in workplace democracy (Van der Voordt, 2003) and status free space. Whether that goal was ever fully achieved is not clear.

The arrangement of buildings and their interior spaces to serve as symbols of power and status may have deep historic roots in palaces and fortifications. Anthropological evidence from a transition from hunting and gathering to pastoralism among the Kalahari ‘bushmen’ has claimed to see a parallel increase in enclosed, territorial, space (cited in Hurst 1995) as if with possessions comes an instinctive desire to screen them. Offices, some would argue, continued that tradition. Equally historical architecture confirms the role of common spaces, the agora, great hall, market or forum where at least the members of a society who had sufficient power could mingle and interact. Critical theorists have sought to interpret such moves as a response to market forces with more democratic workplaces interpreted as a response to the laws of supply and demand in the labour market for skilled knowledge workers (Baldry, 1999) and seen the adoption of uniform designs as another form of managerialism and overt control of the workforce. Alternatively some organizations have seen ‘expressive’ open workplaces, and even, *space by need not status,* as a positive cultural lever to attract the staff they seek and foster greater agility. The argument between those who would see such developments in a positive light and the critics ultimately becomes epistemological and axiological even though, curiously, both proponents and critics of the managerial use of space as a lever could be said to be implicitly agreeing that it is a lever. Less extremely spaces and symbols have been seen as a manifestation of organizational culture (Schein, 1999) and as impositions of solutions without regard to the organizational context, hence Cairns and Beech;'s (1999) *"organisational flexibility or individual straight jacket"*.

Facilities Management professionals, trained to deal in the concrete realities of buildings, furniture and projects can find such considerations and the reactions of users as, at best, an irritant, and at worse a major obstacle which they perceive needs overcoming. Balanced examinations of what are frequently polarized discussions are hard to find, hence the importance of in depth work by Donald (1994). He interviewed FMs and users over a period of 18 months in three different corporate offices in South West London, each of which had seen major relocation projects and concluded with a comment that was ahead of it's time

> It is evident from the research here that while the actual physical characteristics of the environment are of great importance, no matter how good they are, the rules and processes of their management can prevent them fulfilling their potential. This has been a relatively exploratory study of these processes. Further empirical research is required to understand them more fully.

Absent from Donald's research, and many other studies, is a consideration of the business rational behind a new workspace. In one of the first comprehensive studies of new 'open' workplaces Becker et al. (1994) distinguished cases that were primarily business driven (i.e. they were designed to achieve a business result) from those that were primarily cost driven (i.e. they were unlikely to have happened without a pressure to reduce cost by increasing occupation density). They found a very significant and large, positive difference in the average satisfaction with the result in the former as opposed to the latter and a greater commitment to involving users in the process of workplace development versus selling them a template solution. The theme of business pull or cost push appears in other studies of successful new workplaces especially two reviews of central government experience in Canada (La Framboise et al., 2003) and the UK (Allen et al., 2004). A second series of case studies conducted by the Cornell workplace programme (Becker and Sims, 2001) makes the same point and correlates more creative designs with business intent rather than simply an FM solution.

When implementing or discussing work place change it is not uncommon to encounter statements such as *"research has shown open plans don't work*". Protagonists of that view are prone to cite (Kupritz, 1998) who found that privacy problems were found to be perceived very negatively in two engineering departments or Brennan et al.'s (2002) claim to have found evidence to favour "traditional" as opposed to "open" office design. Occupants reported increased physical stress, poorer team member relations, concerns at confidentiality and perceptions of lower perceived performance. Both studies researched rectilinear cubicle designs, with cubicle size, in the Kupritz example allocated by status. Brennan et al.'s longitudinal study of a move to the latter highlighted significant dissatisfaction with what on examination turns out to be cubicles either for 4 or 10 plus arranged in a classic rectilinear pattern (over ordered). The research did not appear to examine the change management process but implies an imposed solution[5]. A wider evidence based argument stems from the North American work of BOSTI[6] Associates (Brill et al,. 2000). What is unclear is whether they are reflecting the views of managers who still enjoy such offices and staff in cubicles.

The same dilemma is posed in an exhaustive review by Heerwagen et al. (2004) who et out to consider the process in a modern office and ask how designs might enhance collaboration without compromising individual productivity thus addressing what they term *"the central*

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[5] The lack of compensating working protocols is mentioned in passing.

[6] Buffalo Organisation for Social and Technological Innovation

conflict of collaboration"; how to balance the need to interact with the need to work individually. Their starting point was to consider studies of what 'knowledge workers' actually do, drawing on research which has considered organizational behaviour but not asked whether a physical setting can influence it. Three dimensions to collaboration are identified: awareness (the response to the activities of others in the work environment), brief interactions and actual collaborative work (involving more sustained interaction). The review seeks to establish the organisational needs that favour demand for each dimension as a guide to framing consideration of the suitability of particular spatial configurations. High awareness, it is suggested, is needed in environments seen being dynamic with a high sense of urgency[7].

RESEARCH CASES

The longer paper presents cases demonstrating the following:

- In one UK University the senior managers had, due to a critical incident, been moved into shared open plan space. They maintained the arrangement seeing it as positive, until a newly appointed VC asked for his own office.

- In a survey of academic staff at a red brick University in the North of England **79% reported that the provision of a cellular office formed part of their contract with the University**. HR confirmed that no member of the University had such a clause in their contract. There were nonetheless some members of the research population working in shared space who were positive about it. e.

- Another study at a red brick University in the North of England, explored postgraduate research students' perceptions. The expectation of one desk per student is projected into a post doctoral expectation of one's own office.

- A negative reaction based on historical perceptions and inertia to an opprtunity to improve working environments.

- A positive development, despite initial FM scepticism of a combined cafe bar, informal meeting area and student reception.

- A positive post occupancy reaction from academic staff relocated into the authors' previous office which had been designed as an exemplar space.

- In contrast to the prevailing views revealed by the MBA projects described above the evidence would seem to be that 'team oriented bull pen offices' (to use Becker and Sims' 2001 terminology) can work and be appreciated at least in certain academic environments.

- A comparison of one teams experience of three different open locations

- A school deliberately mixing members of different subject groups between offices in order to promote more informal cross professional exchange.

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[7] An observation which may explain resistance to moves from cellular offices in some sectors!

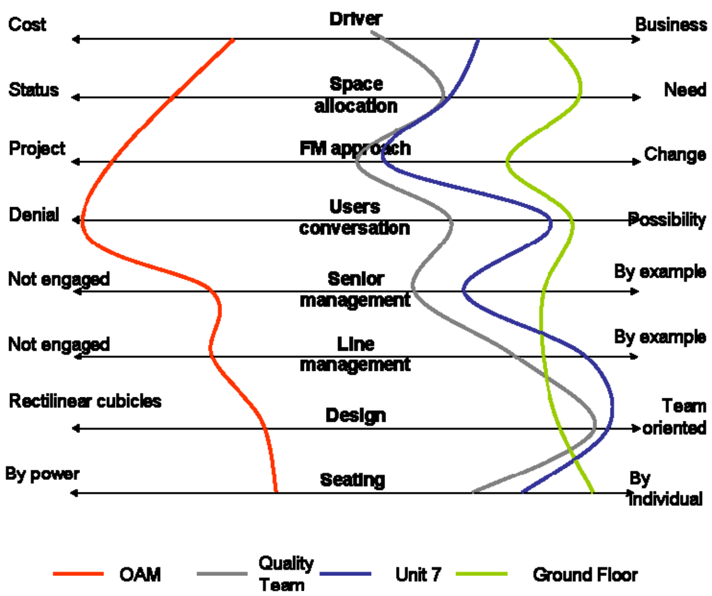
DISCUSSION AND CONCLUSIONS

In general the observations on universities in general and the SHU specific case studies reveal and re-enforce the lessons that can be found in the literature. One intriguing possibility is suggested by Case 1. The traditional route into academia via postdoctoral or research associate positions may influence perceptions of space that develop into a widely held view that dedicated space is, if not a formal contractual right, part of the informal psychological contract between an individual member of staff and their university. The view seems to prevail up the order to the vice chancellors who responded in Case 3 though the same case illustrates that a group at such a level forced by circumstance into an open configuration found it positive.

More generally the cases reveal the various tensions or dichotomies (Figure 4) found in the literature, in the projects above and in the author's experience. The fields on figure 4 are not in any sense independent of one another but they do suggest axes on which different projects can be mapped[8]. 'Open' office arrangements that have been favourably perceived tend towards the right hand side of the figure. They have been developed with a business objective and a determination to avoid 'space by status'. They have been implemented by change management rather than simply a project, succeeded in being seen as an opportunity f not a threat or the users (a change process in itself). They have had at least local if not senior managerial support and probably reflect a 'modern' managerial style, or at least one that recognises that an unseen employee is not an idle one. There is growing evidence that the designs which work owe more to thinking about social learning spaces than to traditional space planning and they recognise that not only does work vary but so do individual psychologies and responses.

[8] It would be interesting but beyond the scope of this project to see if a scale could be devised for any of these axes.

Figure 2 The tensions in open plan layouts related to the four case studies presented here. Scaling is qualitative but the more a case fits the right hand side of the diagram the higher the reported success.



Running through all the cases is the degree to which perceptions of space become part of the socially constructed 'reality' of an organisation declared into existence and re-enforced by generally tacit, and taken for granted, assumptions. Where the underlying managerial approach is also geared to traditional hierarchies newer spaces find it hard to win approval and can revert as occupants recreate physical expressions of traditional structures.

The project orientated world of FM and the ongoing need for active management of space can lead to misunderstandings. Ultimately however the cases examined suggest that in universities as elsewhere space and the way it is perceived reflect the cultural patterns and assumptions of those who occupy it. There is nothing in the research to establish a particular case that academic institutions differ in this regard from other organisations.

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REFERENCES

Anon, (2006), *Promoting Space Efficiency in Building Design*, Bristol, HEFCE Space Management Group

Baldry C. (1999), Space - The Final Frontier, *Sociology*, 33, 3, 535-553

Becker F., Quinn K. L., Rappaport A. J. and. Sims W. R., (1994), *Implementing innovative workplaces - organizational implications of different strategies*. Ithaca NY Cornell International Workplace Studies Program

Becker F. and Sims, W.R., (2001), *Offices that work: balancing communication, flexibility and cost*. Ithaca NY Cornell International Workplace Studies Program

Bootle R. and Kalyan S. (2002), *Property in business - a waste of space?*, London, RICS

Brennan A. Chugh J.S. & Kline T. (2002), Traditional Versus Open Office Design: A Longitudinal Field Study, *Environment and Behavior*, 34, (3),. 279-289

Brill M., Weidemann S., Olson J. and Keable E., (2000), *Disproving Widespread Myths About Workplace Design*, Buffalo, Kimball International

Cairns G. and Beech N., (1999), Flexible working: organisational liberation or individual straitjacket, *Facilities*, 17 (1/2) 18-23
Donald I., (1994), Management and change in office environments. *Journal of environmental psychology*, 14 (1), 21-30.
Heerwagen J. H., Kampschroer K., Powell k. M. and Loftness V (2004), Collaborative knowledge work environments, *Building research & information,* 32, 6, 510-528.
Hurst D. K. (1995), *Crisis & Renewal : Meeting the Challenge of Organizational Change,* Cambridge MA, Harvard Business Press..
Kupritz V., W. (1998), Privacy in the work place: The impact of building design. *Journal of environmental psychology*, 18 (4), 341-356
La Framboise D., Nelson R. L. and Schmaltz J. (2003), Managing resistance to change in workplace accommodation projects, *Journal of Facilities Management*, 1 (4), 306-321.
Matzdorf F. and Price I., (in progress), *Benchmarking income and occupancy in university departments*
Nathan M. and Doyle J., (2002), *The state of the office - the politics and geography of working space*, London, The Industrial Society
Pinder J. A. and Price I., (2005), Application of data envelopment analysis to benchmark building outputs, *Facilities*, 23 11/12 473-486
Price I., (2007), The Lean Asset: New language for new workplaces, *California Management Review*, 49, (2) 102-118.
Price I., Matzdorf F., Smith L. and Agahi, H. (2004), The impact of facilities on student choice of university, *Facilities*, 21, 10, 212-222
Schein E., (1999) *The Corporate Culture Survival Guide,* San Francisco, Josey Bass
Sundstrom E. (1986) Work places: The psychology of the physical environment in offices and factories, New York, Cambridge University Press
Van der Voordt D.J.M., (2003), *Costs and benefits of innovative workplace design* TU Delft Centre for People and Buildings
Van Veel J. and Vos P., (2001), Funky offices: Reflections on office design in the 'new economy, *Journal of Corporate Real Estate,* 3, 4, 322–334.
Vischer J., (2005), *Space meets status: Designing workplace performance,.* London, Routledge.

BETTER STRATEGIC PROCUREMENT FOR MAINTAINING SCHOOLS: AN AUSTRALIAN CONTEXT

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ABSTRACT

At the end of 2005 a school buildings maintenance audit in the state of Victoria. This audit provided details of the condition of all building elements, many sub-elements, external works and services for all government schools, together with an assessment of any immediate future works that may be required to maintain the facilities in a serviceable condition to allow them to function effectively. The results highlighted the need to develop better models for organizing maintenance in the future to reduce the steadily increasing backlog starting to accumulate in all schools across the system.

This paper provides contemporary definitions and reviews of maintenance and procurement and identifies trends and benchmarks for maintenance in school buildings. The final key section of the paper considers a range of potential maintenance procurement strategies from low risk, little change to more radical approaches using a facilities whole life approach and public and private partnerships.

KEYWORDS: Maintenance; procurement; school buildings.

INTRODUCTION

Clients or practitioners involved in the care of buildings and facilities recognize that the organization and delivery of maintenance is important if it is to be carried out in an effective and timely manner. However, in many organizations it is deferred, ignored or just forgotten until it becomes an urgent matter where action is demanded due to failure or breakdown.

In common with many client organizations with a large portfolio of properties the Department of Education and Training in Victoria, Australia, is developing strategic models for better managing the maintenance in its schools. To gain an appreciation of the maintenance task it faces the Department has nearly 1,700 primary and secondary school campuses spread across the state and in the Melbourne metropolitan area, covering an area approximately the size of the UK. Identifying and organizing the maintenance of the buildings and the grounds on these schools is a large and complex task. At the end of 2005 a school buildings maintenance audit in the state of Victoria involved three principal contractors, 52 individual auditors inspecting 6.8 million square metres of floor space in 26,600 buildings. The maintenance audit was completed by mid-2006.

The results highlighted the need to develop better models for organizing maintenance in the future to reduce the steadily increasing backlog starting to accumulate in all schools across the system. This paper summarises the potential procurement strategies for managing maintenance in the whole range of its school buildings. It begins with the basic definitions and types of maintenance and then reviews the various approaches that a range of authors have suggested for this environment.

Benchmarks for Maintenance in Australian Schools

The National Public Works Council[1] (NPWC) (1993) *Predicting Schools Maintenance Costs* is a study that suggests, 'The conclusions from this study show that there is no "mythical" percentage which can be applied Australia wide to assess the level of funds required for the maintenance of schools. There is, however, a range of percentages, which reflect the differing design criteria, maintenance approaches, age and condition of school assets, geographical and environmental factors'.

A model was developed that, '… identified technical activities that have to be undertaken in order to keep a building adequately maintained over the long term (100 years), when they are needed, and what they should cost, given current expectations as to the levels of service provided' (NPWC, 1993:3). Using the NPWC (1993) model the '…average estimated funding requirements for the period 1991 to 2010 ranged from 0.9% to 2.8% of the building replacement value. The results have been summarized in (the Report's) Figure 1.

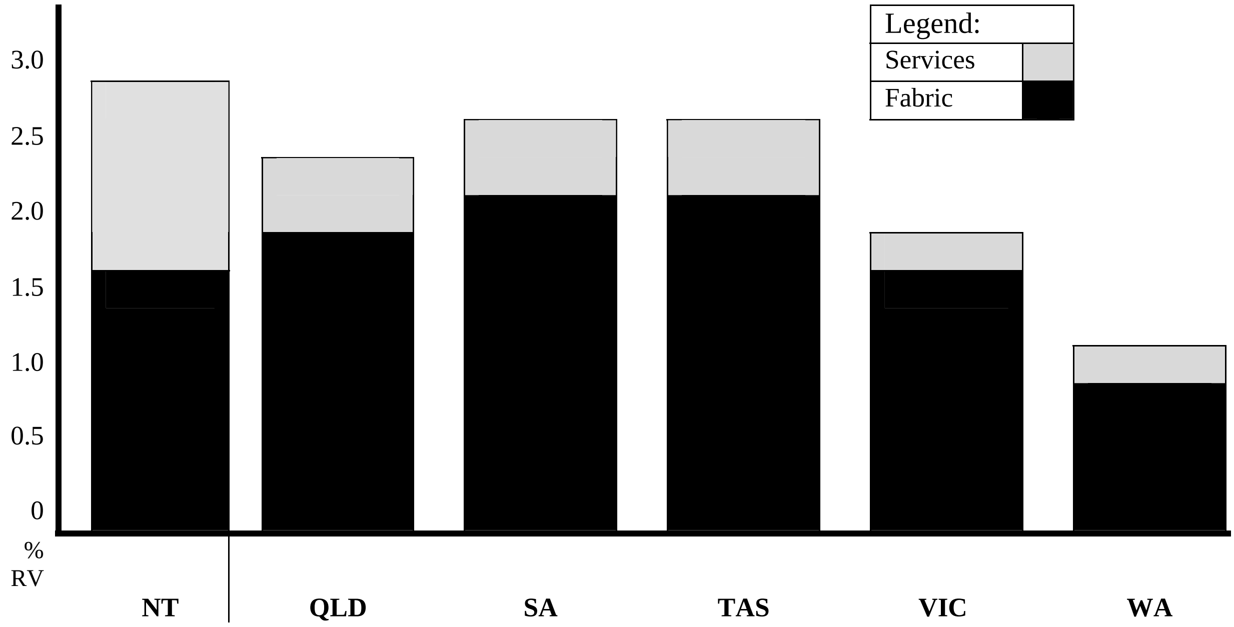
These statistics demonstrate the levels of expenditure that should be required to maintain the schools in each such environment'. So, for instance, Western Australia had the lowest requirement for maintenance to the building fabric at 1% of the replacement value of the school and Tasmania and South Australia as having the largest requirement for fabric maintenance at around 2.25%. The funding requirements for services maintenance is lowest in Victoria and Western Australia at around 0.25% with the Northern Territory with the highest need of around five times greater at around 1.25%. With Victoria being the focus of this work it is interesting to note that Victoria is shown as with an estimated annual maintenance requirement from 1991-2010 of 1.75% of replacement value for the fabric of the Buildings. That is, the second lowest of any states analysed.

The Report was realistic about gaining adequate funding for maintenance and also sounded an ominous warning if the states were unable to properly fund or neglect the maintenance needs of its school buildings (NPWC, 1993:2):

> The implications of the funding that the results showed to be required in order to keep their schools facilities at the intended level of service should be reviewed by the Authorities. Judging by recent experience elsewhere, it is probable that the required levels of funding will prove to be higher than recent budget allocations. If so, the implications are:
>
> (a) an opportunity to present better cases for more appropriate funding, or
> (b) to accept:
> - a build-up of maintenance backlogs, adding to future funding needs;
> - a wastage of assets which, though not always brought to account is none the less real, and
> - a decline in the service provided by schools buildings.

[1] The National Public Works Council (NPWC) was founded in 1967 and became the Australian Procurement and Construction Council Inc (APCC) in the mid-1990s. The APCC has established itself as a national reference point for both government and industry on best practices, principles and emerging issues in procurement, construction and asset management disciplines.

Figure 1 Estimated Annual Maintenance Requirements, 1991-2010, Six Authorities



Source: Adapted from NPWC (1993) *Predicting Schools Maintenance Costs*, page 3.

Legend
- (% RV = Percentage of Total Replacement Value)
- NT = Northern Territory; QLD = Queensland; SA = South Australia; TAS = Tasmania; VIC = Victoria; WA = Western Australia.

In the UK, Spedding (1992) is one of the few authors to document maintenance and capital cost s of schools. In his research paper, he notes that when comparing maintenance costs, 'Changes in intensity of use and long term under funding of maintenance in many counties means that the consequences for maintenance and running costs are significant. The fact is that buildings built for, say, 240 pupils frequently had to accommodate many more pupils at the height of the boom, thus increasing wear and tear at that time, and buildings intended for at least double that number may have less than half. Therefore, the expression of maintenance costs, as costs per pupil cannot, in many schools, be considered as a simple relationship. Similarly, the expression of cost related to area is likely to be flawed' (Spedding, 1992:5).

Table 1 shows the cost of a 5-year program of building maintenance averaged to 1980 prices per annum for 60 typical schools, sampled in proportion to their relative numbers in a county council's stock of buildings.

Table 1 UK Schools: Maintenance Costs per annum

	Number in Sample	**Average cost per annum £ (1980 Prices)**		
		Per School	Per Pupil	Per sqm
Primary Schools	50	£ 3,239 (=A$7,874)	£ 17.80 (=A$32.72)	£ 3.10 (=A$7.44)
Secondary Schools	10	£ 22,377 (=A$53,605)	£ 21.30 (=A$51.12)	£ 2.60 (=A$6.24)

Note: Exchange rate of 1£ = A$ 2.40 used.

Spedding commented on the wide gap between the maintenance costs per annum *per school* with, '… the maintenance cost expressed as per school shows that primaries cost, on average, one-seventh of secondaries. The figures show less variation between costs per pupil in that primaries cost over three-quarters of the secondaries'

However, for the other unit comparisons the range was not so large. For instance, in 1980 prices the schools' authorities maintenance unit spending *per square metre* was around £2.60 to £3.10 per square metre per annum for primary and secondary schools (= A$6.20 to A$7.40 per square metre). The building cost indices in the UK have risen +150% for the period 1980 to 2006 and in Australia by +340% in the same period. Taking the lower percentage (+150%) these costs per square metre on present date prices would be in the region of £6.50 to £7.75 (= A$15.50 to A$18.50) per square metre per annum.

The Scale of Schools' Maintenance in Victoria

A critical factor in assessing the type and extent of maintenance on each school property is the management and updating of the Department's schools property database, *Schools Maintenance System (SMS).* The assessment of the condition of schools is carried out by the updating of this database by periodic audits. Audits were completed in 1997/98, 2000/01 and most recently at the end of 2005. These audits provide details of the condition of all building elements and external works for all government schools, together with an assessment of any immediate future works that may be required to maintain the facilities in a serviceable condition to allow them to function effectively.

An independent experienced inspector familiar with maintenance work and activities carries out the audit. The auditor works closely with the regional offices and schools, but the assessment is an independent one where they are required to identify works and priorities in accordance guidelines published by the Department in its *Schools Maintenance System (SMS): Maintenance Assessment Guidelines* (August 2005), prepared by Sinclair Knight Merz Pty Ltd.

The costs for maintenance work identified by the audit are automatically costed by the Physical Resource Management System (PRMS). A schedule of rates assesses the costs of repair, rectification or replacement works for all the common maintenance items. These costs have been assessed on a consistent basis by a firm of professional quantity surveyors and these estimates are integrated into the software to automatically price or cost each maintenance item on the database.

Thus, at the end of the audit the system can provide detailed costings of each maintenance item within a school and integrated costings for a region and the whole state broken down into elements and condition, priority classifications and other categories, if necessary.

Results of the 2005 Maintenance Audit

After the audit was completed in late 2005 the Department was able to use the audit results in the Department (DEET, 2005) in its *Schools Maintenance System (SMS),* which was integrated with *School Asset Management System (SAMS).* The standard costings provide data, statistics and detailed cost analyses based on the following major variables or criteria:

- All Building elements
- Condition (Poor, Worn, Fair) and priority (A, B, C, D)
- Planned work and Unplanned/Ineligible work
- Specialist work

The audit data has allowed various and detailed analyses to be carried out, but these cannot be included in this paper. The total of all three categories of maintenance (Poor, Worn, Fair) under the four condition categories (A, B, C and D) were evaluated in the 2005 audit (with an early 2006) review update of $250 million.

Managing Maintenance in the Future

To overcome this maintenance backlog requires an approach that will address the problem whilst delivering a good value technical and financial solution. Aggregating the maintenance items that need attention, using the data collected by the maintenance audit and placing them in appropriate packages of work that will attract keen competition and innovation is the challenge facing the Department or any other organization with a similar problem. There is a need to develop an approach that will reduce the present level of maintenance and to ensure that future levels of funding and procurement do not allow the maintenance situation to deteriorate to the levels we presently see in the system.

Grouping of work rather than tackling each individual item of work should bring benefits of continuity of work, economies of scale and gaining the skills of a better organized maintenance contractor. Nevertheless, organizing and managing maintenance on this scale is difficult task. Wood (2003:71) has recognised the problems of maintenance procurement, ' … because of its inherent uncertainties in terms of scope and scale of work, the unpredictability of when emergency work may arise and complications of access, often involving disruption to occupants and their operations, contract arrangements have often been looser.'

Maintenance Management Models

The present system of maintenance in schools in Victorian schools has been manifestly under-funded and has resulted in a massive backlog of poor condition maintenance items as demonstrated by the audit survey conducted in late 2005. School maintenance in Victoria has all the characteristics of deferred maintenance, where insufficient funds are made available.

In common with many organizations the Department must make inroads into the maintenance backlog that has now been identified by considering new funding and organizational maintenance models that will prevent this situation arising again. However, there must be an injection of funds into schools maintenance to overcome the backlog that has developed over decades. In the immediate future, there will also be a need for greater funding than the present model to at least keep pace with the accruing maintenance in all schools. In addition to this commitment it would be necessary to review the methods and arrangements used to deliver maintenance and related services to schools. That is, rather than consider it purely as a maintenance function, the Department should be organizing maintenance as a facilities management service more aligned to the type of integrated service described earlier.

Following the guidance given in the NPWC (1993) *Predicting Schools Maintenance Costs* Report given earlier to demonstrate the levels of annual expenditure that should be required to maintain the schools then a percentage of 1.75% of the replacement value should be applied *Victoria.* With an estimated buildings replacement value from the Department of around $10,000,000,000 ($10 billion) then an annual figure of $175 million ought to be spent on maintenance. On present maintenance assessment values from the 2005 audit such a figure would clear all Poor and Worn condition maintenance items from all schools ($115 million) and still have $35 million to make considerable inroads into the third level of maintenance items in the ‘Fair’ category of maintenance. To clear all these items of maintenance would place schools and the Department in a good position to develop a better strategic approach to ensuring such a backlog of maintenance did not occur again.

Making Progress Towards Better Strategic Models of Maintenance in Victoria

The message from the material presented is that with present levels of funding the Department is not clearing its maintenance backlog through its corrective (unplanned) maintenance approach. In fact, with present levels of funding maintenance levels will continue to increase as the existing school building stock ages and new schools are added to the stock. In addition, new school buildings are being added to the building stock, but the Department is not replacing existing schools (particularly those in poor condition) quickly enough. The value of all maintenance will continue to grow and more items will be added to the ‘Poor’ category as the ‘Fair’ and ‘Worn’ Categories deteriorate through lack of attention. Therefore, the present method of funding maintenance is unsustainable and maintenance will have a negative impact on the function and performance of activities within Victorian schools.

It should also be noted that a reasonable proportion of the capital works, especially that part providing renovations, extensions and upgrading of existing schools in effect is removing many maintenance items from the schools receiving these capital works. The Schools Resources Division assess the proportion of capital works that goes into rectification and maintenance works of this kind as in the region of 15-20% of the capital works budget. To accurately calculate this figure a study is needed that investigates and analyses a sample of these types of renovations and extension works to existing schools to verify the type and extent of maintenance work in such projects.

Conclusion

Victoria has investigated new maintenance approaches and anticipates its program as an integrated facilities management service providing building care on the model espoused by Wood (2003) with his JIT approach to maintenance and customer service. Whilst Wood envisaged his model to be more likely to be adopted by the corporate sector, authorities such as Victoria included it as a strategy for its schools sector, adopting world’s best practice.

Progress toward this model will probably have to be achieved in stages, with the most critical stage being the clearing of all significant maintenance items under the Poor Condition category and many of the Worn category as well. This then provides a new base for the development proposed in Figure 2. This Figure shows the spectrum of development from the existing status quo situation, to overcoming the backlog of maintenance with an injection of new and significant funding. Then the schools system has the ability to proceed to the next stage, regional organizations for maintenance and possibly a broader inclusion of facilities management. Progress towards Wood’s JIT Building Care model then becomes feasible where maintenance is seen in the broader perspective of customer or community service, probably still based on the regional model it supplants. Finally, the strategic partnering for new schools and their care is at the upper end of the model and these building would become the responsibility of the regional or building care models as appropriate.

REFERENCES

Australian Procurement and Construction Council Inc (2001) *Asset Management*, APCC, Canberra.

Department of Education, Employment and Training, Victoria (2005) *Physical Resource Management System (PRMS) Maintenance Assessment Guidelines*, August 2005, developed by Sinclair, Knight and Mertz, Melbourne, Australia.

National Public Works Council (1993) Predicting Schools Maintenance Costs, NPWC, Canberra.

NSW Department of Education and Training (November 2003) *Schools Asset Maintenance Task Force: Focusing on Educational Outcomes*, Final Report.

Spedding, A (1992) Schools' Design and Maintenance in England and Wales, Construction Papers, No 5, The Chartered Institute of Building, Ascot, UK.

Wood, B (2003) Building Care, Blackwell Science, Oxford.

Wood, B (2005) Towards Innovative Building Maintenance, *Structural Survey*, **23** (4), pp. 291-297.

Figure 2 PROGRESSION TOWARDS BETTER MODELS OF MAINTENANCE AND FACILITIES MANAGEMENT

SPECTRUM OF POTENTIAL MODELS						
LESS CHANGE						**MORE CHANGE**
Status Quo	**Increased expenditure with minor organizational change**		**Clustering Schools for Maintenance**		**New Approaches:** **Just-in Time Building Care**	**Public, Strategic and Private Partnerships**
CHARACTERISTICS						
Focused on Corrective Maintenance	Focused on Maintenance	Direct Funding to Schools	Direct Funding to Schools Potential for Facilities Management	Department Directed Condition Based Maintenance	School Core Business (Facilities Management With Building Care)	Facilities Management Whole Life Approach
• Deferred maintenance environment • Limited expenditure on Maintenance at $13.5m pa • Backlog of 'Poor Condition' Maintenance items • Expanding list of unattended maintenance items • Surplus space limiting best use of maintenance funds.	• Injection of funds to overcome backlog of Poor Condition Maintenance Items • Places schools maintenance on a sound basis for continuation and improvement • Move towards sound levels of annual maintenance funding aiming closer to the 1.5% of replacement value per annum	• Option 1 (NSW) • Principal directs maintenance	• Option 2 (NSW) • Regional Asset Management Unit (AMU) supports aggregated regional groupings • Principal directs maintenance • Group contract arrangements • Maintenance performance benchmarking • Regional maintenance & FM skills developed. • Maintenance & FM partnerships can develop • Encouragement of consortia with non-building providers • Schools deeply involved in process.	• Option 3 (NSW): Preferred option • Regional Asset Management Units (AMU). • Principals to direct priorities	• Aggregated clustered and regional groupings • Customer focused • Intelligent use of technology • 'light touch' management • responsiveness • control down to individual level • compatible with corporate strategic directions • quality & continuity • revolutionary change in attitude required by client and contractors	• Adopt a whole life approach to managing schools • Consistent approach to resource allocation • Benchmarking and performance measurement • Commitment to reactive and preventative maintenance • Considerable specialist skills to negotiate with partners to manage performance and relationships

PREFERENCE FOR PLANTS IN AN OFFICE ENVIRONMENT

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ABSTRACT

Plants in the workplace are known to bring a number of benefits including psychological as well as aesthetic and air quality benefits. Therefore, plants can have an impact on overall organisational performance. However, findings of previous studies have rarely been applied in the FM context and yet strategic FM delivery in improving workplace productivity is essential for business survival.

The paper explores the importance of interior plants in maintaining the physical and psychological well-being of office occupants utilising a survey of participants' perceptions of photographs of an office with various levels of planting installed from no plants up to very high levels of planting. The paper provides preliminary results of a longer programme of research into the benefits of plants within the FM context.

The work demonstrates that a reasonable level of interior planting in offices is preferred over offices with no plants. These perceived benefits may have a direct impact on overall organisational performance and therefore incorporating elements of nature within building design and management may in future be considered imperative to achieving the desired strategic outcomes of the organisation.

KEYWORDS: plants, survey, workplace psychology

INTRODUCTION

With evidence that employee disengagement is increasing (Pech and Slade, 2006), it is important to provide workplaces that positively influence the workforce. Pech and Slade (2006) argue that the focus is on symptoms of disengagement such as distraction, lack of interest, poor decisions and high absence, rather than the root causes. The working environment is perhaps a key root cause in employee engagement or disengagement.

Research has indicated that improving the working environment reduces complaints and absenteeism and increases productivity (Roelofsen, 2002). Workplace satisfaction has been associated with job satisfaction (Wells, 2000) and perceptions of workplace quality have a significant effect on building users' psychology.

This research forms part of a larger study into the role of plants in the workplace in contributing to staff productivity and corporate profitability. This stage of research surveyed perceptions of plants in an office environment and gauged the volume of plants that the survey participants perceived to be appropriate. Subsequent stages of the research will measure air quality benefits, psychological benefits, productivity advantages and potential reductions in sickness rates afforded by office planting.

THE BENEFITS OF PLANTS

Privacy is a key requirement of workplaces and Sundstrom et al. (1982b) reported an approximately linear increase in perceived privacy with each number of enclosed sides around the workspace. Maher and von Hippel (2005), however, found that the number of partitions were not correlated with perceived privacy but they did find a positive correlation between the height of partitions and perceived privacy. Sundstrom et al. (1982a) reported that office workers moving from enclosed to open-plan offices perceived a reduction in privacy, the most important component being the ability to hold confidential conversations. They found a parallel between physical workspace enclosure and privacy satisfaction. Their results led to extra panels being installed at workstation entrances to limit visibility and absorb sound.

However, Goodrich (1982) points out that some design solutions might unintentionally reduce perceived privacy by creating more spatial privacy. Partitions make individuals blind to their surroundings. Noises and movements outside are sudden and unanticipated, making them more distracting (Goodrich, 1982). Maher and von Hippel (2005) also found that, although higher partitions provide visual privacy, they may fail to block noise. Like Goodrich, they suggest that this noise may be more intrusive when employees do not have visual cues to determine the locus of the noise.

Duvall-Early and Benedict (1992) completed a survey of perceived privacy. They found that those working in private workspaces felt they could better use their abilities, had better perceptions of accomplishment and were able to keep busy all the time. A study of private offices with interior glass panels (Goodrich, 1982) found that these create a fishbowl effect. The glass invites passers by to look in making users feel exposed, and constantly distracted. Circulation routes are also a consideration in perceived privacy. Although Kupritz (1998) found support for partitions, these were considered less important than having minimal traffic routed through the worker's area and the workspace being located away from the main traffic flow. The engineers studied perceived that loss of production time and mistakes occur due to distractions (Kupritz, 1998).

There are, however, positive distractions, such as trees, plants and water (James, 2007) that may be incorporated into buildings to improve workplace quality, privacy and productivity. Goodrich (1982) also advocates using large plants to increase privacy perceptions. He states that workers agreed that plants made the office more pleasant and informal and this seemed to reduce their need for high privacy levels. Shibata and Suzuki (2002) found that peoples' mood may be affected by plants although they concluded that further research was necessary. Serpa and Muhar (1996) found that plants can be used to influence spatial perceptions outdoors in that smaller trees and light texture can be used to enlarge an open space while large trees with coarse texture have the opposite effect. These results may be relevant to the indoor environment in the selection of office plants.

Kaplan (1993) asserted that those with a view of nature such as trees and greenery were more satisfied and that even a short exposure to a natural setting can serve a restorative function. Kaplan states: 'Those with a view of nature felt less frustrated and more patient, found their job more challenging, expressed greater enthusiasm for it, and reported higher life satisfaction as well as overall health' (Kaplan, 1993).

Kaplan (1993) suggests that having natural areas at the workplace can be useful for views or direct involvement such as lunch areas and areas to walk. Bringing nature into buildings is becoming increasingly popular with the use of landscaped atria and "streets" within buildings.

Larsen et al. (1998) add support for workplace plants, finding that office plants increased participants' perceptions of office attractiveness and comfort. Surprisingly, however, they found that productivity reduced with greater numbers of plants. They suggest this may be due to the repetitive nature of the task.

In Shibata and Suzuki's (2002) research on the effect of foliage plants on task performance and mood they noticed perceptual differences according to gender. Females found plants less distracting and they had greater feelings of familiarity towards the plants than did the male subjects.

As well as psychological benefits, indoor plants improve air quality within the workplace (Young, 1998). Air quality benefits include improving relative humidity and reducing Volatile Organic Compounds (VOCs), which in low concentrations can cause skin irritation and dry throats but in higher concentrations are linked to cancer. Plants also remove carbon dioxide from the air and produce oxygen. Carbon dioxide in offices can cause tiredness and fatigue, which will be reduced by greater oxygen concentration. Plants remove airborne particles, which were found in a recent study (He et al., 2007) to be produced in significant concentrations from office printers.

Wolverton (1985), during research for NASA into air quality in space stations and energy efficient buildings on Earth, demonstrated the ability of common plants such as spider plants and golden pothos to remove indoor pollutants such as formaldehyde and carbon monoxide.

METHOD

A survey was constructed to examine participants' perceptions of an office space using photographs of the office with various different levels of planting installed. The selected office had an area of approximately 32 square metres, with about 24 square metres visible in the photographs. The office contained three desks (two of which were visible in the photographs), a book case, two filing cabinets and a small desk pedestal. A laptop PC, telephone and diary were placed on one of the desks.

The office was decorated in neutral colours, with a light green carpet, chairs and desk dividers. A map of Scotland was positioned on the wall facing the camera, a pin board on the left wall and a fluorescent strip light on the ceiling. One of the two windows was visible in the photographs but the angle of the shots made it impossible to determine what view could be seen from the window.

The conditions tested in the survey were:

- No plants
- Minimal planting
- Low planting
- Medium low planting
- Medium planting
- Medium high planting
- High planting

- Very high planting

The no plants condition was a photograph of the office containing only the above items. The other photographs included plants as follows: Minimal (1 plant), low (2 plants), medium low (3 plants), medium (5 plants), medium high (8 plants), high (12 plants) and very high (13 plants). Example images used in the survey are shown in figure 1.

Figure 1: Example photographs used in the study

No plants	**Low**	**Medium**	**High**

The survey began with some demographic questions on age, gender and occupation. Participants were asked to go through the survey one page at a time without moving on to subsequent pages before completing the current page. The second page of the survey contained the photograph of the no plants condition with two questions requiring a yes or no response; “do you like this office?”, and “would you feel comfortable?”

The following pages contained the photographs of the other plant conditions with two questions requiring a yes or no response; “would you be comfortable now?”, and “is it better than the last office?”

The final page asked several questions around whether or not participants had previously considered plants in the workplace, if they would prefer air quality to be managed using mechanical methods or natural methods (plants), if they have been a smoker in the last 12 months and if they felt this exercise was pointless. Those who answered yes were asked to complete a follow-up question: “do you still feel the same after answering all the questions?” Participants were also asked to go back through all the photographs and, using the no plants condition as a benchmark of five out of ten, rate the other photographs out of ten according to their preference. For simplicity any ratings given that were not whole numbers were rounded up or down to the nearest whole number.

Participants consisted mainly of students from the School of the Built Environment at Liverpool John Moores University but also a range of other participants in other occupations. The participants were not informed as to the purpose of the research.

A total of 181 surveys were distributed and 124 of these were returned, ten of which were unusable due to ambiguous or incomplete responses, giving a response rate of 63% (114). Of these respondents 27 (24%) were female, 82 (72%) were male and 5 (4%) declined to specify. Students made up 85 (75%) of the respondents, 4 (3%) were employed with the majority of their time spent in an environment other than an office and 22 (19%) were employed with the majority of their time spent in an office. One (1%) respondent indicated they were employed in a FM or property related role and 2 (2%) were retired.

The majority of respondents (87, 76%) were in the 16-30 age group. The 31-45 age group accounted for 16 (14%) of the respondents, with 8 (7%) in the 46-60 age group, 1 (1%) in the 61-70 age group and 2 (2%) declining to specify their age.

RESULTS

The results of the questions relating to the eight photographs are shown in table 1. The answers to the yes or no questions indicate that the general preference is for photograph 3, which was the low condition. However, the average ratings show the preferred photograph to be number 4 (5.95), the medium-low condition. Photograph 5, the medium condition is also rated higher on average (5.23) than the benchmark (5.00), which is photograph 1, the no plants condition. This would indicate there is a general preference for a reasonable number of plants rather than no plants, although if too many are present, this reduces the feeling of comfort within the workplace.

Table 1: Results of questions relating to the photographs

	Do you like this office?		**Would you feel comfortable?**		
Photo	**Yes**	**No**	**Yes**	**No**	**Average rating**
1	58	56	67	47	5.00 (Benchmark)
	Would you be comfortable now?		**Is it better than the last office?**		
2	60	54	59	55	5.41
3	63	51	57	57	5.87
4	58	56	55	59	5.95
5	36	78	30	84	5.23
6	18	96	12	102	4.13
7	6	108	5	109	2.87
8	6	108	4	110	2.04

Previous studies have found a gender split in workplace perceptions, for example, Shibata and Suzuki (2002), Goodrich (1982) and Wells (2000). The ratings given to the photographs in this study also uncover gender differences in the preference for plants in the workplace as shown in table 2. The females gave higher ratings than the males for photographs 3 and 4, the low and medium-low conditions. The ratings concurred for photographs 5, 6 and 8, the medium, medium-high and very high conditions. However, the males gave a higher rating to photograph 7, the high condition, than did the females.

Table 2: Average ratings by gender

Photo	1	2	3	4	5	6	7	8
Male	5.00	5.41	5.82	5.95	5.00	4.00	3.00	2.00
Female	5.00	5.36	6.08	6.16	5.00	4.00	2.00	2.00

It was also considered likely that there would be perceptual differences depending on participants' occupation and previous experience of particular working environments. The highest average ratings were given by those employed in environments other than offices, followed by those employed in offices and the lowest ratings given by students. Of those who worked in FM or property roles and retired participants, the sample was not of significant size to give a meaningful average rating.

These results may also be affected by the age group of the participants, particularly as the majority of the students were in the 16-30 age group. An analysis of the results by age group shows that the 46-60 age group has a greater preference for higher numbers of plants, followed by the 31-45 age group, with the 16-30 age group having a preference for lower plant numbers. It was not possible to determine a meaningful average for the 61-70 age group due to the small sample size.

On the question regarding whether or not participants had previously considered the need for plants in the workplace, 50 (44%) respondents indicated they had while 64 (56%) responded no to this question. On the question regarding whether respondents would prefer air quality to be managed using mechanical methods or natural methods, i.e. plants, 69 (61%) preferred plants while 35 (31%) preferred mechanical. Ten (8%) respondents declined to comment. Interestingly, however, out of the 35 respondents who preferred mechanical methods, 32 (91%) of these were students. Given that the students were all studying built environment courses, this result may be due to prior experience or knowledge of air quality management among the students. Among all the student responses (85) there was still an overall preference for plants though with 45 (53%) preferring plants and 32 (38%) mechanical with 8 (9%) not specifying a preference.

It was anticipated that those respondents who were smokers may be less concerned about the quality of air within the workplace than non-smokers. This was not found to be significant however. Only 12 (39%) of the 31 smokers who completed the survey indicated that they felt this exercise was pointless. Among all respondents, 48 (42%) indicated that they felt the exercise was pointless and 20 (42%) of these indicated they felt it was still pointless after completing the survey.

RESEARCH LIMITATIONS

For convenience, the participant sample consisted mainly of students. This meant also that the majority of respondents were male and in the 16-30 age group. It is also likely that many students have little or no work experience, particularly in offices, although they may have had prior knowledge of the subject area as they were studying Built Environment courses. It would be useful to widen the participant range to investigate perceptions of participants of other occupations and age groups and to obtain a more representative sample.

CONCLUSIONS

This study confirms the general preference for a reasonable number of plants in office environments among the participants. The low and medium-low conditions were preferred to the no plant condition but the medium condition was also rated higher on average than the no plant condition.

As expected, a gender split was discovered with female participants generally preferring more plants to male subjects. However, it would have been useful to consider results from a larger female participant sample to increase the integrity of these results.

The results were also affected by the occupation of the participants with those employed in environments other than offices preferring the most plants, followed by those employed in offices and finally students, preferring the least number of plants. These differences may be due to previous knowledge or experience gained dependant on the occupation of the participants.

Results differed by age group with the 46-60 group preferring most plants, followed by the 31-45 age group and the 16-30 group preferring lower numbers of plants.

A general preference was also found for indoor air quality to be managed using natural methods such as plants rather than mechanical methods although the majority who opted for mechanical methods were students. Again, this may be down to previous knowledge gained on their courses.

The results show that there is a general preference for plants within offices, which indicates there is a likelihood of plants having a beneficial effect on organisational performance. It is likely that building users will derive psychological benefits from natural elements within, which may increase productivity. However, further research is required and it would be useful to undertake some physical tests rather than relying purely on self-reporting.

REFERENCES

Duvall-Early, K., Benedict, J. (1992) "The relationships between privacy and different components of job satisfaction", Environment and Behavior, Vol. 24 No. 5, pp. 670-679.

Goodrich, R. (1982), "The Perceived Office: The Office Environment as Experienced by its Users", in: Wineman, J. (1986) Behavioral Issues in Office Design, Van Nostrand Reinhold, New York, pp. 109-133.

He, C., Morawska, L., Taplin, L. (2007) "Particle emission characteristics of office printers", Environmental Science and Technology, Vol. 41 No. 17, pp. 6039-6045.

James, P. (2007), "Indoor green space: influences your health", available at: http://www.rgc.salford.ac.uk/peterbarrett/p/?s=10&pid=6

Kaplan, R. (1993) "The role of nature in the context of the workplace", Landscape and Urban Planning, Vol. 26 No. 1-4, pp. 193-201.

Kupritz, V. (1998) "Privacy in the workplace: The impact of building design", Journal of Environmental Psychology, Vol. 18 No. 4, pp. 341-356.

Larsen, L., Adams, J., Deal, B., Kweon, B., Tyler, E. (1998) "Plants in the workplace: The effects of plant density on productivity, attitudes and perceptions", Environment and Behavior, Vol. 30 No. 3, pp.261-281.

Maher, A., von Hippel, C. (2005) "Individual differences in employee reactions to open-plan offices", Journal of Environmental Psychology, Vol. 25 No. 2, pp. 219-229.

Pech, R., Slade, B. (2006) "Employee disengagement: Is there evidence of a growing problem?", Handbook of Business Strategy, Vol. 7 No. 1, pp. 21-25.

Roelofsen, P. (2002) "The impact of office environments on employee performance: The design of the workplace as a strategy for productivity enhancement", Journal of Facilities Management, Vol. 1 No. 3, pp. 247-264.

Serpa, A. Muhar, A. (1996) "Effects of plant size, texture and colour on spatial perception in public green areas – a cross-cultural study", Landscape and Urban Planning, Vol. 36 No. 1, pp. 19-25.

Shibata, S., Suzuki, N. (2002) "Effects of the foliage plant on task performance and mood", Journal of Environmental Psychology, Vol. 22 No. 3, pp. 265-272.

Sundstrom, E., Herbert, R., Brown, D. (1982a) "Privacy and communication in an open-plan office", Environment and Behavior, Vol. 14 No. 3, pp. 379-392.

Sundstrom, E., Town, J., Brown, D., Forman, A., McGee, C. (1982b) "Physical enclosure, type of job and privacy in the office", Environment and Behavior, Vol. 14 No. 5, pp. 543-559.

Wells, M. (2000) "Office clutter or meaningful personal displays: The role of office personalization in employee and organizational well-being", Journal of Environmental Psychology, Vol. 20 No. 3, pp. 239-255.

Wolverton, B.C. (1985), "Foliage plants for removing air pollutants from energy-efficient buildings", available at:
http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19860066306_1986066306.pdf

Young, L. (1998) "Planting clean air", OH&S Canada, Vol. 14 No. 2, pp. 44-53.

PROVIDING KNOWLEDGE WORKER REQUIREMENTS: A FRAMEWORK FOR DECISION-MAKING AND EVALUATION

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ABSTRACT

Research shows that the primary value workers provide to their organization is knowledge and innovation. Today's knowledge worker demonstrates the dual need for collaborative spaces for meetings, interaction, and innovation, along with heads-down concentration space for detailed work. This paper provides an overview of research on a novel process providing facility managers a decision-making tool addressing one portion of this dilemma, auditory distractions, which dominates knowledge workers' issues in the workplace. A key message is that new ways to solve knowledge worker requirements and provide more supportive environments is through highly adaptable workspaces. These technologically improved spaces are costly; an NPV evaluation method is suggested to bring together financial analysis and other benefits to provide appropriate tools for decision-making. Background, current research and the model are presented to facilitate evaluation of the investment needed to provide this adaptability for knowledge workers against other benefits of improved worker productivity and flexibility.

KEYWORDS: adaptable workspace, NPV analysis, productivity

INTRODUCTION

A significant transformation of the economy is underway, from manufacturing to knowledge-based work. This has caused a significance shift towards knowledge workers who are now becoming the most critical assets in terms of costs (salary + benefits) to an organization and the revenue they generate for the organization. In a U.S. General Services Administration report (GSA, 1999), knowledge workers costs are reported as 78% of total annual operating costs for knowledge organizations; more than three-fourth of total costs. The productivity of a knowledge organization depends primarily on the productive output of each knowledge worker; therefore, work environment factors identified as negatively impacting the performance of these knowledge workers carry significant importance for knowledge organizations.

One of the most significant factors shown to negatively impact workers are auditory and visual distractions originating within the workspace. Numerous studies revealed that the performance of knowledge workers on complex tasks was disrupted significantly by auditory and visual distractions originating from the open work surroundings, with co-workers' conversations in cubicle environments being the number one disturbance (Sundstrom et al., 1980, Jensen et al., 2005, ASID, 1996, Sundstrom et al., 1994, Berti and Schroger, 2001, Zijlstra and Roe, 1999, Heerwagen et al., 2004, Olson, 2002, ASHRAE, 2005). The impact is tremendous since more than half of the offices in America and Canada are open plan, cubicle environments (IFMA, 1997).

Studies from communication research, human factors, and architectural design provide argument, in contrast, that open work environments are preferred to enhance learning and performance of knowledge work since employees learn from increased interpersonal interactions and overheard peer conversations providing knowledge (Allen and Gerstberger, 1973, Pile, 1978, Zahn, 1991, Frohlich, 1995). However, sharing knowledge is not the only kind of auditory interaction taking place in work environments. Within the office there are multiple personal interactions going on daily. Significantly, the timing of auditory interactions, whether personal or work related, is also crucial, as a poorly timed interruption potentially distracts one or multiple workers from critical flows of thought (Demarco and Lister, 1993, 1999) to which they may or may not return within the same day (Frohlich, 1995).

The two most desired or required qualities in workspace taken from research on workplace issues and building environment are distraction-free workspace for individual work, and support for impromptu interaction at the same workspace without distracting others and without causing workers to devote time seeking an enclosed collaboration space (Brill et al., 2001, Chou et al., 2001, Heerwagen et al., 2004, Olson, 2002). All these studies report that within knowledge organizations both qualities must coexist for maximized knowledge worker productivity in the formal workplace.

It is suggested that an effective way to mitigate the negative impacts of distractions on the performance of knowledge workers during complex tasks is with provision of a changeable workspace called adaptable workspace (AW), which allows the individual knowledge worker to regulate their micro-environment to control the impact of distractions on their job performance and environmental satisfaction.

Definition of an Adaptable Workspace

For this research a adaptable workspace (AW) is defined as supporting quick transformation of the micro-environment into open, partially-open, and closed environments as required by a knowledge worker. It allows multi-functionality for individual work, two-person discussion, or team work at the same workspace, without disturbing workers in adjoining workspaces.

AW can be implemented in a number of ways. Examples are IBM’s BlueSpace (Lai et al., 2002); and Clemson University’s Animated Work Environment (Green et al., 2005). BlueSpace is a nine feet by ten feet workspace designed with a number of environmental factors to provide control over the workspace micro-environment by the user. The seamless integration of design and technology allows the user to adjust the surrounding environment to complement functional and psychological needs of collaboration, concentration, and personalization. Similarly, Animated Work Environment (AWE) incorporates the concept of continuous metamorphosis providing the user control of the micro-environment for “composing, presenting, collaborating, viewing, meeting, and playing” (Green et al., 2005). This research aims to extend the discussion of AW design and construction concepts, innovations in progress, and guidelines for future study.

Background

Initial research began with literature review of previous work on the impacts of auditory and visual distractions originating in the workplace and their impact to performance on complex tasks.

The impacts of distractions in workspace surroundings have been studied from a number of perspectives in the domains of architecture, building sciences, behavioural sciences, social sciences, computer sciences, ergonomics, management sciences, communication sciences, and cognitive sciences. Convincingly, research from the fields of behavioural sciences and human factors have shown that knowledge worker performance on complex tasks is significantly disrupted by conversational distractions, lack of speech privacy, and uncontrolled noise in the work surroundings (Hedge, 1982, Jensen et al., 2005, ASID, 1996, Sundstrom et al., 1994, ASHRAE, 2005). These studies revealed that distractions from intelligible and irrelevant conversations – for instance, people talking about sports or personal relationships – are the most distracting. Similarly, Olson (2002) found that people spend about twenty-five percent of their time on average, talking in and near individual workspaces, which disrupts the concentration of workers in adjoining workspaces. Some of these conversations may be business critical, but others are personal and non-critical to the knowledge worker. In either case, the impact is the same; reduced ability for the adjacent workers to concentrate on their tasks.

Another substantial body of research in the cognitive science domain studied the correlation of an impact of irrelevant auditory and visual distractions on processes of sensory and working memory systems that impacts performance on various tasks that involve memory and cognitive abilities. Berti and Schroger (2001) documented that both auditory and visual distractions impact the performance negatively. However, they document a difference in visual distractions as more problematic than auditory distractions due to the processes required to reorient attention back to tasks at hand start more easily after a long auditory distraction; however they do not start at all after long visual distractions. Witterseh, et al. (2004), and Evans and Johnson (2000) reported that participants performed worse on various tasks involving proof-reading, addition, and creative thinking when distracted by irrelevant speech or intermittent noise such as telephone ringing, even when they were told to ignore the irrelevant speech. Banbury and Berry (1998) showed that irrelevant speech could reduce even simple mental arithmetic task performance by about two-thirds. Similarly, Zijlstra and Roe (1999) in their study of effects of interruptions on cognitive performance on text editing tasks and well-being, found a negative impact to the state of the person after interruptions. The results of the study revealed that interruptions have negative impacts on emotional well-being and lead to an increase of efforts to account for performance decline. However, with an increase in the number of interruptions during the day, the resumption time, which is the time needed to re-start the task execution, becomes disproportionately longer, decreasing motivation and increasing mental fatigue.

Further research is found with Demarco and Lister's (1993, 1999) in which they assert that complex tasks such as designing, programming, engineering, writing, editing, and analysis, often involve a psychological state of flow that can take fifteen minutes or more of ramp-up time to effectively engage in a particular task. This flow is easily broken by distractions such as irrelevant speech. They called this the concept of flow, which was also presented by Takahashi (2006) in which he concluded that text memory that remembers the text to use in the task at hand, is susceptible to background sound, regardless of whether the sound consists of speech or music. These studies are of theoretical interest because they represent the cognitive costs incurred due to distractions. In summary, the results of all the studies cited are significant to corroborate the theory that in open work environments where the probability of distraction is high, there is a high probability of reduced performance and thus, reduced net revenue.

Another stream of studies identify design features in the workplace that influence knowledge worker's job performance and environmental satisfaction. Olson (2002) conducted a study of employees in U.S.-based organizations with data from about 13,000 employees, collected over a six-year period. The study concluded that the two most desired requirements in the workplace are a distraction-free individual workspace and the support for impromptu interactions anytime and anywhere in the workplace. According to the study, both requirements must coexist for significant improvement in job performance and environmental satisfaction. Brill (2001) corroborates Olson's findings states that compromise in either of the two requirements suggested by Olson results in true costs to the organization via lost productivity, higher attrition, and difficulty to recruit highly valued intellectual capital. Similarly, Heerwagen, et al. (2004) conducted an ethnographic study of the collaborative knowledge work environments and concluded that provision of effective support for both interactive and individual work is the primary issue. Further evidence is provided in a study of West Bend Mutual Insurance Company where personal environments (PE) system from Johnson Controls were installed (Miller and Lomonaco, 2005). PE provides desktop controls each worker to adjust the micro-environment as often as necessary to maintain personal comfort levels. Workers can select their own settings for air temperature, air flow, radiant heat, lighting and background noise masking. Further details for the PE can be found at the web site for Johnson Controls (2005). This study evaluated the costs and benefits of PE on the basis of participation from 300 employees whose results were measured against an existing internal productivity measurement system. This measure existed within West Bend Mutual more than two years prior to this study, providing credibility. Measurements included work for 27 weeks in the old building and 24 weeks in the new building. Although distractions from noise in the surroundings were still an issue, the study documented an overall productivity gain of 12.8% overall, 2.8% directly attributed to PE. This equates to annual savings of $260, 000 based on $13,000,000 of company total salary.

These studies provide a strong theoretical and practical base for theorizing that increased performance of knowledge workers on complex tasks with the adoption of adaptable workspace can be justified. The acquisition and installation of adaptable workspace is costly and requires any investment to be backed with substantial gains. The calculation of these gains is missing. The development of a mathematical valuation model to analyze the value of adopting AW over a static workspace is proposed.

THE MODEL

With the assumptions that knowledge workers are motivated to work effectively and efficiently, and that AW allows the user to regulate the micro-environment to suit ones need of open, partially-open, and closed surroundings at any given time during the day, the underlying premise is that there is a cognitive cost of distraction in terms of influence on the knowledge worker's ability to generate productive output effectively and efficiently. This cost is equal to the time for the event of distraction, plus the recovery or the reorientation time associated with resumption of task (Solingen et al., 1998, Spira and Feintuch, 2005, Demarco and Lister, 1993, 1999). The limitation of this current model is that the variables are solely derived on the basis of the existing literature. Further development of the model will be guided by a future research.

Mathematical Modeling

This paper theorizes that AW provides an opportunity to minimize distractions and thus the reduced performance. Additional costs to acquire and install AW will occur. Thus, the value of AW is a function of the change in performance of knowledge workers minus the costs for deploying AW. Mathematically, the value of adopting AW is:

$V = P – C$

where V = Value of an AW in dollars; P = Change in performance of knowledge workers (in dollars) with the adoption of AW; and C = Increase in costs (in dollars) with the adoption of AW.

The service life for optimal functioning of AW is T years. This implies that deployment of AW will generate cash flows until time T. It is recognized that the best method to calculate the value of implementing AW will be to calculate its net present value (NPV). Furthermore, NPV was used because it is a realistic representation of future costs and returns on an investment in present dollars. This implies that the equation becomes:

$NPV = P_T - C_T$

where, NPV = Net present value of AW in dollars over the time period T; P_T = Net present value of change in performance of knowledge workers (in dollars) with the adoption of AW over the time period T; C_T = Net present value of increase in costs (in dollars) with the adoption of an AW over the time period T.

To calculate the NPV of AW: If ΔP is the incremental change in performance per hour, then $\Delta P = n * R * W$. Details of the variables and parameters used in the equation are listed in Table I.

Table I. Summary of parameters and variables used in the equations

Notation	Definition	Units	Value range	Data source for value
n	Number of knowledge workers employed by the firm.	Number	1000 (constant)	Assumed for the model illustration in the next section. Is kept constant so as to contain the impact of change in "n" on NPV calculations.
R	Net revenue generated per knowledge worker per hour = revenue/knowledge worker – costs/knowledge worker	$ / hr	54- 186 [1]	Calculated Net Revenue = Gross Revenue – Costs
S	Office space rent per square foot	$ / sqft	25.19 (averaged over north American and Canadian office market)	(Grubb and Ellis Research, 2006)
W	Time that is lost per hour per employee due to distractions	--	Min = 1 min per hour = 1/60 hr/hr Max = 20 min per hour = 20/60 hr/hr	(Spira and Feintuch, 2005, Demarco and Lister, 1993, 1999)

Notation	Definition	Units	Value range	Data source for value
e^{-rt}	Discount factor , where r is the discount rate		r = 6.25 % (current discount rate, February)	(Federal Reserve, 2006)
I	Acquisition and installation cost of one adaptable workspace	$	One BlueSpace workstation costs approx $5000. Animated Work Environment costs approx $4000-$4500.	(Ricadela, 2002) Green, Keith
a_{aws}	Minimum area required per adaptable workspace	sq ft	48 sq ft minimum area for any cubicle to avoid claustrophobic effect	Workstation standards
a_{sw}	Minimum area required per static workspace	sq ft	Minimum area for any open workstation space = 5'x5'	Includes the chair+desk+circulation
A_{aws}	Total usable workplace area other than workspaces in the case of offices with AW.	sq ft	$A_{aws} = A_{sw}$	Assumed to keep variables other than performance and AW costs, constant.
A_{sw}	Total usable workspace area other than workspaces in the case of offices with static workspaces.	sq ft	$A_{aws} = A_{sw}$	Assumed to keep variables other than performance and AW costs, constant.
NPV	Net present value of adaptable workspace over a time period T.	$ in Millions	Min value = 64.23 Max Value = 5,000	Calculated

[1] The cost of knowledge workers is equal to their gross salary (salary plus benefits). According to the U.S. Department of Labor – Bureau of Labor Statistics (2005), the values for minimum and maximum hourly wages per knowledge workers (computer analysts and scientists) for the year 2005 are $18 and $62. Assuming that the average gross revenue per knowledge worker at 100% productivity is equal to four times the cost per knowledge worker (GROXIS INC, 2006), we get the minimum and maximum values for gross revenue per knowledge worker per hour as $72 and $248.

To calculate the net present value of change in performance over the time period T, the equation (3) will become; $P_T = n * R * \int_0^T W(t) * e^{-rt} dt$

ILLUSTRATION OF THE COST MODEL

A sample or demonstration is used to illustrate an application of the valuation model. Consider an organization with 1,000 knowledge workers, where the knowledge workers are computer analysts and researchers. Informed by Brand's theory of layering (Brand, 1995) for a building's life-cycle, which states that the building is divided into hierarchical systems of different life spans based on how buildings evolve over time, the service life of the adaptable workspace is assumed as seven years. This example is for replacement of an open, static workspace system with an adaptable workspace system. Calculations include the minimum and maximum values presented in column four of Table I, and provide results for minimum and maximum values for NPV over the period of seven years. In addition, average minimum and maximum values for W can be standardized. The calculations shown are based on an industry standard of eight working hours in a day and 250 working days in a year. Also, to contain the cost implications due to change in usable area, the values of A_{aws} and A_{sw} remain equal. Substituting the minimum and the maximum values into the sample equation produces:

NPV (min) =

$[1000 * 54 * \int_0^7 233.3 * e^{-(6.25*7)/100} dt]$ – [1000 * 5000 + [1000 * {25.19 * (48 - 25)} + 25.19 * (0)] * 1/..0625(1- $e^{-.0625*7}$)] = \$ 64,228,460.80 ≈ \$ 64.23 Million

And, NPV (max)=

$[1000 * 186 * \int_0^7 4666.67 * e^{-0.0625*7} dt]$ – [1000* 4000 + [1000* {25.19 * (48 - 25)} + 25.19 * (0)] * (1/.0625)(1- $e^{-7/20}$)] = \$ 4,992,346,400 ≈ \$ 5.0 Billion

Significant positive results for NPV confirm that over the period of seven years the sample company would achieve between a minimum benefit of \$64.23 millions and a maximum benefit of \$5.0 billions with the adoption of AW. The primary cause for benefit is the substantial increase in net revenue due to increased performance of knowledge workers. Investments in AW are justified for the sample .

These results are based on a number of assumptions; however, the values for the minimum and maximum NPV are significant enough to corroborate the importance of adopting adaptable workspace over a static workspace. Therefore, further research to test the proposed model shown in Figure 1 and to further develop the valuation model is desirable and timely.

CONCLUSION

Researchers from various disciplines have substantially advanced understanding of the relationship between distractions and their negative impacts on the performance of knowledge workers on complex tasks over the past fifty years. Another group of researchers contributed by rationalizing the value of designing and developing workspaces that support the need for distraction-free individual work along with the need for impromptu interaction anytime anywhere in the workplace.

A definition of AW was provided as workspace that allows a quick transformation of a micro-environment into open, partially-open, and closed environments as needed by a knowledge worker at a given time, thereby providing the control over distractions into a knowledge worker's hands. Building further on the arguments from literature review, a theory that the performance of knowledge workers on complex tasks would be enhanced by reducing the distractions originating from a workspace's surroundings; AW as an effective way to control these distractions, was made. A model mathematical calculation (shown in Figure 1) and example were provided. The testing of this model is proposed as a future study. A decision tool for Facility Managers and other workplace decision-makers is needed and this model fills a critical knowledge gap in the current literature.

REFERENCES

Allen, T. J. and Gertsberger, P. G. (1973), "A field experiment to improve communication in a product engineering department: The non-territorial office," *Human Factors,* Vol. 15**,** pp. 487-498.

ASHRAE (2005), *ASHRAE Handbook - Fundamentals - SI Units,* American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Atlanta, GA.

ASID (1996), *Sound solutions: Increasing office productivity through integrated acoustic planning and noise reduction strategies*, American Society of Interior Designers, Armstrong World Industries, Inc., Dynasound, Inc., Milliken & Co., Steelcase Inc.

Banbury, S. and Berry, D, (1998), "Disruption of office-related tasks by speech and office noise," *British Journal of Psychology,* Vol. 89**,** pp. 499-517.

Berti S. and Schroger, E. (2001), "A comparison of auditory and visual distraction effects: behavioral and event-related indices," Cognitive Brain Research.

Brand, S. (1995) How Buildings Learn: What Happens After They're Built, Penguin Group, New York.

Brill, M., Weidemann, S. and Olson, J. (2001), *Disproving widespread myths about workplace design*, Kimball International, Jasper, IN.

Chou, P., Gruteser, M., Lai, J., Levas, A., McFaddin, S., Pinhanez, C., Viveros, M., Wong, D. and Yoshihama, S. (2001), *BlueSpace: Creating a personalized and context-aware workspace*, IBM Research Division, Thomas J. Watson Research Center, New York,.

Demarco, T. and Lister, T. (1993, 1999), *Peopleware : Productive Projects and Teams*, Dorset House Publishing Company, Incorporated, New York.

Evans, G. W. and Johnson, D. (2000), "Stress and open-office noise," *Journal of Applied Psychology,* Vol. 85**,** pp. 779-783.

Federal Reserve (2006) Current discount rates, Washington, D.C.

Frohlich, B. O. C. A. D. (1995), "Timespace in the workplace: Dealing with interruptions," *Human factors in computing systems,* Denver, Colorado.

Green, K. E., Gugerty, L. J., Walker, I. D. and Witte, J. C. (2005), "AWE (Animated work environment) : Ambient intelligence in working life," *Ambience 05 Conference.* Tampere, Finland, Clemson University, Clemson, South Carolina.

Groix Inc. (2006), Earn a Higher ROI from Your Information Assets, San Francisco, CA.

Grubb and Ellis Research (2006), *Office market trends North America -second quarter 2006*, Grubb and Ellis - property solutions worldwide, Chicago, Illinois.

GSA (1999), *The Integrated Workplace: A Comprehensive Approach to Developing Workspace*, U.S. General Services Administration, Office of Governmentwide Policy, Office of Real Property, Washington, D.C.

Hedge, A. (1982), “The open-plan office: A systematic investigation of employee reactions to their work environment,” *Environment and Behavior,* Vol. 14**,** pp. 519-542.

Heerwagen, J., Kampschroer, K., Powell, K. and Loftness, V. (2004), “Collaborative knowledge work environments,” *Building Research & Information,* Vol. 32**,** pp. 510-528.

IFMA (1997), *Benchmarks III,* International Facility Management Association, Houston, Texas.

Jensen, K., Arens, E. & Zagreus, L. (2005), “Acoustical quality in office workstations, as assessed by occupant surveys,” *Indoor Air.*

Johnson Controls (2005), *Personal Environments – Introduction*, Johnson Controls, Inc., Milwaukee, Wisconsin.

Lai, J., Levas, A., Chou, P., Pinhanez, C. and Viveros, M. (2002), “BlueSpace: personalizing workspace through awareness and adaptability,” *International Journal of Human-Computer Studies,* Vol. 57**,** pp. 415–428.

Miller, D. and Lomonaco, C. (2005), Environmental satisfaction, personal control and the positive correlation to increased productivity - White paper, Johnson Controls, Inc, Milwaukee, Wisconsin.

Olson, J. (2002), “Research about office workplace activities important to US businesses - And how to support them,” *Journal of Facilities Management,* Vol 1**,** pp.31-47.

Pile, J. F. (1978), Open office planning: A handbook for interior designers and architects, The Architectural Press, Ltd., London.

Ricadela, A. (2002), “New way to work,” *Information Week,* January 28 issue.

Solingen, R. V., Berghout, E. and Latum, F. V. (1998), “Interrupts: Just a minute never is,” *IEEE Software,* Vol. 15**,** pp. 97-103.

Spira, J. B. and Feintuch, J. B. (2005), The cost of not paying attention: How interruptions impact knowledge worker productivity,. Basex, Inc., New York.

Sundstrom, E., Burt, R. E. and Kamp, D. (1980), “Privacy at work: Architectural correlates of job satisfaction and job performance,” *Academy of Management Journal,* Vol. 23**,** pp. 101-117.

Sundstrom, E., Town, J. P., Rice, R. W., OsbornN, D. P. and Brill, M. (1994), “Office noise, satisfaction, and performance,” *Environment and Behavior,* Vol. 26**,** pp. 195–222.

Takahashi, M. (2006), “Effects of irrelevant sounds on text comprehension and memory after reading silently and orally,” Sun, R. (Ed.) *The 28th annual conference of the Cognitive Science Society,* Vancouver, British Columbia.

Vilimek, R. and Hempel, T. (2005), “Effects of speech and non-speech sounds on short-term memory and possible implications for in-vehicle use,” *Proceedings of ICAD 05-Eleventh Meeting of the International Conference on Auditory Display.,*. Limerick, Ireland.

Witterseh, T., Wyon, D. P. and Clausen, G. (2004), "The effects of moderate heat stress and open-plan office noise distraction on SBS symptoms and on the performance of office work," *Indoor Air,* Vol. 14**,** pp. 30-40.

Zahn, L. G. (1991), "Face to face communication in an office setting: The effects of position, proximity and exposure," *Communication Research,* Vol. 18**,** pp. 737-754.

Zijlstra, F. R. H. and Roe, R. A. (1999), "Temporal factors in mental work: Effects of interrupted activities," *Journal of Occupational and Organizational Psychology,* Vol. 72**,** pp. 163-185.

USERS' PERCEPTIONS OF HEALTH IN SUSTAINABLE BUILDINGS – WORLDWIDE

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ABSTRACT

Users' perceptions of the performance in practice of a range of commercial and institutional buildings in eleven countries have been investigated. All the buildings had received national awards for sustainable design or had scored well in terms of their respective country's building sustainability rating tool. A questionnaire survey sought the users' perceptions of a range of factors – operational, environmental, personal control, and satisfaction (the latter including health).

In this paper, the authors focus on how the users perceived these buildings to be affecting their health, both in terms of their quantitative rating of that effect (on a seven-point scale) and their written comments (positive, balanced and negative) on that aspect of the study.

Based on respondent's scores on a seven-point scale, it was found that, on average, these 'sustainable' buildings were perceived to be healthier than a data-set of 'conventional' buildings. Good correlation was found between the nature of the comments received (both positive and negative) and the perception scores. Similar results were found for the respondent's perceptions of and comments on productivity, and a very strong correlation between health and productivity was also evident.

KEYWORDS: Health, sustainable buildings, POE, users' perceptions.

INTRODUCTION

It seems very little time since one of the major concerns of building researchers and building users was sick building syndrome. Research teams around the world administered questionnaires of varying size and complexity (usually very long) to the occupants of a range of buildings (offices mainly), measured the environmental conditions in typical work spaces, and tried to deduce cause and effect from the resulting mass of data.

The overall consensus seemed to lay blame on factors such as off-gassing products or particulates from building materials, high levels of bacteria, fungal growth in humid conditions, all combined with low ventilation rates; the latter being blamed on the responses of over-zealous facilities managers, HVAC system designers, and ventilation standards writers to the escalating costs of the electricity to run the fans, following a succession of direct 'energy crises' (Kumar and Fisk, 2002).

More recently, in response to the more pervasive 'environmental crisis', building designers and developers have been producing 'sustainable' buildings for their more environmentally conscious clients. Are these resulting in healthy and creative facilities with stimulating work environments for their employees, or are we producing a new set of problems for the unsuspecting building occupant? With these, and related questions in mind, the authors set out to investigate the performance of a number of this new generation of 'sustainable' buildings.

We have placed quotation marks around the word ‘sustainable’ up to now, not to imply any irony but simply to indicate one should be careful with this terminology – we are sure that none of the buildings would claim absolute sustainability (however that may be defined) but rather that they are moving towards that goal. Bordass and Leaman (2007) have coined the useful phrase ‘green-intent’ which neatly encapsulates the concept. However, we shall revert to ‘sustainable’, but without the quotes, for the remainder of this text.

RESEARCH METHODS

For the last four years the performance in practice of around 40 commercial and institutional buildings in 11 countries worldwide has been investigated (Baird, 2008). These investigations involved the principal author in one or more visits to each of the buildings and the personal distribution and collection of a questionnaire survey seeking the users' perceptions of a range of factors: operational , environmental, personal control and satisfaction (the last of these covering design, needs, comfort overall, productivity, and health).

The questionnaire has evolved over several decades, from a 16-page format used for the investigation of sick building syndrome in the UK in the 1980s, to a more succinct 2-page version. Developed by Building Use Studies (BUS, 2004) for use in the Probe investigations (BRI, 2001/2), it is available under licence to other investigators. Analysis of the responses yielded a mean value (on a 7-point scale) for each variable. Each of these was simply assessed in relation to the selected scale, or compared with the mean value from the BUS dataset benchmark (which is based on the previous 50 or so buildings analysed at that particular time). Once collected, the data from the questionnaires was entered into pre-formatted Excel files provided by BUS. On completion and checking of these, the completed files were then emailed to BUS for analysis. Upon their return the resulting average scores were entered into an SPSS spreadsheet for further analysis by the authors.

For this paper, the authors focus on how the users perceived these buildings to be affecting their health, both in terms of their quantitative rating of that effect (on the seven-point scale) and their written comments (positive, balanced and negative) on that aspect of the study. Statistical analysis was used to find the level of association that existed between the occupants perception of health and some of the other key factors that were assessed, in particular their productivity. In the context of this conference, with its focus on healthy and creative facilities, it is suggested that productivity could be viewed as a reasonable surrogate for creativity.

THE BUILDINGS SURVEYED

The buildings surveyed were as follows, by country:

- Australia: 40 Albert and 60L, Melbourne; Red Centre and Institute of Languages, UNSW, Sydney; Student Centre and General Purposes Building, Newcastle University; Scottsdale Forest Ecocentre, Tasmania.
- Canada: Computer Science and Engineering, York University; Liu Institute, University of British Columbia; Toronto Military Families Resource Centre; National Engineering Yards, Vancouver.
- Germany: Sciencepark, Gelsenkirchen.
- India: Torrent Research Centre, Ahmedabad.

- Ireland: St Mary's Credit Union, Navan.
- Japan: Nikken Sekkei HQ, Tokyo; Earthport, Yokohama.
- Malaysia: Menara UMNO, Penang; MEWC HQ, Putrajaya .
- New Zealand: AUT Akoranga, Auckland; Landcare Research, Auckland; Mathematics Statistics and Computer Science, Christchurch.
- Singapore: Institute of Technical Education, Bishan
- UK: Arup Campus, Solihull; City Hall, London; Eden Foundation, St Austell; Gifford Studios, Southampton; Renewable Energy Systems HQ, Kings Langley; Zicer Building, University of East Anglia.
- USA: Natural Resources Defence Council, Santa Monica; NRG Systems, Vermont.

These were selected on the basis of their sustainability 'credentials'. Virtually all of them were recipients of national awards for sustainable or low energy design or highly rated in terms of their respective countries building sustainability rating tool (LEED, BREEAM, CASBEE, Green Globes, etc - see Cole, 2005 and 2006 for reviews) or in some way pioneered green architecture. Of course, willingness on the part of the building owner and tenants to be surveyed was also an essential prerequisite, and not all building owners felt in a position to accept our invitation.

While most of the buildings were in temperate climates of one kind or another (ranging from warm-temperate to cold-temperate) a significant number were located in warm-humid climates. Their systems of ventilation ranged from full air conditioning, through mixed-mode (concurrent, changeover and zoned) to natural ventilation (both conventional and advanced).

OVERALL PERCEPTIONS OF HEALTH

The 'health' question on the survey form was couched in the following terms – "Do you feel less or more healthy when you are in the building", with the guidance footnote "please try to evaluate this building with respect to your experience of using buildings in general". The occupants were asked to indicate their response on a seven-point scale ranging from 'less healthy' to 'more healthy'. Immediately under was a box where respondents were invited, should they wish, to write any "Comments about health".

Health scores on the seven-point scale

Figure 1 shows the frequency distribution of the average scores for each building. The mean value for this group of sustainable buildings is 4.25. If one considers the scale mid-point value of 4.00 as the 'break-even' score, this result indicates that on average the occupants judge these buildings to be on the 'more healthy' side, but only just!

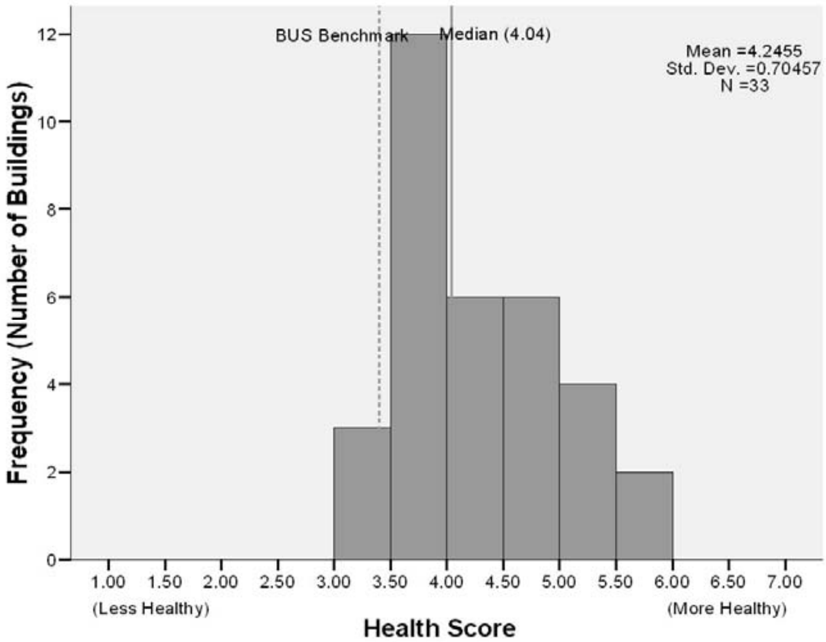

Figure 1. Frequency distribution of average health scores.

The mean value of 4.25 for these buildings may be compared to the Building Use Studies (BUS) benchmark figure which is based on the immediately preceding 50 buildings surveyed by BUS and their licensees (which of course would have included our buildings from time to time). As might be expected, this figure varied slightly over the duration of the current project, ranging from 3.3 to 3.6. Evidently, the average person feels less healthy in the average building. In that context, our sustainable buildings are perceived as a significant improvement – all but three are better than the benchmark, and more than half of them score higher than the scale mid-point.

By way of comparison, a recent analysis by Bordass and Leaman (2007) on a larger dataset of 165 UK buildings (including both conventional and, in their phraseology, 'green-intent' buildings) found that "Twenty-five per cent of buildings have health scores greater than 4, the scale mid-point". When the data set was broken down into these two categories, 'conventional' and 'green-intent', analysis of variance indicated their mean values were significantly different.

It was found that the median score for the 'conventional' buildings was around 3.2, while that for 'green-intent' buildings was approximately 3.7. The median value for the sustainable buildings in our 'worldwide' dataset works out even higher, at 4.04. The likelihood that some of our sustainable buildings were included in the 'green-intent' data-set makes it impossible to test the significance of the latter difference, but the trend seems clear.

Occupants comments on health

By no means all the occupants took up the opportunity to make a comment on this aspect of the building. However, a significant number did so and it is of interest to analyse the nature of their responses. As far as the comment rate is concerned (the number of respondents who wrote a comment, compared to the number of respondents) this ranged up to 42 per cent, with a mean value of around 23 per cent.

In terms of the nature of their responses, the comments were placed into three categories: positive (extolling the virtues of the building, health-wise – around 25% in this case), negative (noting health problems they attributed to the building – 50%), and balanced (where the respondent was neutral about the effect of the building on their health, or made a combination of positive and negative comments – 25%).

Given that not all respondents ventured a comment, it was of interest to see if there was any inherent bias or correlation between the nature of the comments and the scores. Figure 2 plots the positive, negative and balanced comments for each building (expressed as a percentage of the total number of ‘health’ comments received for that building) against the scores. The line of best fit and 95% confidence limits for each case are also indicated. It is reassuring to note that the positive and negative comments trends are as one would have anticipated, while a good number of the balanced comments are clustered around 4.00 the mid-point of the scale.

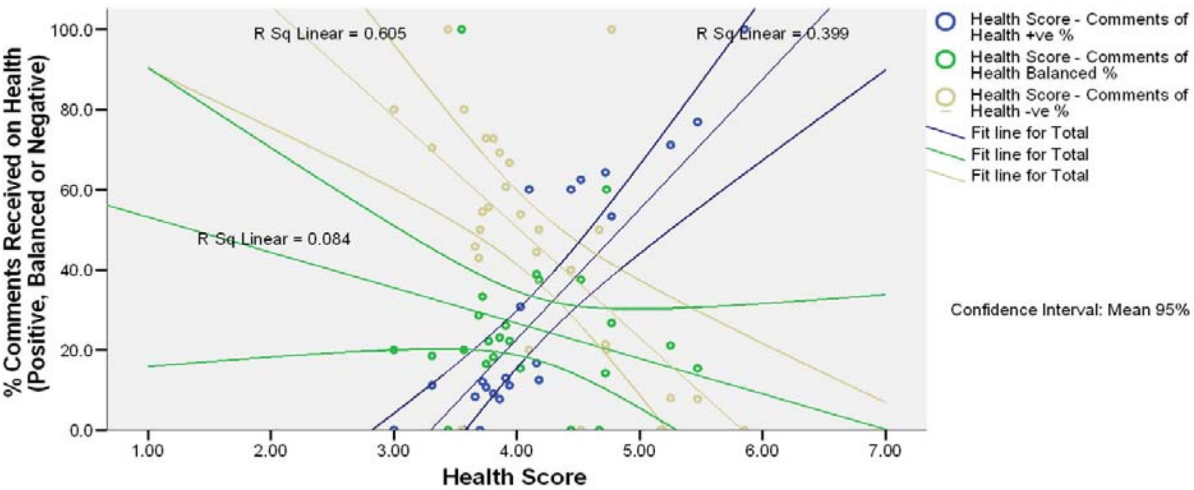

Figure 2. Plots of health comments rate versus average scores for each case. Note that ‘R Sq Linear’ indicates the percentage of variation explained by the regression line

OVERALL PERCEPTIONS OF PRODUCTIVITY (CREATIVITY?)

The ‘Productivity at Work’ question asked respondents to ‘Please estimate how you think your productivity at work is decreased or increased by the environmental conditions in the building?’ Occupants indicated their response on a scale ranging from ‘-40% or less’ to ‘+40% or more’ with 10% intervals. Respondents were invited to write any “Comments about productivity”. Figure 3 shows the frequency distribution of the average percentage productivity for each building. The mean value is +4.18%. Considering the scale mid-point value of 0% as the ‘break-even’ score, this result indicates that on average the occupants perceive themselves to be more productive (and arguably more creative too?) in these sustainable buildings. The BUS benchmark has hovered between 0 and -5% during the period of these surveys. By that measure, 21 of our sustainable cases were perceived higher, 5 lower, and 7 about the same.

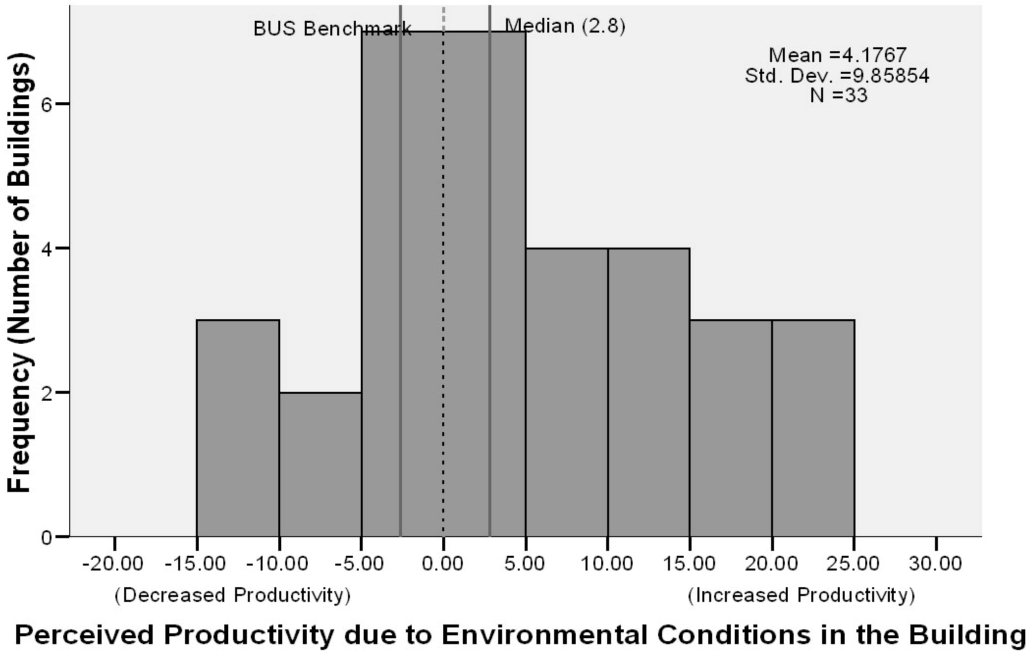

Figure 3. Frequency distribution of average perceptions of productivity

As with health, a number of respondents commented on this aspect as well as scoring it – this time the comment rate ranged up to 55% with an average value of 26%. Figure 4 plots the nature of the comments on productivity versus the corresponding scores for each case. Again, a good percentage of the variation is explained by the regression line for comments of a positive and a negative nature.

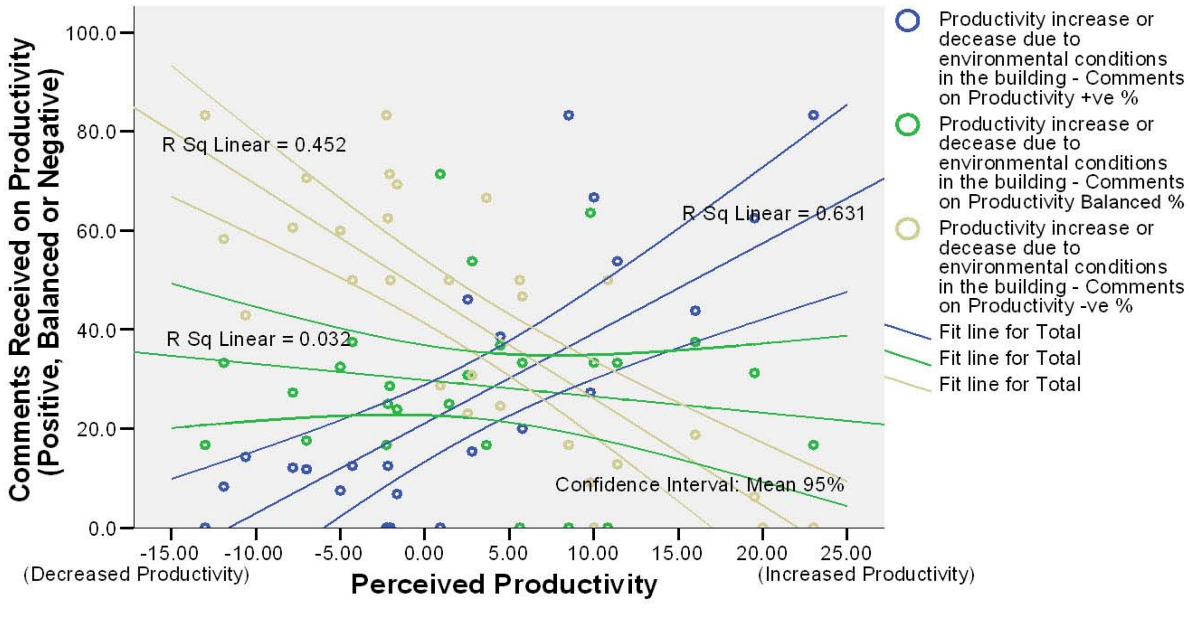

Figure 4. Plots of productivity comments rate versus average scores for each building

CORRELATION OF HEALTH WITH OTHER VARIABLES

Previous studies (BRI, 2001/2) had indicated strong correlations existed between such factors as productivity and overall comfort. Here, the scores for health and a number of other factors were tested to determine how strongly they were correlated for this group of sustainable buildings.

Of the ten factors assessed against health, productivity with a value of 0.910 had the highest Pearson correlation coefficient. This was closely followed by building design (0.869), comfort overall (0.855), and space in the building (0.822), all illustrating a very strong relationship; summertime conditions (0.752), summer temperatures (0.684), wintertime conditions (0.671), lighting overall (0.625), noise overall (0.616) and winter temperatures (0.589) had a strong relationship. All of these were significant at better than the 0.01 level (2-tailed).

By way of illustration, Figure 5 is a plot of the average perceived increase or decrease in productivity versus health, with a straight line fitted to indicate the overall trend.

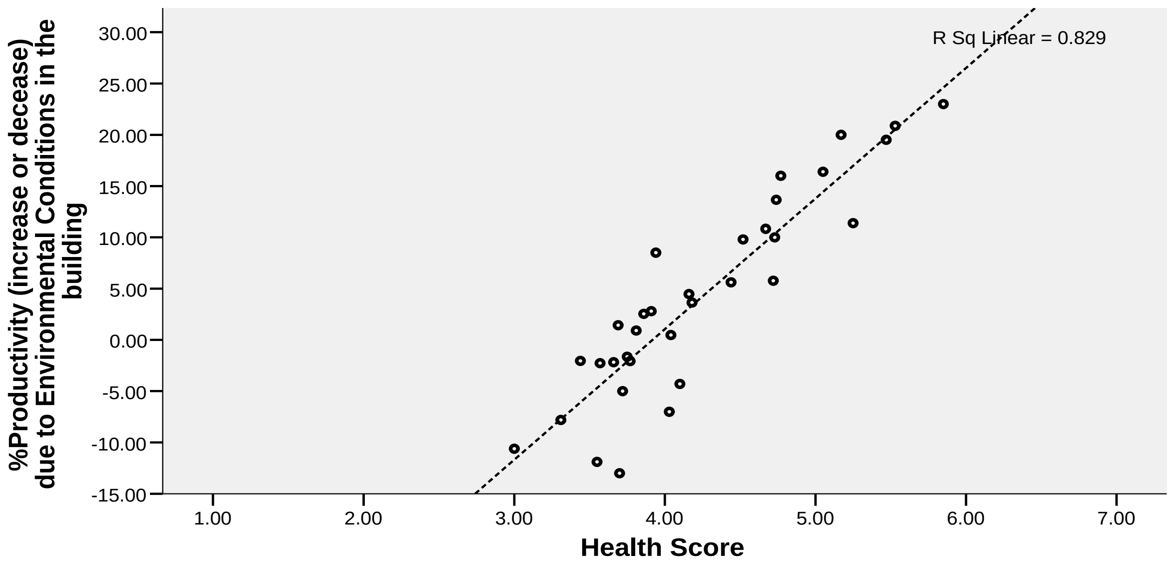

Figure 5. Perceived productivity versus perceived health

DISCUSSION AND CONCLUSIONS

With a median value of 4.04, just over half of the cases surveyed were perceived to be on the ‘more healthy’ side of the scale mid-point of 4.00; on the face of it a not especially encouraging result. However, when one considers that the BUS median score for conventional buildings was only 3.2 it is clear that these results from our data-set of sustainable buildings imply a considerable improvement has been achieved.

The nature of the comments on health (negative comments outnumbered positive by 2 to 1) confirmed what every facilities manager knows – the propensity of building occupants to complain rather than praise. However, it was reassuring to see a good correlation between the scores and both the number and nature of the comments. Both positive and negative comments correlated reasonably well with the perception scores.

The distribution of the productivity perception scores was considerably more positively skewed than that for health with the result that some 64% (21 out of 33 cases) of these sustainable buildings indicated productivity increases. Their median and mean values, at +2.8% and +4.2% approximately, are higher than the BUS benchmark which is about -2.6%.

Again, there was good correlation between the scores and the negative and positive comments. The ratio was again 2 to 1, but there were rather more balanced comments here (32% as against 25% in the case of health).

Of the individual factors tested for their correlation with health, productivity was by far the strongest, closely followed by building design, comfort overall, and space in the building. While it is not feasible to ascribe cause and effect, there seems little doubt that these factors go hand in glove with one another.

It is anticipated that future analyses will give further insights into the nature of these and other relationships that have a significant impact on the health of the building users. These may also give further credence to the assertion that 'Results of hundreds of studies and reports have demonstrated a significant and causal correlation between improving the indoor environment and gains in productivity and health' (Shah, 2007, p222).

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge Adrian Leaman for permission to use the Building Use Studies questionnaire under licence. Thanks are also due to Jessica Ferris who provided research assistance and to Victoria University of Wellington for funding assistance. Finally, we must also thank all the building owners and occupants for their responses.

REFERENCES

BRI 2001 & 2002, Special Issue – Post-occupancy Evaluation. Building Research and Information, 29, 2, 79-174; and subsequent Forums in 29, 6, 456-476 and 30, 1, 47-72.

Baird, G. (2008) Users perceptions of sustainable buildings, Spon Press, (forthcoming)

BUS 2004, Web site – http://www.usablebuildings.co.uk (last accessed: 12 December 2007).

Cole, R.J (2005) Building Environmental Assessment Methods; redefining intentions and roles, Building Research and Information, 33, 5, 455-467.

Cole, R.J (2006) Shared Markets; coexisting building environmental assessment methods, Building Research and Information, 34, 4, 357-371.

Kumar, S. and Fisk, W.J. (2002) The role of emerging energy-efficient technology in promoting workplace productivity and health: final report. (see http://gaia.lbl.gov/IHP/Final-Report.pdf - last accessed 20 December 2007).

Leaman, A. and Bordass, B. (2007) Are users more tolerant of 'green' buildings. Building Research and Information, 35, 6, 662-673.

Shah, S. (2007) Sustainable practice for the facilities manager. Blackwell, Oxford.

EVALUATING BUILDINGS IN RELATION TO USERS' EXERCISE ACTIVITY

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ABSTRACT

Traditionally, employees' health has been seen as an individual responsibility rather than an organisational one. When exercise has been promoted by organisations, the expectation has been that extra-curricular interventions such as the use of lunch-time gyms be embraced, rather than any requirement to incorporate non-sedentary behaviour within the work routine itself. Sedentary behaviour at work could be seen as an inevitable consequence of modern organisational practices. Most conspicuous of these factors is the design and operation of facilities. In turn, these facilities management solutions are driven by attempts to optimise space usage and the minimisation of walking distances. This is reinforced by the view that walking time is unproductive time.

This paper presents the rationale behind a study being undertaken by the authors as part of the 'Paths to Health' initiative. Paths to Health was established in 2001 to contribute to health improvement in Scotland through the promotion of walking for health and now forms a key delivery mechanism for Scotland's Physical Activity Strategy - Let's Make Scotland More Active. It seeks to investigate whether a significant window of opportunity can be afforded for exercise during the normal course of an office workers daily routine.

KEYWORDS: obesity, workplace health, sedentary, pedometer, Scotland.

INTRODUCTION

Employees who are seated for long periods during the working day carry a serious health risk akin to smoking and long-term exposure to sunlight. This is the evidence that is emerging from various sources (Hamilton, 2007). Moreover, the data suggests that we cannot assume that simply by engaging in exercise a few times per week you can offset the effects of workplace inactivity. The injurious effects of sitting too much are more deep-seated if you will pardon the pun. These effects are collectively described by the term 'metabolic syndrome'.

Exercise at Work

Metabolic syndrome is a group of metabolic risk factors that are associated with low activity levels including sedentary behaviour in the workplace. They are known to increase the risk of cardiovascular disease and diabetes. Risk factors include (Grundy et al, 2004):

- Abdominal obesity
- Blood fat disorders leading to plaque build up on the arterial walls.
- Raised blood pressure

- Resistance to insulin or glucose intolerance
- An increased tendency to thrombosis

The findings of Hamilton (2007) and Booth et al, (2000) suggest that the physiology of inactivity is fundamentally different from exercise physiology. This is largely because energy expended during inactivity in the form of heat production (thermogenesis) is a much greater contributor to total energy expenditure than that produced from exercise. It is these 'non-exercise' activity levels that are giving rise to the medical conditions associated with metabolic syndrome.

Facilities Management and its influence on user behaviour

Short bouts of exercise do not compensate for the long hours of inactivity endured by many office workers. The idea of 'compartmentalising' exercise separately from work is brought into question. Facilities managers impose significant controls over the level of activity that employees experience through the denial of walking or even standing opportunities.

So let us look at some of the most pernicious assumptions that facilities managers might be tempted to make:

- Walking interferes with work
- Stair climbing is an inconvenience
- Sharing of resources creates an unnecessary need to get up from your desk.

Many of these assumptions are often embedded in CAFM programmes when carrying out stacking and blocking plans. Being close to a key colleague is of course useful. However, such visibility does not have to be achieved at the expense of an exercise opportunity. Indeed the reduced proximity of co-workers may have a positive organisational benefit, encouraging employees to get to know their organisation.

A milestone publication in the history of facilities management which appeared in the Harvard Business Review in 1985 introduced the world to the idea of 'activity settings'. In this futuristic view described by Luchetti and Stone, office employees were no longer tied to their desks, but were encouraged to migrate from one setting to another – to work in a setting that best suited their needs. They proposed abandoning the idea of reliance on a single dedicated workstation. Others in the area of anthropology supported this idea, arguing that such a migratory model was much closer to the habits of our hunter-gatherer ancestors. As such, the human condition was much more attuned to the preceding two million years of evolution than that of the last one-hundred years. Today, the idea of activity settings is ubiquitous, adding a new dimension to the open plan office. However, the term 'activity settings' remains something of a misnomer. The mobile workforce has never been less mobile than today.

Initiatives for stimulating active behaviour at work

Several initiatives around the world have attempted to counter sedentary worker behaviour. In North America stair climbing is an activity which is increasingly promoted at corporate level. Take, for example, the initiative led by the Public Health Agency in Canada (http://www.phac-aspc.gc.ca). Over 1100 office workers with sedentary positions, occupying two Health Agency buildings (six and seven storey) were studied in 2004.

The following facilities management interventions were undertaken:

- So called 'Point-of choice' posters strategically placed at lobby areas to communicate the 'Stairway to Health' initiative

- Stairwell beautification through the use of attractive colours on the stairwells and the use of artwork.

- Posters located in lunch-rooms explaining the benefits of stair climbing.

Other research by a group at Birmingham University (Webb and Evans, 2007) in the UK has attempted to systematically examine the effectiveness of different poster messages used to encourage stair climbing, including. Expressions such as 'free exercise' or 'keeps you fit' were experimented with: it was found that messages conveying specific consequences to the employee were more effective than general statements. Walking at any pace expends energy and as such is beneficial for weight loss. But walking faster (like stair climbing) carries a greater benefit of increasing cardiovascular capacity and fitness. This is when employees are able to move into the 'training zone' which is 70% of the maximal heart rate.

The influence of facilities management decision making

Undoubtedly, the overriding rule used by facilities managers, which in turn determines the health of a building layout, is the 'stacking' and 'blocking' plan. Both techniques are routinely used as part of a 'computer-aided facilities management' (CAFM) package. They incorporate algorithms that enable the minimization of travel times, based on 'affinity diagrams' or 'interaction matrices'. These matrices indicate the relative strength of relationships that exist or are sought between departments and resources/services within a facility. The optimized stacking plan indicates how departments and individuals are dispersed throughout the building to enable efficient functioning of the organization. Those parts of the organization that require proximity to one another are typically located on the same floor, since a floor separation is detrimental to such intense and regular exchanges.

It is however, the intention in the remainder of this paper to consider the implications of these decision rules used by facilities managers. The assumptions upon which they are based are challenged and the author suggests a more flexible contingency approach to space planning that embraces the concept of 'embedded' health in buildings.

The value of walking time

Implicit in space planning systems widely used today is the belief that the necessity to travel (walk) is inherently bad. This, despite the growing evidence that the sedentary nature of work brought about by reliance on the car and the computer have 'designed out' exercise from the normal work routine. In particular, the ubiquity of email has circumvented the need to walk to a colleague's workstation, even if only a few metres away. From an organizational perspective, travel time is universally considered to be undesirable. Not only is it perceived as 'lost' time: it also is seen to hamper 'processes', that are seen to be affected by layout. However, some of these assumptions need to be challenged.

- Work involving one-to-one communication can be undertaken whilst walking. Little is known about how the activity of walking affects the richness or productivity of such interactions. Indeed it is possible that an active behaviour may positively affect the interaction.

- Adjacency to support ‘process’ is significantly less important in modern work environments where most knowledge exchange is played out in a virtual environment (e.g. exchange of documents). Thus the imperative for close proximity to support process is less evident.

- Organisations are seeking to stimulate ‘non-routine’ rather than ‘routine’ interactions whereby individuals exchange ideas and approaches with people in different departments or areas. This cross-fertilisation thus challenges ‘the way we do it here’ mentality and encourages innovation and inter-group collaboration.

Quite at odds with organizational desires to increase efficiency, compact designs may only be producing organizational ‘straight jackets’ imposed by space plans.

FORTHCOMING RESEARCH

This paper so far has described the evident health imperative which informs the research currently being undertaken by the authors at Heriot Watt University in Edinburgh. The research forms part of the ‘Paths to Health’ initiative. Paths to Health was established in 2001 to contribute to health improvement in Scotland through the promotion of walking for health and now forms a key delivery mechanism for Scotland’s Physical Activity Strategy - Let’s Make Scotland More Active. The study itself involves 1) pedometer trials; 2) behavioural studies and 3) evaluation of facilities management strategies. Using accelerometer studies and focus groups, the study will examine the impact of various building solutions and facilities management strategies on the sedentary behaviour of its occupants.

One of the measurement systems used in the study is ActivePal. This enables the accurate measurement of physical activity patterns to identify sedentary behaviour and assists in the evaluation of interventions aimed at reducing inactivity. This method has been shown to provide a valid and reliable measure of posture and motion during everyday physical activities (Grant et al, 2006). The study will involve volunteers from a range of work environments involving a variety of job roles and tasks. The results from the study will be published at the end of 2008.

DISCUSSION

This paper has presented an argument for the creation of buildings that encourage active working. In other words - an environment which coerces occupants into physical activity, as part of their everyday work routine. One such example is stair walking (i.e. not taking the lift). It recognizes the fact that direct intervention involving scheduled workplace exercise activities are often difficult to implement, largely as a result of apathy and embarrassment on the part of employees (particularly in Western societies). Furthermore, provision of specialized gym facilities may fail to attract those employees most in need of exercise and who are unable to commit time to exercise activities, because of their busy working day.

The paper also argues that facilities management decisions in relation to stacking and blocking have a fundamental influence on the ‘embedded’ health of buildings. This profession needs to carefully re-examine their assumptions in relation to space utilization and travel time. Is travel distance something that should always be minimized? Accessibility and the ‘embedded’ health of buildings need not be conflicting objectives. Travel distance is only one of the factors that affect the accessibility of environments. A contingent approach, rather than a ‘one-size fits all’ approach may be most appropriate (for example, the choice of taking the lift or stairs). Undoubtedly we are only just beginning to wake up to the immensity of the obesity challenge in modern workplaces. This paper has attempted to highlight the pervasive effect of facilities management decisions in this context. The questions raised in this paper present the framework for a research project currently being formulated, to understand the impact of space planning on the cardio-vascular activity of office employees.

REFERENCES

Booth, F.W., S. E. Gordon, C. J. Carlson, and M. T. Hamilton (2000), Waging war on modern chronic diseases: primary prevention through exercise biology, Journal of Applied Physiology Vol. 88, Issue 2, 774-787

Grant, P.M., C. G. Ryan, W. W. Tigbe, M. H. Granat (2006), The validation of a novel activity monitor in the measurement of posture and motion during everyday activities, British Journal of Sports Medicine, 40:992-997

Grundy S.M., Brewer H.B., Cleeman J.I., Smith S.C., Lenfant D, (2004), Definition of metabolic syndrome: report of the National, Heart, Lung, and Blood Institute/American Heart Association conference on scientific issues related to definition. Circulation. 2004;109:433-438

Hamilton, M.T. et al, (2007), Role of Low Energy Expenditure and Sitting in Obesity, Metabolic Syndrome, Type 2 Diabetes, and Cardiovascular Disease in Diabetes, Published online September 7, 2007

Stone, P.J. and R. Luchetti - Harvard Business Review, (1985), Your office is where you are, Harvard Business Review, Volume, 63 , Issue 2 (March/April 1985)

VTPI, (2002). “Accessibility,” Online TDM Encyclopedia, Victoria Transport Policy Institute (www.vtpi.org)

Webb, O.J. and F.F. Eves (2007), Promoting stair climbing: effects of message specificity and validation, Health Education Research 2007 22(1):49-57