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FOREWORD

This year's theme - 'FM for a Sustainable Future' - reflects one of the major challenges facing Facilities Management in Europe, as well as providing an important opportunity for positioning the profession and industry. The response to this challenge is made more difficult by the downturn in the global economy and the continuing financial crisis. Organisations of all kinds are being asked to achieve exacting targets for carbon reduction and to contribute to community development whilst facing reduced budgets and limited investment.

The papers presented in this volume, reflects the work that is being carried out by researchers across Europe, usually in collaboration with partners in FM practice, to address some of the key issues emerging in the field. The papers are organised in three main themes – added value, FM innovation and sustainability in FM and represent the first contributions to
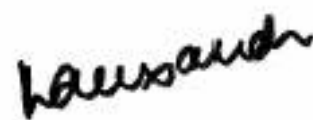
Once again this year, the number of abstracts and papers submitted to the Research Symposium has increased, reinforcing EuroFM's position as a leading organisation for the presentation and discussion of cutting edge research to a global audience. For the first time, research workshops, hosted by local Universities, have been organised to provide a broader opportunity for academics and postgraduate students to participate.

EuroFM continue to strive for world-class standards of research quality and is indebted for the support of an internationally recognised team of scientific reviewers. EuroFM aims to be an authoritative voice for FM knowledge in Europe, and to make it openly accessible for application in education and practice.

We thank all of the reviewers and organisers of this the 12th EuroFM Research Symposium for their tremendous effort and wish you all a successful gathering.

Ron van de Weerd   Prof Keith Alexander
Chairman EuroFM   Chair Scientific Committee
                                                                                         EuroFM Research Symposium

Introduction
EuroFM Research Symposium
FM FOR A SUSTAINABLE FUTURE

Prof Keith Alexander
Chairman, EuroFM Research Network
Centre for Facilities Management, Manchester, UK

As the incoming chairman of the EuroFM research network, it is an honour to have the opportunity of leading the Research Symposium and its contribution to developing the EuroFM knowledge base in this important area. Ensuring the future of facilities management as a profession and as an industry and creating an enduring legacy for the next generation is a truly worthwhile endeavour. It is particularly important in the extremely difficult economic, social and environmental climate for organisations throughout the world.

Sustainability has many facets and is the focus of the 12th EuroFM research symposium on FM. Therefore, this volume contains a diverse set of research papers which address a broad spectrum of concerns. The framework for the Symposium includes social, economic and environmental approaches within the field, from an ecological perspective in FM.

The call for papers reminded us that FM is not just support services representing necessary cost to organizations. FM can provide essential benefits and positive impacts of importance for both for the primary activities of organizations, for all stakeholders and for society. It is rewarding to work with a network of researchers and practitioners who believe that FM can make a difference to people's lives and to the success of private, civil and social enterprise.

In all twenty four original papers have been selected for publication, representing new knowledge, relevant to the focal issues identified in the call for papers. The papers for the research symposium are organised in the three themes that underpinned the call for papers. As such the papers represent the first contributions to newly formed working groups to advance knowledge.

In addition, for the first time this year, EuroFM has organised research workshops, jointly hosted by the Czech Technical University in Prague and Slovakia Technical University. The workshops provide a broader opportunity for academics and postgraduate researchers to present and discuss the theoretical and methodological issues arising from FM research.

This year, for the first time, we have asked three leading practitioners, to act as moderators and to report back to EuroFM on the relevance of this research to practice. The research network recognises the importance of its leading contribution to overall EuroFM objectives to develop knowledge at the interfaces amongst education, practice and research. To this end, the overall programme for EFMC again includes a joint session between practitioners and researchers to discuss and debate the importance of evidence-based practice.

Further changes to the format of the Research Symposium are planned for the coming year, as part of a broader open access publishing initiative. A continuous call for papers within the three working groups will address EuroFM' s intention to be an authoritative voice for FM in Europe, achieving world-class standards in scientific enquiry.

SECTION ONE:
ADDED VALUE OF FM

EuroFM WG1

Workshop introduction
Added value of FM

Per Anker Jensen, Convenor, EuroFM WG3 Added Value of FM
CFM Realdania, DTU, Copenhagen, Denmark

Relationship value in FM: a customer perspective
Christian Coenen and Ying Ying Schäfer-Cui
Institute of Facility Management, Zurich University of Applied Science, Switzerland

Facilitating new ways of working in Dutch Higher Education

Ronald Beckers and Theo van de Voort
HAN University of Applied Science, Faculty of Economics and Management, The Netherlands and
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Can FM contribute to study success?

Herman Kok, Mark Mobach and Onno Omta
Wageningen University, Wageningen, The Netherlands

EuroFM WG1: The Added Value of FM

Workshop Introduction

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BACKGROUND

The EuroFM research group on "The Added Value of FM" was established in 2009. The background for the collaborative research was that the perception and application of Facilities Management during the last decades gradually has shifted from primarily steering on cost reduction towards managing of facilities as a strategic resource to add value to the organisation and its stakeholders and to contribute to its overall performance. The main results of the work so far were presented in the anthology "The Added Value of Facilities Management – Concepts, Findings and Perspectives", which was launched during the European Facility Management Conference (EFMC) in Copenhagen, May 2012. In a workshop in Copenhagen in November 2013 ideas were discussed about possible follow-up of the collaborative research. One of the topics was: "Value dimensions - further elaboration of the Added Value of FM".

Following from that it was decided to arrange a workshop at EFMC2013 on the topic: *How to manage and measure different value dimensions?* At the Euro FM member meeting February 2013 in Zürich it was agreed to continue the work on the Added Value of FM, and the workshop at EFMC2013 is seen a first event in this continuation of the collaborative research. Besides, a position paper for the research group has been prepared as a foundation for the further work. The workshop during EFMC2013 is supplemented with a paper session on Added Value of FM, including presentation of the three papers mentioned below.

THE THREE PAPERS

Two of the papers, both from the Netherlands, concern learning environments. In their paper: "Can Facility Management contribute to study success", Kok, Mobach and Omta investigate this topic based on a large national online survey among 1,752 lecturers at 18 Dutch Universities of Applied Science. The results indicates that the perceived quality of facility services, that are education-related and provide personal comfort to teachers, have a positive relationship with study success. Layout, fitting out, and general facility services show no statistically significant relationship with study success, whereas (traditional) workplaces have a negative relationship.

In the other paper: "Facilitating New Ways of Learning in Dutch Higher Education", Beckers and Van der Voordt compare New Ways of Working and New Ways of Learning. Based on interviews with facility managers in 14 Dutch Institutes of Higher Education they conclude, that new ways of learning requires an integral approach that considers new ways of education, the new student, digitisation of learning and teaching and new learning space.

In the third paper: "Relationship Value in FM: A Customer Perspective", Coenen and Cui from Switzerland identify nine dimensions of relationship value divided in benefits and sacrifices. They investigate these with a combination of qualitative and quantitative methods. The surprising result is that not only the benefit dimension but also the sacrifice dimension is positively correlated with relationship value for the customer in their relationship with FM suppliers.

Relationship Value in FM: A Customer Perspective

Prof. Dr. Christian Coenen and Ying Ying Schäfer-Cui
Institute of Facility Management, Zurich University of Applied Sciences
Switzerland

ABSTRACT

Purpose – Facility management (FM) is a relationship-management discipline. The present study focuses on business-to-business (B2B) buyer-supplier relationships between FM customers and external suppliers. The research adopts the buyer's perspective in order to identify the dimensions of relationship value. The objective is to conceptualize a relationship-value framework in the context of FM.

Theories – Relationship management and value constitute the fundamental theoretical background of this research. Value dimensions are developed based on previous research of relationship value in B2B relationships.

Design/methodology/approach – This research is conducted as a mixed method, including a qualitative literature review, workshops and discussions with FM academics, interviews with FM managers and a quantitative online survey.

Findings – Nine dimensions of relationship value were identified and a framework of relationship value for FM was established and measured. The sacrifice dimension positively correlated with relationship value in the relationship with FM suppliers, which is different from previous studies of relationship value in the context of business markets.

Originality/value – This research narrowed the gap in relationship-value studies in FM. The findings can contribute to traditional theory that customer value can be the add-on between benefits ("what you get") and sacrifices ("what you give"), rather than just a trade-off between these two dimensions. There are some implications for practitioners. For example, FM suppliers could involve customers in their daily work, since the more effort the customers contribute to the relationship, the higher value they perceive from it.

1   INTRODUCTION

Adding value to corporations is a fairly new research trend in the facility management (FM) field (Jensen, 2010). As a relationship-management discipline, FM is the management of relationships between internal and external customers and suppliers (Coenen et al., 2012b). It is worthwhile exploring what constitutes a good relationship between FM customers and suppliers.

Relationship management, especially buyer-supplier business relationships and their value, has been an important and increasingly studied field in academic marketing literature (Dwyer, et al., 1987; Morgan & Hunt, 1994). In marketing practice, more companies than ever are investing in building good relationships with customers or suppliers (Verhoef, 2003). Therefore, it is necessary to understand customer needs and expectations in a relationship.

Business relationships are set up through delivering FM services and contact between customers and external FM suppliers. This research starts from a customer's point of view to investigate which value dimensions can be achieved from the specific relationship with external FM suppliers. Coenen et al. (2012b) provided a deeper understanding of relationship value in FM. They discussed the customer-perceived value and illustrated value dimensions to provide a contrast to the dominating financial-value perspective in FM. The dimensions of

customer-relationship value in FM have not yet been closely examined. For example, there is a lack of knowledge on the salient value dimensions (benefits/sacrifices) of the FM business relationship.

2   LITERATURE REVIEW

2.1   Facility management and key relationships

CEN (2006) defined facility management as "integration of processes within an organisation to maintain and develop the agreed services which support and improve the effectiveness of its primary activities." From the organisation's point of view, there are three key stakeholders: clients, customers and end users (CEN, 2006). Therefore, the key relationships are the relationships between these three key stakeholders and FM suppliers. Since this research is focused on business buyer-supplier relationships, it is centred on the relationship between customers (defined as organizations, organizational units, or people that procure facility services and have direct relationships with the supplier) and the external FM supplier (defined as organizations that provide the customer with one or more FM services and products) (CEN, 2006).

2.2   Relationship theories

A thorough understanding of the theoretical background of relationships is necessary for this research, because different relationship values emerge from different relationship approaches. All approaches introduced below can be found in the FM field. According to Baxter (2008), relationship theories can be classified as economic-, behavioural- or social-based theories.

The economic view of relationships is a start of classical economic theory. Transaction-cost economics (TCE) originated from Coase (1937), who stated that a company forms, is to reduce the costs of purchasing resources in a market. Williamson (1979), MacNeil (1980) and Dwyer et al. (1987) further developed TCE. The latter established models for long-term relationships between buyers and sellers to distinguish transactions and relational exchanges. TCE is a powerful tool for companies to analyse their organisation and strategy (Robins, 1987), and can explain the early stages of relationships between companies to reduce transaction costs (Baxter, 2008). However, it prohibits empirical investigation to assess value in business relationships. As Zajac and Olsen (1993) argue, cost reduction is not the only motivator in forming business relationships. Hakansson (1982) and the Industrial Marketing and Purchasing (IMP) Group, developed an interaction approach to B2B buyer-seller relationships. This interaction approach focuses on the factors that bring buyer-seller relationships closer (Metcalf et al., 1992). The IMP approach emphasised that transactions are merely episodes in on-going buyer-seller relationships. Both suppliers and customers can be actively involved in determining, developing and implementing transactions.

Taking the behavioural or social views of business relationships, the network approach was derived from the IMP approach. It included formal and informal relationships among different actors (such as purchasers and suppliers). Companies within the network helped their counterparts develop (Baxter, 2008) because they needed resource support from each other. The value of a relationship cannot be anticipated (Ford et al., 1996). According to Homans (1958) and Bagozzi (1975), tangible and intangible goods are exchanged in a social network, such as money, products, services and reputation. People communicate and negotiate to influence others' satisfaction of their needs. Dore (1983) adapted this social-exchange concept to business relationships. *Competence* is a company's ability to allocate tangible and intangible resources in a way that helps it compete in its market (Sanchez et al., 1996). The competence theory introduced "an essential supply side dimension to industry dynamic" and recognised "important interdependencies and complementarities (Sanchez & Heene, 1997). According to Eisenhardt (1989, p. 58) "agency theory is directed at the

ubiquitous agency relationship, in which one party [the principal] delegated work to another [the agent], who performs that work."

2.3   Relationship value theories

Long-term buyer-seller relationships are formulated because the partners expect synergies, which are the values that each partner could not achieve alone (Wilson & Jantrania, 1995). Partners in this business relationship share resources, technology and knowledge to improve their competitive advantage. Borys & Jemison (1989) called this process *value creation*.

According to Zeithaml (1988), *customer value* can be defined as the trade-off between benefits and sacrifices in a market exchange. Ulaga (2003) identified four characteristics of customer-perceived value. It is subjective (Kortge & Okonkwo, 1993), it is a trade-off between benefits and sacrifices (Zeithaml, 1988), benefits and sacrifices can be multifaceted (Grisaffe & Kumar, 1988), and finally, value perceptions are relative to competition (Gale, 1994).

Relationship value consists of benefits and sacrifices (Anderson et al., 1993; Gwinner et al., 1998; Ulaga & Eggert, 2005). Therefore, higher value in relationships occurs either from increasing benefits or decreasing sacrifices (Ravald & Grönroos, 1996). Academics have investigated these two dimensions. According to Coenen et al. (2012b), these relationship issues go far beyond simply financial aspects. Berry (2009) noted that sacrifices have both monetary (economic costs) and nonmonetary forms (such as inconvenience or incompetent service).

3   METHODOLOGY

The research used a mixed-method approach. It combined a qualitative literature review, in-depth interviews, professional discussions, and a quantitative survey. Possible dimensions of relationship value and potential drivers were initially identified, based on relevant literature on relationships and relationship value in a B2B context. Interview guidelines were then developed, together with visualized cards of value dimensions (Figure 1) and drivers (Figure 2) of the relationship between FM customers and suppliers.

FM (service) Quality		Service Support	
Delivery		Supplier Know-how	
Core Business Support		Personal Interaction	
Direct FM Costs(Price)		Process Costs	
Sustainability		Others	

Figure 1 Visualization of Dimensions of Relationship Value in FM (Cui, 2013)

FM Quality:
- FM performance
- FM reliability
- FM consistency
- ......

Service Support:
- FM-related services
- Customer information
- Activity flexibility
- ......

Delivery:
- On-time delivery
- Delivery flexibility
- Accuracy of delivery
- ......

Supplier Know-how:
- Knowledge of supply market
- Improvement of existing FM services
- Development of new FM services
- ......

Core Business Support:
- Improvement of productivity
- Improvement of user satisaction
- Innovation to improve business process
- ......

Personal Interaction:
- Communication
- Problem solving
- Mutual goals
- ......

Direct FM Costs (Price):
- Price above, below, at competition
- Annual price decreases
- Cost reduction programs
- ......

Process Costs:
- Inventory management
- Order-handling
- Performance monitering
- ......

Sustainability:
- Social responsibility
- Environmental friendly
- "Green" economy
- ......

Others:
- ......
- ......
- ......

Figure 2 Drivers of relationship value (derived from Ulaga, 2003)

The second step consisted of six in-depth interviews with senior-level facility managers (Table 1) from different international companies in eastern Switzerland. The participating companies were active in various industries, such as pharmaceuticals, agriculture and financial services. They purchased various FM services from external suppliers. The participants had a direct relationship with their FM suppliers and an average 10 years' experience in this kind of business relationship. The interviews lasted from 60 to 90 minutes. There were three sections of the interview. Respondents were initially asked to describe what kind of relationship they had with their external FM suppliers. Based on this key question, participants answered further questions regarding the specific relationship, such as what kind of activities did they share with their supplier and what reasons would they have for changing their current supplier. In the second part, respondents were asked to describe the benefits and sacrifices of the relationship. To facilitate the process, participants were asked to rank the cards (Figure 1) to evaluate whether these dimensions were important. Participants were also asked to add other elements they considered important in terms of the supplier relationship. Finally, with the help of prepared potential drivers (Figure 2), participants were invited to assess whether these drivers were relevant.

Table 1 Qualitative Study Sample

Name	Participant Background	Company Activity and Size	FM Service and Supplier Context
A	Service Contract Manager, Five years in this position	Agriculture Sales: approx. $11 billion Scale: global Employees: more than 20,000	Almost everything except core business Multiple FM suppliers
B	Facility Manager, 24 years in supportive services, three years in FM	Financial services Sales: approx. $1.5 million Scale: global Employees: more than 3,000	Operational services Multiple FM suppliers
C	Facility Manager, four years in supportive position, eight years as FM manager	Pharmaceuticals Sales: approx. $36 billion Scale: global Employees: more than 111,000	Almost everything at an operational level Multiple FM suppliers
D	Project Manager, 12 years in FM	Pharmaceuticals Sales: approx. $58 billion Scale: global Employees: more than 119,000	Almost everything from production equipment to FM services Multiple FM suppliers
E	Head of Facility Management, six months in position	Pharmaceuticals Sales: approx. $43 billion Scale: global Employees: more than 80,000	Almost all services Multiple FM suppliers
F	Director of Property Management, 10 years in position	Banking, Finance Sales: approx. $30 billion Scale: global Employees: more than 63,000	Almost all FM services except core business Single FM supplier

After the interview session, workshops and discussions with FM academics were set up to formulate the quantitative measurement tool. To ensure the content validity of the measures (Gilbert & Churchill, 1979; De Vellis & Robert, 2003), several steps were taken. Nine dimensions of relationship value and 34 drivers were developed (Figure 3) on the basis of the qualitative study and the discussion with FM academics. The questionnaire was developed based on these value dimensions and drivers. The questionnaire comprised three parts. In the first part, participants provided general information about their companies. The second part contained items for evaluating the relationship value and a list of items tapping the relationship constructs. All items used seven-point rating scales (1 = "strongly disagree"; 7 = "strongly agree"). In the third part, participants responded to a set of questions describing themselves and what makes a FM-supplier relationship valuable for them.

After the pre-test by three facility managers, the online questionnaire was sent to companies in Denmark, Germany, the UK and Switzerland that outsourced FM services. The participants were selected from members of IFMA, FM Alumni Switzerland, CFM Denmark, and personal contacts. The targeted participants were in senior positions, and all of them had direct relationships with FM suppliers. A total of 478 e-mails with the questionnaire were sent.

4   ANALYSIS AND RESULTS
4.1 Dimensions of relationship value in FM
The nine dimensions of relationship value, together with drivers (Figure 3), were identified based on relevant literature, interviews and discussions with FM academics. The meaning of each value dimension was as follows.
Relationship value dimension 1: FM Service Quality

According to CEN (2011), service quality is fundamental, since the quality of the support processes may considerably influence the primary activities and organizations objectives of the client. In business buyer-supplier relationships, product quality is a critical dimension of relationship value from suppliers (Ulaga, 2003; Lapierre, 2000). The quality of certain FM services is the extent to which the supplier's services meet the customer's specifications. Key aspects are performance, reliability and consistency over time.

Relationship value dimension 2: Service Delivery

Delivery performance is also an important dimension in value provision by external suppliers. As Ulaga & Eggert (2006b) described, suppliers create value in this area by consistently meeting delivery schedules, adjusting to changes in delivery schedules and consistently delivering the correct FM services. Therefore, this value dimension is influential to value provision in the relationship between customers and FM suppliers.

Relationship value dimension 3: Supplier Know-how

In many industries, companies turn to suppliers to help them achieve a stronger competitive position (Ganesan, 1994). Research in relationship management suggests that the buyer-supplier relationships represent a strategic resource to gain competitive advantages (Wernerfelt, 1984; Jap, 1999; Hogan & Armstrong, 2001). Customers seek to access the critical resources in a supplier relationship. Kalwani and Narayandas (1995) stated that companies search for access to suppliers' resources, skills and strength in long-term buyer-supplier relationships.

Suppliers may hold a specific technical expertise, which the customer may not have in-house or may not want to acquire. Therefore, customers may benefit from their suppliers' know-how in multiple ways (Ulaga, 2003). FM suppliers provide value to their customers by offering access to knowledge from a supply market standpoint, assisting the customer in improving existing services and developing new services. In the interviews, the managers confirmed this value dimension, in which they expect to gain more professional knowledge from external partners.

Relationship value dimension 4: Core Business Support

As defined by CEN (2006), FM provides services to support customers' primary activities. Therefore, whether customers can get support for their core business from external FM suppliers is an important dimension to evaluate the buyer-supplier relationship. From studies in the FM field, suppliers can add potential value in this dimension by improving employees' productivity, increasing user satisfaction and innovating customer's business process.

Relationship value dimension 5: Troubleshooting Support

This dimension was originally defined as *service support*, which was identified from relevant literature. After the interviews with facility managers and discussions with FM academics, the dimension was modified to *troubleshooting support*, which fits the character of FM. CEN (2011) proposed that the company's primary activity required that FM suppliers identify and analyse the potential risks/criticality of the product and services delivered to the primary activities in case of unavailability or non-performance. FM suppliers can create value by supporting customers with solutions to problems and taking responsibility when the problem is their fault.

Relationship value dimension 6: Personal Interaction

Although business relationships are established between organisations, they are actually managed by individuals (Ulaga, 2003). People make relationships work or fail (Wilson & Jantrania, 1995). Personal relationships are part of the relational exchange, and buyers consider personal relationships as one important aspect of purchasing (Dwyer et al., 1987; Dwyer & Tanner, 2002).

The FM managers emphasised this value dimension in the interviews, since they preferred partnership relationships with FM suppliers. Therefore, personal interaction is an important

aspect that can benefit customers from cooperation with FM suppliers. As shown in Figure 3, there are several benefits in this dimension that customers seek to get from their external suppliers.

Relationship value dimension 7: Sustainability

Sustainability is an important issue for FM, having an important position in facility managers' agenda (Cotts et al., 2010). After the interviews, workshops and discussions with FM academics, the final drivers in this dimension were modified, as shown in Figure 3, to assess sustainability of relationships between customers and FM suppliers.

Relationship value dimension 8: Price

In the research of customer company's costs in buyer-supplier relationships, Cannon and Homburg (2001) mentioned direct product cost, which is the actual price suppliers charged. Price as sacrifice was the most easily identified dimension (Ulaga, 2003). The price of FM services was an important consideration when selecting suppliers. Managers mentioned that the price of FM service was their top focus when considering purchasing services. They looked at whether the price was above, below or at a competition level, and whether the supplier had annual price decreases and cost-reduction programs.

Relationship value dimension 9: Process Costs

According to Ulaga (2003), companies collaborate in relationships to achieve improvements in overall operations, not just price reductions. Other costs occur in the process of acquiring, operating and monitoring. Particularly in FM, costs take monetary and non-monetary forms, such as time or effort. FM suppliers can find multiple ways of adding value through this dimension.
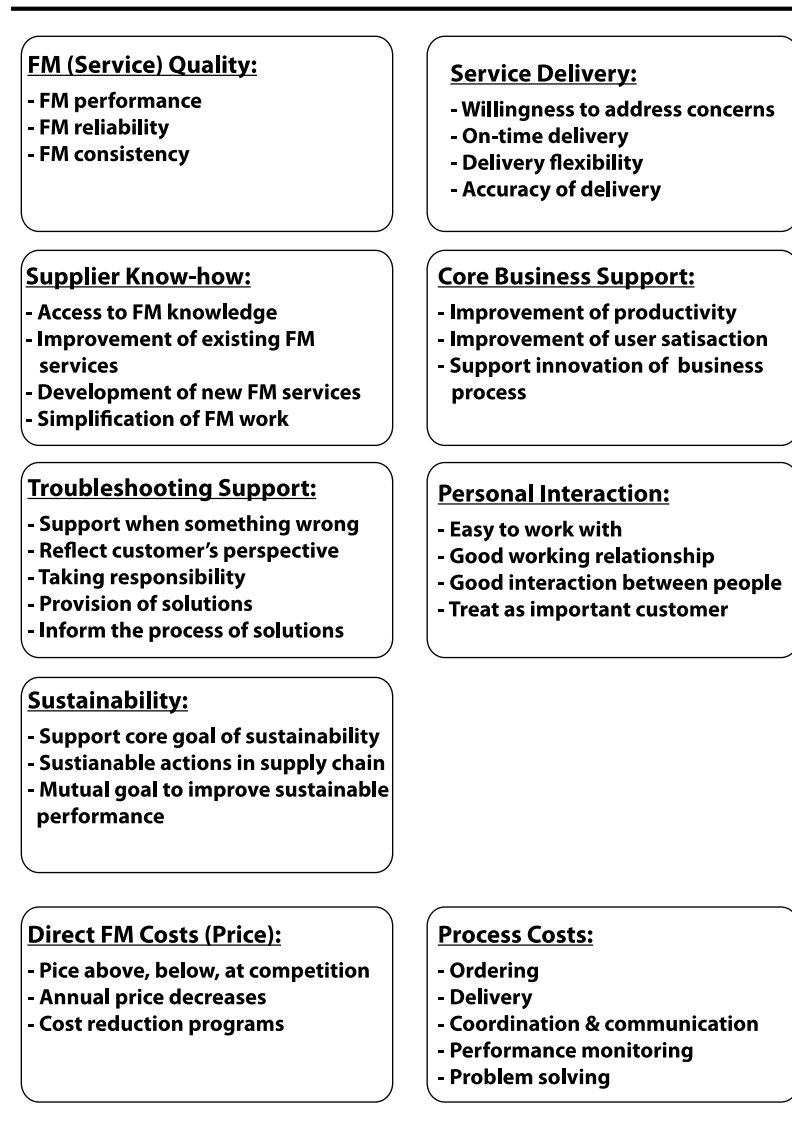
FM (Service) Quality:
- FM performance
- FM reliability
- FM consistency

Service Delivery:
- Willingness to address concerns
- On-time delivery
- Delivery flexibility
- Accuracy of delivery

Supplier Know-how:
- Access to FM knowledge
- Improvement of existing FM services
- Development of new FM services
- Simplification of FM work

Core Business Support:
- Improvement of productivity
- Improvement of user satisaction
- Support innovation of business process

Troubleshooting Support:
- Support when something wrong
- Reflect customer's perspective
- Taking responsibility
- Provision of solutions
- Inform the process of solutions

Personal Interaction:
- Easy to work with
- Good working relationship
- Good interaction between people
- Treat as important customer

Sustainability:
- Support core goal of sustainability
- Sustianable actions in supply chain
- Mutual goal to improve sustainable performance

Direct FM Costs (Price):
- Pice above, below, at competition
- Annual price decreases
- Cost reduction programs

Process Costs:
- Ordering
- Delivery
- Coordination & communication
- Performance monitoring
- Problem solving

Figure 3 Relationship Value Dimensions and Drivers (Cui, 2013)

4.2 Quantitative analysis and results

As described, 478 emails with a questionnaire were sent to targeted participants. Within six weeks, 60 respondents completed the questionnaire (response rate: 12.55 %). Six responses came from Denmark, three from Germany, two from UK, 47 from Switzerland and two from other countries. The respondents were from different industries and held senior positions in their companies. They had an average of eight year experience in this position and an average of 6.9 years in a relationship with their FM suppliers. Considering the fact that there was no pre-notification of the participants, only partial follow-up contacts, a rather low issue salience for an average participant and a medium length of the questionnaire, this response rate still can be considered as satisfactory.

All 60 respondents were taken into the quantitative analysis, although 11 of them from other countries. Because they are all European countries and the 11 companies are international and most of them have branch offices in Switzerland.

Firstly, reliability analysis was conducted to test whether the different items, which represented the measure of one variable, could indeed be combined within one scale (Field,

2010). With the help of SPSS, Cronbach's alpha indicated overall high reliability of the questionnaire. Values were approximately 0.69 – 0.95 (Field, 2010).

Before testing the framework of relationship value (Figure 4), confirmatory factor analysis was applied by using SmartPLS 2.0. Partial least squares (PLS) analysis was conducted because of the formative nature of the higher-order value construct. This estimation procedure accommodated both reflective and formative measures (Fornell & Bookstein, 1982). The framework of relationship value was measured on the basis of the higher-order formative dimensions, which were identified from literature and exploratory study, and several reflective items that captured these dimensions as a uni-dimensional concept.

An overall goodness-of-fit cannot be reported for the relationship value framework because the objective of PLS analysis is prediction versus fit (Fornell & Cha, 1994). The scale properties of the framework are shown in Table 2. Factor loadings, t-values, average variance extracted (AVE) and coefficient alpha indicated that the framework of relationship value had an acceptable level of convergent validity (Chin et al., 2003).

Table 2 Scale Properties of Relationship Value

Item	Dimension	Factor Loading	T value	AVE	Coefficient Alpha
FMQuality1	Benefits	0.91	19.09		
FMQuality2		0.96	69.88	88%	0.94
FMQuality3		0.95	49.82		
Delivery1	Benefits	0.81	10.26		
Delivery2		0.92	27.68	77%	0.90
Delivery3		0.91	32.56		
Delivery4		0.87	13.97		
Know-how1	Benefits	0.92	23.71		
Know-how2		0.96	106.18	91%	0.97
Know-how3		0.96	110.58		
Know-how4		0.96	83.70		
Core Support1	Benefits	0.93	57.36		
Core Support2		0.93	33.94	78%	0.85
Core Support3		0.78	10.19		
Troubleshooting1	Benefits	0.83	12.78		
Troubleshooting2		0.87	18.05		
Troubleshooting3		0.84	15.12	76%	0.92
Troubleshooting4		0.92	39.88		
Troubleshooting5		0.91	25.47		
Interaction1	Benefits	0.92	22.90		
Interaction2		0.95	42.02	85%	0.94
Interaction3		0.92	28.33		
Interaction4		0.91	20.48		
Sustainability1	Benefits	0.88	25.94		
Sustainability2		0.91	22.56	83%	0.90
Sustainability3		0.94	52.21		
Ordering Costs	Sacrifices	0.92	54.80		
Delivery Costs		0.74	6.52		
Coordination Costs		0.87	22.86	69%	0.89
Monitoring Costs		0.80	11.05		
Problem Solving Costs		0.81	13.41		

| Price | Sacrifices | 1.00 | Single indicator |

After summing up the scale of each value dimension, correlations between the dimensions in the first order construct were computed by SPSS, as shown in Table 3. They provided an initial indication that the data matched the pattern shown in the proposed framework (Figure 4) and that the correlation patterns showed that the constructs in the framework had convergent and discriminant validity. FM quality, delivery, know-how, core support, troubleshooting, interaction and sustainability correlated very well with the benefits dimension (all above 0.79). They correlated well with each other within the benefits dimension (all above 0.56). The price and process costs correlated with the sacrifices dimension at 0.84 and 0.87 respectively, suggesting convergent validity.

Table 3 Pearson Correlations between Value Constructs

Construct	1	2	3	4	5	6	7	8	9	10
1 FM Quality										
2 Delivery	0.93									
3 Know-how	0.63	0.67								
4 Core support	0.69	0.76	0.81							
5 Troubleshooting	0.56	0.67	0.74	0.79						
6 Interaction	0.80	0.79	0.64	0.69	0.63					
7 Sustainability	0.68	0.64	0.79	0.67	0.58	0.67				
8 Price	0.27	0.25	0.38	0.23	0.07	0.26	0.45			
9 Process Costs	0.15	0.20	0.27	0.14	0.08	0.20	0.29	0.77		
10 Benefits	0.87	0.90	0.86	0.88	0.79	0.85	0.80	0.27	0.19	
11 Sacrifices	0.16	0.22	0.34	0.22	0.13	0.18	0.33	0.84	0.87	0.23

Note: Correlations were between the summed scales of the constructs; minimum significance of correlation was 0.05 (two-tailed): most were at 0.01.

Estimation of measurement and structural models that more rigorously assessed validity of constructs in relationship value were analysed by AMOS. Higher-order measurement models assessed convergent and discriminant validity of the lower-order constructs and discriminant validity of the higher-order constructs modelled in Figure 4.

Table 4 shows information for judgment of convergent validity of the first-order value dimensions. The first column indicates the paths in the measurement framework corresponding to the paths on the left of Figure 4. The next columns show the regression weight and its standard error for each of these paths. The critical ratio that follows these is the ratio of the regression weight to the standard error. The *p*-value then gives the probability of such a critical ratio occurring. The last column provides the correlation between the constructs as calculated in SPSS. The information in Table 4 shows that the regression weights for the paths from the second-order to the first-order constructs were all good. Most of them were significant at $p < 0.001$ (Anderson & Gerbing, 1988), except in the path sacrifices to price ($p = 0.002$), which was acceptable.

Table 4 Convergent Validity of First-Order Value Dimensions

Path	Regression Weights	Standard Error	Critical Ratio	P Value	Correlation
FM Quality ← Benefits	1.17	0.15	7.75	***	0.87
Delivery ← Benefits	1.11	0.14	7.99	***	0.90
Know-how ← Benefits	1.04	0.17	6.29	***	0.86
Core Support ← Benefits	1.00	0.15	6.82	***	0.88
Troubleshooting ← Benefits	0.83	0.14	5.84	***	0.79
Interaction ← Benefits	1.08	0.15	7.00	***	0.85
Sustainability ← Benefits	1.00				0.80
Process Costs ← Sacrifices	1.00				0.87
Price ← Sacrifices	1.47	0.48	3.04	0.002	0.84

Note: Regression weight of 1.00 indicates that this path was fixed at 1. *** indicates the probability of occurrence of the critical ratio was less than 0.001.

Bootstrapping in SmartPLS assessed discriminant validity. Two-hundred replications calculated the correlations between the constructs of relationship value, as shown in Table 5. The last two columns show the mean ± 2 x standard errors (SEs) for each pair of constructs, at both the lower and upper level of the relationship value framework. None of these value ranges overlapped the value of 1, supporting discriminant validity of the constructs in the framework (Anderson & Gerbing, 1988).

Table 5 Discriminant Validity of Value Dimensions

Bootstrapped Correlation between	Mean of bootstrapped correlation	Standard error (SE)	T statistics	Mean Plus 2xSE	Mean Minus 2xSE
Benefit → Relationship value	0.69	0.09	7.74	0.87	0.51
FM Quality → Benefits	0.15	0.01	15.40	0.17	0.13
Delivery → Benefits	0.17	0.01	13.92	0.19	0.15
Know-how → Benefits	0.19	0.02	11.94	0.23	0.15
Core support → Benefits	0.13	0.01	13.51	0.15	0.11
Troubleshooting → Benefits	0.21	0.01	18.07	0.23	0.19
Interaction → Benefits	0.19	0.01	14.04	0.21	0.17
Sustainability → Benefits	0.13	0.01	12.59	0.15	0.11
Sacrifices → Relationship value	0.08	0.11	0.79	0.30	-0.14
Process Costs → Sacrifices	0.80	0.01	71.13	0.82	0.78
Price → Sacrifices	0.24	0.02	13.26	0.28	0.20

Summated scales were developed for each value dimension. They operated as formative indicators for the higher-order dimensions of relationship values: Benefits and sacrifices

(Zeithaml, 1988). The relationship value was addressed by three reflective items. Figure 4 summarizes the conceptualization of relationship value in FM as a multidimensional, higher-order, formative construct, and reports the parameter estimates based on PLS analysis. Relationship benefits are positively correlated with relationship value (r = 0.68). Relationship sacrifices are also positively correlated (r = 0.08), although the effect size is small. Overall, the value dimensions scale shared 50 percent of variances with the relationship value.
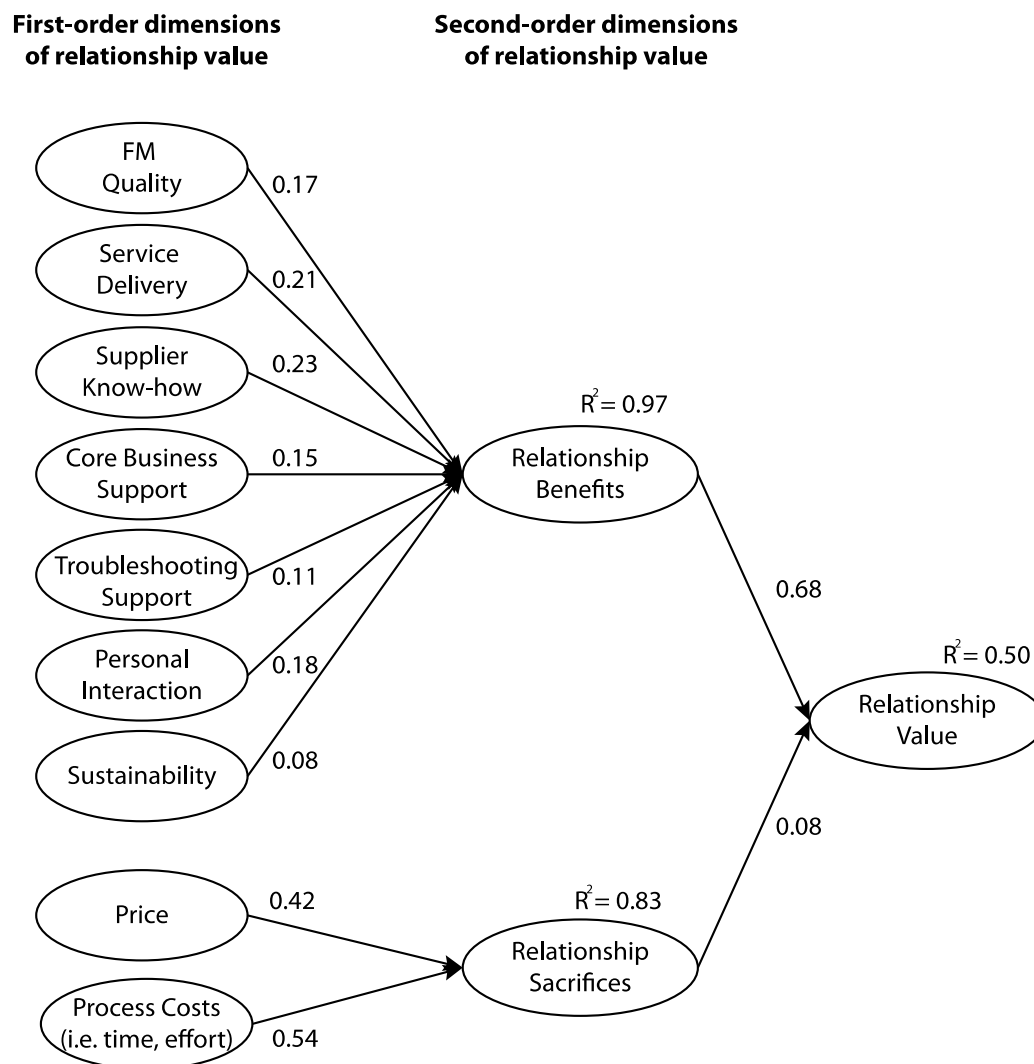
Figure 4 Conceptualization of Relationship Value in FM (Cui, 2013)

5   CONCLUSION

The framework of relationship value in FM with nine dimensions (Figure 4) from a customer's perspective was established and tested, based on a formative measurement model by PLS. This approach was adapted from Ulaga (2003) and Ulaga and Eggert (2003, 2006a), who investigated relationship values from the buyer's perspective in business contexts and measured how these value components influenced the relationship values.

5.1   Value dimensions

The results in Figure 4 indicate that the relationship benefits dimension positively correlated with relationship value, which was consistent with past relationship-value research in business contexts (e.g., Lapierre, 2000; Ulaga and Eggert 2006b, 2009). However, the results of the relationship sacrifice dimension were distinct from Ulaga and Eggert (2006b, 2009). As shown in Figure 4, the relationship sacrifice was positively correlated with relationship value (path coefficient r = 0.08, although not significant). These results could be explained by the fact that services are intangible, and customers need to contribute time and effort in discussion with FM suppliers to make sure that services are performed correctly and on time. Customers also need to inform their FM suppliers when some core strategies change, because certain FM services also need to be modified to fit the new requirements. By doing this, customers may perceive the relationship value as greater, even if they sacrifice more in the relationship with external FM suppliers. This finding also supports the idea of value co-creation between customers and suppliers (Coenen et al., 2012a; Alexander 2012). These findings are different from goods-related buyer-supplier relationships, where customers have concrete products as the final point to evaluate the relationship with their suppliers.

5.2   Theoretical Implications

New trends, such as globalisation and outsourcing, are emerging. Single-approach relationships may not be sufficient in business relationships. A mix of economic- and behavioural- or social-based relationships are needed in daily business. Especially in the FM field, it depends on the core business and what types of FM services are required from external suppliers. Customers may combine several approaches to manage the relationship with their FM suppliers.

This study provides another possibility for customer-perceived value, which was traditionally defined as the trade-off between benefits and sacrifices (Zeithaml, 1988). The sacrifice can be a driver that positively influences the buyer-supplier relationship, meaning customer value can be the add-on between benefits and sacrifices.

5.3   Managerial Implications

For FM suppliers, the nine described dimensions of relationship value and drivers (Figure 3) can be seen as references to understand customer expectations regarding a successful relationship. Since certain types of customer sacrifices may increase their perceived value, FM suppliers could consider involving the customers more in their relationship, and therefore co-creating value.

For FM customers, the study provides a set of dimensions that can be used as assessment tool for judging what value can be added from an external FM supplier. Customers emphasize relationship benefits, whereas suppliers mainly focus on relationship sacrifices (Lyons et al., 1990). However, in a mutually beneficial relationship, which may bring more value to both sides, customers could also consider contributing more in the relationship with suppliers.

5.4   Future Research

This research opens up opportunities for further understanding of value creation in buyer-supplier relationships in the FM context. Each value dimension is worthwhile to investigate more deeply. For example, the FM service-quality dimension can be examined according to the customer's needs and how to assess and guarantee that quality is consistent over time. It is also important to evaluate the relationship from a FM supplier perspective, as Ford and Hakansson (2006) recommended. This study also offers evidence for the research of value co-creation with customers, since customer sacrifices may increase their perceived value in the relationship.

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Facilitating new ways of learning in Dutch higher education

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ABSTRACT

Literature shows that 'new ways of learning' cause a shift in learning settings with a growing attention to facilitating autonomy, interaction and knowledge exploration anytime, anywhere. These trends show evident similarities with developments in office environments known for as 'new ways of working'.

The purpose of this paper is to explore how facility managers in Dutch higher education perceive developments in learning and teaching in order to keep the learning facilities aligned to the changing demands of modern education.

The study first describes the similarities between existing theory of new ways of working in offices and new ways of learning in educational environments, resulting in a conceptual framework that links learning space to new ways of learning. The framework is empirically explored based on interviews with facility managers in 14 Dutch Institutes for Higher Education.

The findings show that new ways of learning requires an integral approach that considers new ways of education, the new student, digitisation of learning and teaching and new learning space. The study presents ten points of attention to pro-actively cope with new ways of learning in higher education institutes.

The results of the research contribute to a better understanding of the alignment of learning space to the evolving needs that come from new ways of learning supported by advanced information and communication technology (ICT) and can be used by facility managers and corporate real estate managers to support strategic decision-making.

Keywords

SPACE MANAGEMENT, LEARNING SPACES, NEW WAYS OF LEARNING, HIGHER EDUCATION

1   INTRODUCTION

The field of facility management shows an increasing interest in the educational sector and the way educational processes can be accommodated and serviced (Dunyar, 2010; Kok et al., 2011; McConnell & Alexander, 2012; Van Sprang, 2012). That makes sense because at the start of the 21th century education stands for substantial changes (Johnson et al, 2011; Robinson, 2010; Collis & Van der Wende, 2002). Today's schools educate young people for the knowledge economy of tomorrow and they must teach them in 21st century skills (Voogt & Pareja Roblin, 2010). New learning outcomes, new kinds of learning processes and new instructional methods currently stressed in psychological and educational theory have resulted in new ways of learning (Simons et al., 2000). There is a shift from a supply-driven approach of traditional learning to new, more customise and demand oriented ways of learning (Van Aalst & Kok, 2004). Students (have to) transform into self-directed learners who take responsibility for their own learning process, learn how to build and use networks, cooperate with others and use information and communication technology (ICT) as a tool to find resources that can help them to achieve their learning goals. The role of school is changing from a place of instruction to a place to produce learning (Barr & Tagg, 1995). The developments in the education sector are reminiscent of the changing needs of knowledge workers in the early 1990s, known as new ways of working (Vergunst, 2011). In new offices work is characterised by a high need for autonomy and interaction of the knowledge worker (Duffy, 2000). The developments in ICT make it possible to work 'anytime, anyhow and anywhere'. New ways of working have resulted in a shift in the appearance of workspaces. In new offices space is designed to stimulate meeting. Office buildings progressively look like grand cafés, restaurants and trendy clubs combined with flexible non-assigned activity-based places for concentration work, formal and informal meetings, and all kinds of information-processing activities.

These developments may lead to the question if and how school buildings and learning environments will undergo similar changes as workspace settings in modern offices? The present study aims to explore the alignment of learning space to new ways of learning in higher education from the facility management perspective, making use of theories of new ways of working in office environments.

2   FRAMING NEW WAYS OF LEARNING

In literature and practice of facility management there is a persistent attention for workplace innovations and new workplace design (Becker, 2004; Greene & Myerson, 2011; Maarleveld, Volker & Van der Voordt, 2010; Van Meel, in Jensen & Nielsen, 2012). Research concerning workplace design not only focuses at the physical office environment. From the beginning publications like 'Workplace by design' of Becker & Steele (1995) and 'The New Office' of Duffy (2000) tried to picture a holistic view of workplace design by linking place to people and process and discussing the subject in relation to developments in ICT, work processes and individual preferences of office users.

An important characteristic of new ways of working is that developments in ICT changed the time - place nexus, resulting in a concept of *hybrid spaces* where knowledge workers have the choice for synchronous and asynchronous interaction on different times and at different places (Kojo et al, 2011). New ways of working are associated with several 'space' dimensions, like physical, virtual, social, emotional, mental space. In essence there are four focus points in terms of new ways of working formed by four opposite values:

organisational focus   ⟷   focus on the individual knowledge worker

physical workplace   ⟷   virtual world

These four focus points lead to four basic principles of new ways of working, underpinned by literature (see table 1):

- The organisational focus is concerned with changing roles of and relationship between managers and employees. Managers have to manage knowledge workers based on results (output-oriented leadership).

- The individual focus refers to knowledge workers that are self-managing and have varying needs for autonomy and interaction in their activities.

- The virtual world is the enabler of working anytime and at any place and makes free and unlimited access to information possible.

- The physical workplace has to be tuned to knowledge workers being able to work anytime and anywhere. The office workplace supports the need for meeting others and also the need to do concentrated work.

Concerning the four focus points (organisation/individual and physical/virtual) literature shows that there are many similarities between new ways of working and new ways of learning (table 1).

Table 1 Basic assumptions of new ways of working and new ways of learning - comparison from literature

	New ways of working	**New ways of learning**
Organisation	Changing roles and relationships between managers and employees (Baane et al., 2010). Output-oriented leadership: knowledge workers are managed on results (Baane et al., 2010).	The teacher doesn't have the monopoly on knowledge. That leads to new didactical forms and a shift in the relation teacher – student. The role of the teacher is changing from 'the sage on the stage to the guide on the side' (Martin et al., 2007).
Individual	Distinction of different types of knowledge workers (Green & Myerson, 2011). Individualisation of the employee: not one size fits all, but one size fits me (Baane et al., 2010).	Characterisation of new learners with different needs and preferences: • homo zappiens (Veen & Vrakking, 2006) • net generation (Oblinger & Oblinger, 2005) • digital natives (Prensky, 2010) Individualisation of the student. From one size fits all towards individual learning routes (Veen & Vrakking, 2006).
Physical	Diversity of spaces that support the need for autonomy and interaction (Duffy, 2000). The new office (Van Meel, 2012). An increasing use of third places (Oldenburg, 2001; Fruianu et al., 2011).	Traditional class room space replaced by variety of learning settings in school buildings and at campuses (Fisher, 2005; SFC, 2006; JISC, 2006; Beckers et al., 2013a).
Virtual	The virtual organisation (Sotto, 1997). Development of the virtual world in knowledge work like Skype, video conferencing, E-business; groups and networks in the cloud (Kojo et al., 2011).	Development of the virtual world in the class room like E-learning, distance learning, web lectures; social media used in education; digital learning environments; groups and networks in the cloud (Jamieson et al., 2000; Oblinger & Oblinger, 2005; Veen & Vrakking, 2006).

Yet, new ways of learning can be framed in a figure that builds on the four opposite values: 'physical/virtual environment' and 'organisation/individual'. The four areas that appear are defined as: 'new learning space', 'digitisation of learning and teaching', 'new ways of education' and 'the new student' (figure 1).

In the next sections this paper explores how the four areas of new ways of learning come together in practice and in what way the separate fields are considered in the alignment of physical learning space to the changing demands of education.
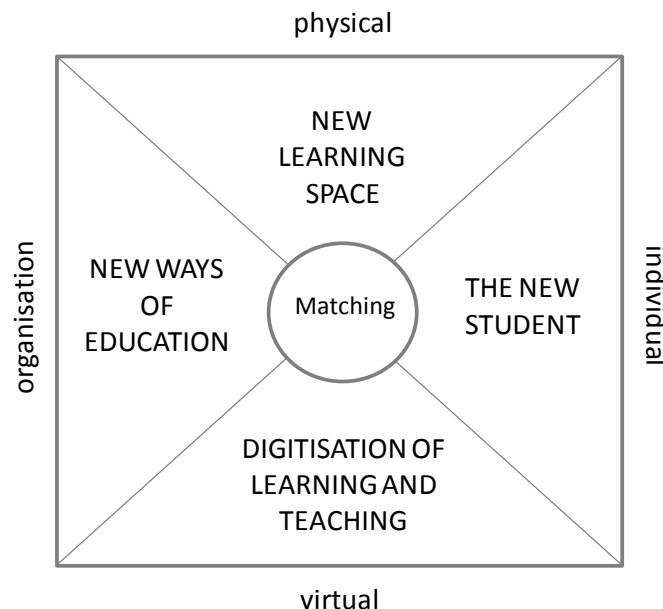
Figure 1 New ways of learning framework

4   EXPLORATIVE STUDY

4.1   Methodology and data analysis

For the practical exploration of the framework interview data were used of a PhD-study from the first author into the effects of new ways of learning on learning space in higher education. First findings of this study will be published in Beckers et al., 2013b.

Interviews were conducted in Dutch Higher professional Education Institutes (HEI), also indicated as University of Applied Sciences. The Netherlands counts 39 HEI with a total of 423,776 students (reference date 2011). The study involved 14 of the largest Dutch HEI that together represent a total market share of 84% of all students in Dutch higher professional education.

The research concerned semi-structured in-depth-interviews with the facility manager, corporate real estate manager or a facility professional in the role of internal consultant or policy officer.

All interviews were tape recorded and transcribed for subsequent analysis. Because multiple data collection contributes to strengthening the grounds of the findings (triangulation) document analysis of annual reports (2010) and strategic plans of all 14 institutions and building walk-throughs were included in the research design as well.

4.2   Results

This section describes how facility managers in HEI experience the four areas of new ways of learning.

New ways of education

Facility managers confirm visible changes in the learning and teaching processes. Education at school shifts from a cognitive process to education as a social process. In new ways of learning there is an increasing 'need to meet'.

Besides the proven concept of teaching in class rooms with one teacher and thirty students, students progressively work together in small project groups. When learning takes place in the class room most groups are smaller than the regular 30 students because of changing educational principles.

Modern education shows more variation in teaching and learning activities that doesn't fit with the scheduled class timetable; for example classes start nowadays often with a short instruction, then students start working on an assignment in small groups and after that students come together again for a plenary closing session.

The new student

Interviewees indicate remarkable differences between students of different faculties e.g. students of an education faculty stay longer at school at the end of the school day and attach much importance to face-to-face contact, whilst economic students leave school immediately after the last lesson is finished and keep in touch online.

The interviews also point out that there are dissimilarities between the preferences of students who study at urban oriented HEI (in large cities) and students who are enrolled at an HEI in rural areas. The latter type of students conduct their individual study activities often at home, while the urban school students prefer to study at school.

In general there is an increase of student expectations and demands, not only regarding their education, but also about the place where they study. There is a strong 'experience factor' in education, due to the new generations. School must be fun and attractive.

> Interviewee: "Education isn't only about learning and teaching, but above all about the whole context around learning and teaching and the atmosphere in which learning and teaching take place".

Digitisation of learning and teaching

Interviewed facility managers mention the increase of ICT and the increasing use of virtual space as one of the most notable aspects of the changing context of learning and teaching. However, according to the interviewees it is not obvious that the increase of ICT leads to a decrease of physical space.

> Interviewee: "The influence of digitisation on school buildings is heavily overestimated".

Respondents don't see a significant incorporation of ICT in the way HEI teach their students apart from the growing use of smart-boards and digital presentations. In the opinion of facility managers the impact of technology will only have serious consequences for the number of square meters if students are stimulated not to come to school to attend lessons, for example because lessons are available online.

New learning space

Considering space for learning and teaching there are two areas of interest: the quantity and quality of space. The main focus is on quantity: taking care of enough square meters of space.

> Interviewee: "the panic of having a lack of space is more stressful than offering the right space quality".
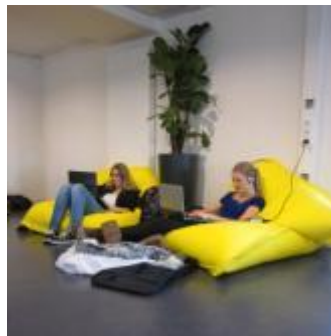
Yet, there is a trend in reducing the number of square meters per student in the last years. This isn't related to supporting new ways of learning in the first place, but due to a strong focus on efficiency and cost reduction.

Concerning the quality of space facility managers indicate that traditional classroom space is progressively being replaced by a variety of learning settings to support learning activities of students (figure 2, 3 and 4), not only inside the building but also by other kinds of learning spaces all over the campus. There is a shift from the classroom as place for learning to the campus as learning space. The growing 'need to meet' leads to an increase of informal learning space where students can work together and being facilitated by hospitality services like grand cafés, restaurants, coffee bars, etc. Due to these 'Starbucks concepts' in schools and the experience factor there is higher standard level of the finishing of building interior.

> Interviewee: "a place to meet is not possible without good coffee and service with a smile".

| Space that supports collaboration | Informal learning space | 'Starbucks concept' in school |

Figure 2, 3 and 4 New learning space

A dilemma of the focus on space efficiency and 'the campus as learning space' is that the supply of generic space for multi-use is at the expense of students who want to identify themselves with a group and want to recognise that group in the building.

Matching

Beside the four areas of new ways of learning another important aspect is how to match the four areas. The interviews show four key items in the matching process:

- The various stakeholders involved don't speak the same 'language'. In the perception of facility managers the educational professionals formulate their needs based on that what they used to do or what they used to have, whereas they should try to formulate what they want to do and how they want to do that (now and in the future) in terms of processes and core activities. Needs and requirements are often operationally and focused on problem solving, such as 'can you remove that wall for me'.

- 'The user' doesn't exist and part of the end users is hardly approachable. In general educational managers are the conversation partner for corporate real estate or facility managers. Only in new construction projects or large scale building renovations teachers and students are involved in the planning process of learning space. Students are difficult to reach, because they are like passers-by and often not even interested in having influence on their future learning space. So in most cases educational managers formulate their idea of the student needs. What students really want or need often keeps implicit.

- Fixed scheduling (timetables) of lessons that align a class room to a teacher and a group of students doesn't comply with new educational activities that alternate more quickly.

- There is a gap between the planning horizon of education and accommodation. Education institutions have 'strategic' plans with a maximum scope of four years. Facility managers and corporate real estate managers have to plan buildings for at least 10 years; in case of new buildings 30 years or even longer.

5   DISCUSSION & CONCLUSION

Many authors have concluded that learning can be affected by the physical environment in which learning takes place (Tanner, 2000; Higgins et al., 2005; Kok et al., 2011).

Despite the wide range of subjects most research focus on 'hard' technical variables in the school environment such as air quality, temperature, noise, etcetera. Only a few publications consider learning space design integrally. Studying these publications showed that all present characteristics of learning spaces as 'design principles' (Jamieson et al., 2000; Oblinger & Oblinger, 2005; JISC, 2006). These 'design principles' are more like points of special interest for new ways of learning as a whole. They not only respond to the physical learning environment, but refer to all four main focus points related to new ways of learning: organisation/individual and physical/virtual. However, most studies are not extensive and are modestly supported by empirical research. Based on the literature review and interviews, our own study may contribute to a better founded understanding of the alignment of learning spaces to new ways of learning. Table 2 summarises the main lessons learned by presenting a set of ten points of attention.

Table 2 Ten points of attention to cope with new ways of learning

Organisation	Anticipate on the shift from a cognitive focus to a social focus in education; Consider increasing flexibility in education processes; Face the need to meet;
Individual	Pay attention to the 'experience factor' in education; Anticipate on dissimilarities in student background;
Physical	Offer a variety of different learning settings; Take care of sufficient informal learning space; Add high quality services to space; Offer a balance between 'the campus as learning space' and visible identification in the building;

Virtual	Make advantage of ICT opportunities;

To incorporate the ten points of attention in space management and to take care of an integral approach of new ways of learning, four matching criteria should be taken into account:

- Try to develop a common language between education people and people that are responsible for real estate and other facilities;

- Organise user contact at all levels;

- Deal with differences between planning horizons of education and accommodation;

- Consider the effects of fixed scheduling of lessons in classrooms.

Although the present study is based on the perception of the supply side i.e. the perceptions and experiences of corporate real estate and facility managers, the results show a remarkable similarity with a Dutch study (Borgijink, 2011) that looked at the perception of educational professionals concerning new ways of learning. Borgijink also comes to the conclusion that the implementation of new ways of learning is "a transition that affects the entire organization" (p4).

This study focused on the perceptions and experiences of facility managers and real estate managers. It turned out that new ways of learning and teaching are an important factor in accommodating higher education. In addition, many other factors have an impact on accommodation decisions, such as cost-effectiveness, the need for nice experiences according to the experience economy (Pine & Gilmore, 1996), the societal need for sustainability, and so on. As such, aligning learning environments to new ways of learning should be an integral part of performance based value adding management. Conceptual frameworks regarding adding value by facilities (see for instance Den Heijer, 2011; Jensen et al., 2012) can be helpful to balance different needs and objectives from a core business point of view and requirements from other stakeholders such as the end users and technical managers.

To conclude

At the start of the 21th century the principles of new ways of working of knowledge workers in offices are more and more being applied in other contexts as well, inter alia in schools and hospitals. New ways of education, digitisation of learning and teaching, a new generation of students and new learning settings come together in 'new ways of learning'. School buildings are progressively developing from buildings with long corridors and mainly classroom settings to a variety of physical and virtual learning environments.

This study makes clear that an integral vision on education and accommodation too often is missing. Integral alignment of the four focus points related to organisation, individual, physical and virtual environment is essential to implementing new ways of learning.

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Can Facility management contribute to study success?

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ABSTRACT

Purpose– The present paper aims to explore to what extent the quality of facility services can be related to the differences in educational achievements in higher education.

Design/methodology/approach - This paper is based on the first preliminary analyses of a national online survey among 1,752 lecturers of 18 Dutch Universities of Applied Sciences. Via explorative desk research, additional data were gathered regarding the educational achievements, size and religious identity of the institutions. Exploratory factor analysis and multiple regression were used to test the propositions.

Findings – The results seem to indicate that the perceived quality of facility services that are education-related and provide personal comfort to teachers have a positive relationship with study success. Layout, fitting out, and general facility services show no statistically significant relationship with study success, whereas (traditional) workplaces have a negative relationship. Also, we found that the size of the education institution strongly negatively relates to study success, and institutions with a Christian identity outperform non-Christian institutions.

Practical implications– These preliminary research findings suggest that a prime consideration in learning space design is the facilitation of social interaction, creating a (virtual) small-scale learning environment in large institutions.

Originality/value - This paper suggests that facility services can assist the quality of higher education.

Keywords
Quality perception, Facility design, Facility services, Study success, Higher education

Paper type: Research paper

1   INTRODUCTION

A growing body of evidence links the quality of the physical environment of schools to outcomes of their occupants (e.g. Fraser and Fisher, 1982; Temple, 2007; Uline and Tschannen-Moran, 2008). Although many other aspects impact the learning outcomes directly and indirectly also, for instance, prior achievement, instructional time, and home environment (Reynolds and Walberg, 1991), one may question whether (re)designing the building in an appropriate manner may then significantly improve the educational achievements. This understanding may then override planners' assumption that space design is technical in nature and that the constraints of funding narrow the choices available, as observed by Van Note Chism (2002).

Previous studies on the relationship between the learning environment and learning outcome cover only small sample sizes of mainly single or regional elementary and secondary schools, and therefore are not representative for the educational sector. This study aims to explore to what extent the quality of facilities explains differences in educational achievements specifically in Dutch higher education. The research question underlying this study is: To what extent is the quality of different facility services positively related to the differences in the educational achievements of Dutch institutions of higher education?

To answer the research question and meet the objective a nationwide cross-sectional non-experimental study was designed. The present paper first presents an overview of the relevant theory and the research model. Then the research methods used and the data collection are detailed, followed by the preliminary results, conclusions and discussion, and limitations.

2   THEORY AND RESEARCH MODEL

The learning environment in terms of educational buildings and their fitting out should be able to motivate teachers and students and promote learning. To support the educational processes it is the role and challenge of Facility management (FM) to add value to the educational environment in terms of enabling teaching and learning for achieving academic objectives at minimum costs and risks. In order to establish this contribution of FM, with Kok *et al*. (2011), information about the effects that the use (or non-use) of facility services have on the outcome of the educational processes must be obtained. Differences in the quality of the facility services may then be related to the differences in the outcomes of educational processes.

For this study we adapted the research model focusing on the impact of facility services on the educational process that consists of knowledge transfer, for example, in the form of lectures and seminars (Figure 1). The outcome of this process is termed the educational achievement. According to Jansen (1996), learning outcomes in higher education can be measured as the percentage of students who pass an exam, e.g. a propaedeutic (foundation year) or final master's degree exam, within one or four years, respectively, after starting the study program. Besides this so-called "numerical returns" or study success, a more commonly used outcome measure is the dropout rate (Bruinsma, 2003). For studying the relationship between the quality of facility services and educational achievements the dropout rate is assumingly less suitable. Whereas study success can be enhanced by a prolonged positive influence of enjoying a good quality of education, and perhaps also of facilities, dropping out most probably cannot. The limited time dropouts enjoy the schools' facilities in contrast with successful students, make that dropping out of higher education entirely can hardly be attributed to poor quality of facility services.
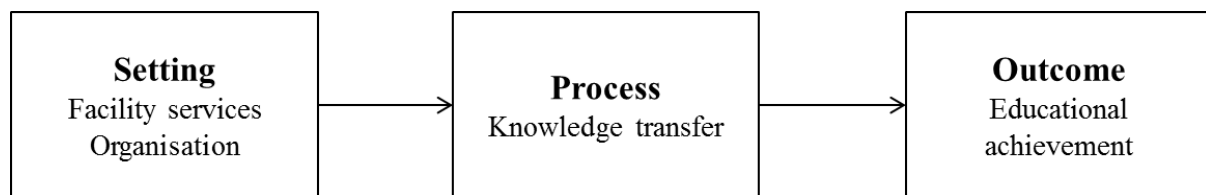
Figure 1. Conceptualisation of added value of facility services in the educational environment adapted from Kok *et al*., 2011)

Facility services as the deliveries of FM come in a wide variety and supposedly each with a different relation with the educational process and its outcome. Both standard FM-literature (Friday and Cotts, 1995; Booty, 2006; Rondeau *et al*., 2006) and existing standards (CEN, 2006) provide a comprehensive overview of facility services, such as accommodation, workplace (e.g. furniture, equipment), technical infrastructure (e.g. maintenance, lighting, climate control), cleaning, fitting out, security, hospitality (e.g. helpdesk, catering and vending), ICT, and logistics (e.g. internal mail, repro and print). Since this present study looks at the educational environment from the user's perspective, the quality of facility services can then be assessed as the subjective quality their users experience in relation to their needs, also termed use value (Bowman and Ambrosini, 2000). Building on Woodruff (1997) and Vargo and Lusch (2004) use value is defined as a customers' (as users) outcome, purpose or objective that is achieved through service. Use value therefore is strongly related to the effectiveness of FM. In general, we expect that different qualities of facility services of educational institutions have a different effect on the educational achievement. More specific, we assume that the quality of facility services is positively related to educational processes and subsequently to their outcome. Therefore the following proposition was formulated:

P.   The quality of the facility services and educational achievements of Dutch Universities of Applied Sciences are expected to be positively related.

The users of facility services in the educational environment are teacher, student, non-educational staff, and visitor. For assessing the quality of facility services, both teachers' and students' appraisal may be used. As primary actors in education, teachers are being responsible for the carrying out of the study program, and students are the ones who have to do the learning. Both engage in a collaborative and formal practice in the educational environment. Although students cannot be ignored, this study focuses on teachers as informants for their professional judgment of the learning environment.

3   METHODS AND DATA COLLECTION

Our study population was drawn from educational institutions of the same academic level, being the Universities of Applied Sciences in the Netherlands. All thirty nine Universities of Applied Sciences were invited to participate in the study, of which eighteen institutions agreed to (a response rate at institution level of 46%). The sample population varies in size (from 504 students to 34,765 students), type of institution (single sector or multiple sector), as well as religious identity, and corresponds to the distribution of the institutions in the population.
Empirical data were collected by using an online survey questionnaire, during the fall of 2011. This allowed us to reach thousands of potential respondents in a short period of time. In the present study the targeted population exceeds 13,000 potential participants. The participants were the teaching staff with an appointment at the University of Applied Sciences (part-time, fulltime) and were invited through an email that was sent to them either

by the principal or the facility manager on a predetermined day. This email included the URL for the website that by clicking automatically gave access to the electronic survey tool. After one week a reminding email was sent, with an appeal to non-respondents to respond.

The questionnaire consisted of 47 items in total. Firstly, six demographic aspects were asked to indicate the respondent. The demographic data included name of the institution, position, gender, age, number of years in current position and years working within the institution. This was followed by an assessment of the teachers' perception of the quality of the facilities. The questionnaire was based on an extensive literature review of Kok *et al.* (2011), and covered a total of 40 items with regard to classrooms, indoor climate, ICT-equipment, repro and print, cleaning, reception desk, catering facilities, maintenance, and building and environment, all with a different reported relation with educational outcome. The items were posed in such a way that the respondent would indicate the use value of that item using seven-point Likert scales from 1, very poor to 7, very good. Finally, respondents were invited to share any remarks, tips, or other comments. Via desk research additional data were gathered of the different institutions being educational achievements, school size, religious identity, and educational study program. We used study success as indicator for educational achievement, defined as percentage of students who successfully leave the University of Applied Sciences within five years after attending.

4   RESULTS

Seventeen hundred and ninety five questionnaires were returned. This is a total of 13% of the teachers' population of the studied eighteen Dutch Universities of Applied Sciences. Response rates of participants varied from 2% for the larger, to 45% for the smaller institutions. After deleting incorrect and insufficient answered questionnaires, seventeen hundred and fifty two questionnaires could be analysed using principal components with varimax rotation and replace missing with mean. Eleven components had eigenvalues over Kaiser's criterion of 1 and in combination explained 71.3% of the variance of the quality measurements of facility services. The scales for all components had high reliabilities, with coefficient Cronbach's α from .74 to .92. The components extracted seemed to relate to maintenance conditions, the layout and fitting out of the building, (traditional) workplaces, catering facilities, ICT facilities, indoor climate, cleanliness, classrooms, classroom conditions, front office services, and finally local printing.

Subsequently, multiple regression was used to estimate the relationship between first size, second type of institution, third religious identity, fourth the principal components (predictor variables), and study success (outcome variable). The size of the different institutions in this study was strongly negatively related with study success (b = -3.266E-6, p < .001), explaining 39.9% of its variance. After controlling for size, type showed no statistically significant relationship with study success. Religious identity, however, was positively related with study success (b = 0.075, p < .001), explaining 7% of its variance. The religious identity of the studied institutions was either none, or Christian. Additionally the identified components had an adjusted r^2 = .035, p < .001 indicating 3.5% of the variance in study success can be explained by the quality of the different facility services, with classrooms (b = 0.003, p < .01), classroom conditions (b = 0.002, p < .1), ICT facilities (b = 0.002, p < .1), cleanliness (b= 0.005, p < .001), front office (b = 0.003, p < .01), and local printing (b = 0.002, p < .05). Traditional workplaces was negatively related to study success (b = -0.009, p < .001), and maintenance conditions, layout and fitting out, catering facilities, and indoor climate were statistically not significantly related to study success.
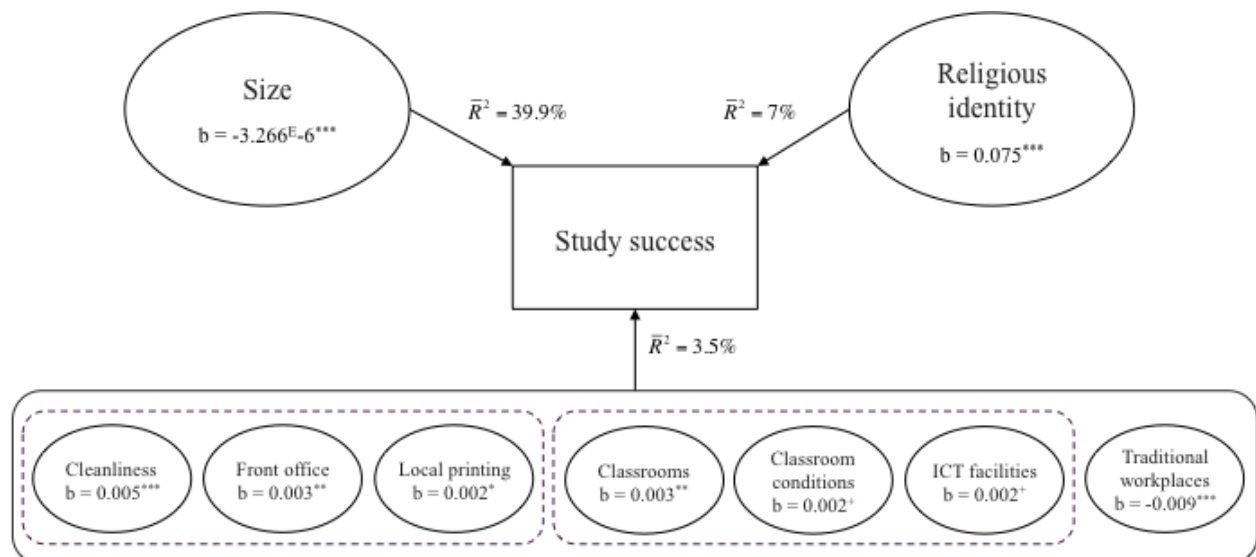
Figure 2. Regression model of the effects of size, religious identity, and facility components on study success.
Note. + p < .1; * p < .05; ** p < .01; *** p < .001. Size concerns number of students enrolled at the higher education institution. Religious identity is either none, or Christian.

In other words, if we are trying to explain why some Dutch higher education institutions have a higher study success than others, we can look at the variation in the quality of different facility services. There might be many factors that can explain this variation in study success (e.g. Reynolds and Walberg, 1991), but our model, which includes size, religious identity and quality of facility services, of which a graphical representation is shown in Figure 2, can explain 50.4% of this variance.

5   CONCLUSION AND DISCUSSION

5.1.   Control variables
Our findings seem to suggest that school size strongly negatively relates to study success, which indicates that as the number of students increases, we can expect a lower study success rate. Silins and Mulford (2002) found that the social and relationship factors of teachers and students interacting are critical for learning. The negative effect of school size on study success may be explained by the anonymity associated with the large scale of some institutions that adversely affects the social aspect of learning. For larger institutions it may be more difficult to become a meaningful environment that appeals to all individuals in terms of identification.
After controlling for size, institutions with a Christian identity showed significantly better educational achievements than institutions without a religious identity. In literature, the term 'Catholic school effect' is mentioned in this context as a generalisation of its positive attainment effect (Pugh and Telhaj, 2008). The results indicate support for the beliefs that there are certain aspects of how religious schools are run that may explain the achievement gap that exists between religious and nonreligious schools.

5.2.   Quality of facility services
This study provides early indications that learning spaces can actually produce conditions that may improve teaching and learning. Yet, we only found statistically significant relationships between seven components and study success. This partly supports the proposition that if there is a good quality of facility services, the higher education institution also performs well.

Items with regard classrooms, classroom conditions, and ICT facilities are positively related to study success, and seem to give teachers the opportunity and the means to perform their core tasks properly. This positive relationship seems not surprising, and teachers may naturally expect these facility services to be supportive to their education. Therefore, we suggest, provided a basic quality level of education-related facilities is met, their users may well succeed in education.

Cleanliness, front office, and local printing are cumulatively most strongly related to study success. These services could be seen as a distinguishing factor that contributes to the good feeling and convenience of teachers, and therefore may be of influence on the motivation of teachers, and study success as a consequence. Given the relatively strong relationship between specifically cleanliness and front office and study success, this may also be due to the fact that their high quality respectively tells something about the order and discipline that exists at the institute and the extent to which the FM organisation can respond rapidly to temporary discomfort of its users. These aspects may prove to be beneficial for the progress of the educational process.

Maintenance conditions, layout and fitting out, catering, and indoor climate, from a teachers' perspective, had no statistically significant relationship with study success and seem to constitute general conditions of the learning environment. However, they may have a significant relation with the attractiveness and appearance of the higher education institution, and may to that effect be deployed for marketing purposes.

Traditional workplaces showed a negative relation with study success. This may indicate that the more privacy teachers enjoy, students may experience a barrier when having questions and wanting to interact with teachers, with possible negative effects on study success. This probably also indicates that, with Van Note Chism and Bickford (2002), the whole campus is potentially a learning space (e.g. corridors, lobbies, outdoor spaces) and a prime consideration in learning space design must be the facilitation of social interaction.

6   IMPLICATIONS OF FINDINGS

Considering the diversity of variables that all have a relationship with educational achievement, and the quality of facility services explaining for 3.5% of its variance, we argue that facility services are part of a complex setting of organisational and spatial aspects that seriously deserves attention to constitute a successful learning environment. Although no causal inferences can be made, and many other aspects impact the learning outcomes too (e.g. Reynolds and Walberg, 1991; Lizzio *et al.*, 2002), the results may be used by school administrators and facility managers to engage in evidence-based decision-making on the use of facility services when seeking to improve their effectiveness in terms of achieving academic objectives. Given the vast amount of money spent on buildings and services (Amaratunga et al., 2000), we suggest educational institutions would better use these scarce resources in an effective manner. The challenge is to design buildings where social interaction and quality of education, and consequently study success is paramount. Also, given the negative size effect on study success we found, creating a (virtual) small-scale environment in large institutions should be considered. The challenge for facility managers is to put users' interests first and to learn to work much better with architects and designers, as argued by Duffy (2000).

7   LIMITATIONS AND FUTURE RESEARCH

The present study has limitations with regard to generalizability. First, the study focuses on teachers' perceptions only, while, with Zeithaml (1988) students may perceive the same

learning environment differently. Especially, since the learning outcome after all is a students' performance, one can argue whether teachers are then the best informants on the quality of the learning environment. Yet, early work of Cooper (1985) shows that teachers are very informative when it comes to assessing the environmental conditions necessary for, and conducive to, the practice of education. It may also be debatable whether it is likely to assess teachers' perceptions, instead off regressing study success against tangible measures of the physical learning environment. We argue that, although tangible measures may be used for evaluation purposes, it is peoples' perception of this physical environment (e.g. ambient conditions, layout, furnishing, and signs) that influences their behaviour (e.g. Becker, 1981; Bitner, 1992).

Second, the study does not address the individual situations of the quality of facility services in different buildings, while, due to teaching in different buildings at the institutions, results may have varied per building. We do acknowledge that in multiple building situations different results per building may occur. However, the relationship between the quality of facility services of different buildings and study success cannot always be identified unambiguously. Teachers can teach in multiple buildings and their perception of the quality of the facility services in a building is likely to be based on the overall view of the educational environment.

Third, the present study does not identify the specifications of the different facility services of which the quality is positively related to study success. To be able to improve the quality of the learning environment, we need to establish performance indicators for this quality.

Therefore, we suggest further analyses to be carried out on the collected data and the underlying construct of the quality of the learning environment, as well as the governance aspects of determining the users' needs and the delivery of facility services to improve the quality of the learning environment. This should allow us to refine our conclusions. Also, conducting this study on a longitudinal comparative base makes it possible to measure the effects of alterations of the spatial environment on study success and to identify the potential success factors amongst the different facility services. For comparison and to obtain a comprehensive picture of supportive or constraining potential of the learning environment, we also recommend this study to be performed amongst students.

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Section two:
FM INNOVATION

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EuroFM WG2
Introduction

FM Innovation - towards a research agenda

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From the outset, innovation has been a recurrent theme and has featured in all EuroFM research symposia. However, there has never been a concerted effort to understand the need for innovation in FM, the culture that supports it and the role of a facilities manager as change agent.

The papers accepted in this Symposium represent the first contributions to the working group on FM innovation. The papers are organised in two sessions dealing with service innovation and workplace innovation. A further contribution by Nardelli (pp.), presented in the EuroFM research workshops, addresses the nature of innovation in FM.

The nature of FM demands an open, demand oriented, user driven approach to innovation. A workshop of FM innovation will explore existing research in this multi-faceted field and will seek to establish objectives and agenda of the proposed working group. The workshop will discuss all dimensions of innovation in FM – eg product, service, technological, organisational – and consider all stakeholder perspectives. A further contribution presents a recent Nordic study on leadership in FM and its implications for innovation.

In their report of the CRE&FM Futures Forum, hosted by Zurich Financial, Varcoe and Hinks suggest that innovation has to be nurtured and rewarded, so the culture and environment must foster this way of thinking. They also highlight the need to recognise the importance of innovativeness, since organisations are collections of people and, whilst you can enable and foster the possibility for people to innovate, you cannot make them innovate. Varcoe and Hinks argue that the art of managing innovation isn't so much about making organisations more innovative as about nurturing an organisational setting that enables and fosters the possibility for innovation to occur, commonly referred to as incubation. They suggest that this includes creating an environment where people feel safe to innovate and share their ideas, especially since the people who come up with an idea don't always have the skills to take it forward.

To preserve any newfound innovativeness, FM will need a culture of open communication and constant reflection and questioning. This poses a challenge for clients and suppliers alike, so it's probably best to tackle it together. Somehow, all of the interests have to be properly aligned or at least mutually tenable.

It has been decided that innovation will be a focal theme in the next Research Symposium. Contributions to the Symposium will be managed by the working group for FM Innovation and research papers will be considered as part of a standing call for the proposed EuroFM open access publishing platform.

Reference
Barry Varcoe and John Hinks, CRE&FM Futures Forum: final report, Zurich Financial, June 2012.

Section Two
FM INNOVATION

Part One
Service innovation

Separate or consolidate? FM in changing times

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Gaps in perceived quality of facility services between stakeholders in the built learning environment

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Reconstructing the image of the cleaner

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Separate or consolidate? – Facility Management in changing times

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ABSTRACT

Endless discussions accompany Facility Management since its beginning. The question whether facilities or facility management is the correct term is still one of the most harmless. Development within the last few years gives rise to the fear that the complete value creation chain as being the core of facility management shall be separated again. This paper wants to contribute to draw the attention to the long tradition and special characteristics that are part of facility management.

The basic thesis of this paper is that there has been a high demand for bundled facility management services ever since. The second thesis is that the special characteristics of facility management can be deducted from the world of physics.

In order to clarify that FM services have been of high importance ever since, historic developments are analysed in order to deduct connections between facilities and human needs from that. In the second part of this paper relationships out of the world of physics are described and afterwards transferred into the world of facility management.

This paper comes to the conclusion that facility management has already been of major importance in medieval times. More than that, it becomes clear that out of this assignment of tasks – highly depending on trust – much more can arise. Not all analogies that were created have worked out. However they have all led to the result that FM has to be applied from a higher rank in a holistic approach. Facility management therefore has to stand as an independent discipline in order to unfold its added value.

Keywords
Facility Management, Analogies, Definition, Added Value, Future Development

1 INTRODUCTION

Facility Management (FM) suffers from too many discussions about definitions and service delimitations. In spite of a European standard one still philosophizes whether the name should be Facility or Facilities Management. At the same time the real estate value creation chain is separated into Asset, Property and Facility Management. Others intend to reorganize job descriptions within Facility Management in order to separate Facility Managers from managing Facility Managers. All this shows that there is still no clear identity in our business – and all that with every 10th job (in Germany) being related to FM. It is time that Facility Management takes over a confident position.

2 POINT OF DEPARTURE

The core question posed in this paper is whether Facility Management is the sum of many services or if an added value arises out of this sum of many services. Aristotle has dedicated himself to this question over 2,300 years ago with his thesis "The whole is more than the sum of its parts".

On the other side there is Democritus' thesis "Sweet exists by convention, bitter by convention, colour by convention; atoms and Void alone exist in reality." (Freeman (1948) p. 142) In terms of facility management the question behind these thesis' must be "is facility

management only a cramp around a variety of services?" or is Aristotle right in this specific case and FM grows beyond the sum of its parts. Out of the answer to this question it can be directly deduced, whether FM is an independent discipline which therefore cannot be classified under one of its subheadings.

In order to approach this question this paper describes first of all the historic roots of FM that range far beyond the time of its definition phase. Basis to this question is whether there has been an ever existing need to consider the built environment and associated services in an overall context.

3   HISTORIC ROOTS

The term facility management has its roots in the 1990s. However the duties and responsibilities that are combined in this term have played a decisive role already in medieval times and can still be found in current language up until today. Two examples in the following shall describe how strong duties and responsibilities of facility management have affected the development of the occident.

3.1   The Major-domo

The German word for Major-domo is "Hausmeier" and Grabois describes it in his encyclopaedia of the medieval times (Grabois (1981), p. 265 – translated by the author) "Frankish office established in the 7th century by the Merovingian kings and in charge of the life guards and the royal palatine." This means that the in German still – but most of the time in disrespect – used term "Hausmeister" derives from a medieval office to which the most important premises including verification of necessary security services were entrusted. Out of this very important mutual trust the Major-domo evolved into the prime minister (cf. Grabois (1981), p. 265). Still in current times the term Mayor is used in military as degree of an officer or in public administration being the head of the municipality or city.

3.2   The Chamberlain

Another master of the private chambers evolved into a meaningful office. While the term "valet de chambre" sounds like a very simple employment status, the term Camerlengo is well known out of other contexts. From the personal valet of the pope of the Roman Catholic Church evolved the Apostolic Camera whose leader was the Camerlengo. Höfer and Rahner (Höfer et Rahner (1960), p. 1270 – translated by the author) note regarding the Apostolic Camera "Curial office for the administration of the asset of the Apostolic See with a great past". While the pope could dedicate himself to the propagation of the faith the Camerlengo took care of the secular duties. In this he "not only took over asset and financial management of the papal court he exercised jurisdiction and finally extended the court sovereignty to such a large area that his main auxiliary the 'auditor camerae' became 'iudex ordinarius' within the papal state and the Camerlengo himself represented the appellate court." (Höfer et Rahner (1958), p. 906 – translated by the author) Still up until today the chamberlain (Kämmerer) is responsible for finance in German municipalities. And it was a German chamberlain who established the term sustainability (Nachhaltigkeit) regarding stable long-term developments. Already in 1713 Johann Carl von Carlowitz (Carlowitz (2011) p. 105f – translated by the author) wrote that "wood should be conserved and cultivated in such a manner that a continuous, durable and sustainable utilization is enabled."

3.3   Analysis of the historic roots

The examples clearly show that it has been of major importance ever since to take care of the physical well-being. And this meant in history not only to take care of food, beverages and clothes but also to take care of the physical well-being in form of protection against wind,

weather and enemies. The delegation of responsibility over land, buildings and life guards demanded enormous trust. Only based upon this trust the sovereign could concentrate on his political or religious duties. Was this trust justified; powerful positions arose from these former valets.

4   ANALOGIES

Hardly any other saying could describe the idea of facility management more precise than the one of Aristotle "The whole is more than the sum of its parts". In the translation of W. D. Ross it reads: "In the case of all things which have several parts and in which the totality is not, as it were, a mere heap, but the whole is something beside the parts, there is a cause" (Aristotle Book VIII Part 6). If a building should be more than just a 'heap' of piled matter – so it shall be more than that; a whole is existing.

However this thesis is absolutely not indisputable. Within physics notable theories exist which – at least at first glance – point into the opposite direction. Is it to minimize the zoom factor in order to have the whole in sight? For this theory the term emergence is being used. Or is it to maximize the zoom factor in order to have more detailed knowledge available? The correspondent term in this case would be atomism.

Thus examples out of the field of physics shall be given for both directions. Subsequently these phenomena will be transferred to the world of facility management and it is tried to deduce conclusions from that regarding future developments.

4.1   Examples out of the field of physics and transmission to facility management

The field of physics delivers examples for both emergence as well as atomism. Electrodynamics and thermodynamics deliver examples for emergence whereas the physics of elementary particles delivers a sample for atomism.

Emergence

The term emergence has its roots in the Latin word 'emergo – emergere'. The theory behind it is that certain characteristics of a system cannot be explained by observation of the single parts of the system.

Example 1 – Resonant circuit

By observation of a capacitor (see figure 1) or an inductor (see figure 2) to each component a specific characteristic can be assigned like the capacity (C) to the capacitor and the inductivity (L) to the inductor.

Figure 1: Capacitor   Figure 2: Inductor

If the two components are put together the outcome of this is a dynamic system – the so called resonant circuit (Figure 3).
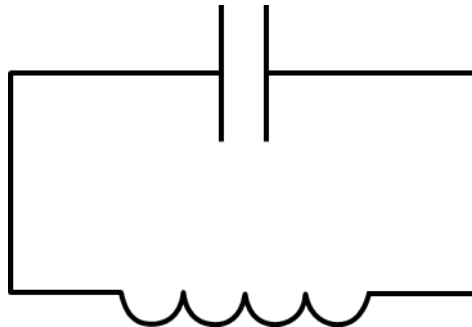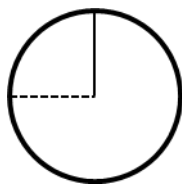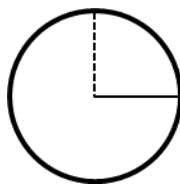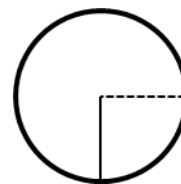
Figure 3: Resonant circuit

Once activated by charging the capacitor (Condition 1), the resonant circuit starts an interplay between capacitor and conductor which sustains endlessly if no resistivity exists. At maximum voltage at the capacitor first of all current will start to flow and rise almost linear. At the same time the rising current induces a magnetic field around the inductor. With decreasing voltage the increase of the electrical current flow will slow down until finally the voltage falls to zero (Condition 2). Now the established magnetic field induces a current although there is no voltage. Through the on-going current the capacitor is recharged but now with opposite polarity compared to condition 1. The magnetic field now declines and the voltage at the capacitor rises to a maximum (Condition 3). Then the electric current starts to flow again with reverse direction and a magnetic field is re-established until the voltage drops down to zero and the magnetic field rises to its maximum (Condition 4). Finally the capacitor is charged by the current induced by the declining magnetic field until condition 1 is reached and the procedure starts again. This correlation between voltage and force of the magnetic field can well be depicted in a circle as shown in Figure 4.
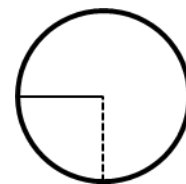

Condition 1   Condition 2   Condition 3   Condition 4
Figure 4: Conditions of the resonant circuit with _____ for voltage and - - - - - for field strength

Both components considered individually give no indication that the combination leads to a resonant circuit which – under ideal circumstances – would oscillate endlessly. Only by combining the two components something new with an absolute specific characteristic emerges. In case of the resonant circuit it is the resonant frequency ω_0 which arises from the specific characteristics of the components:
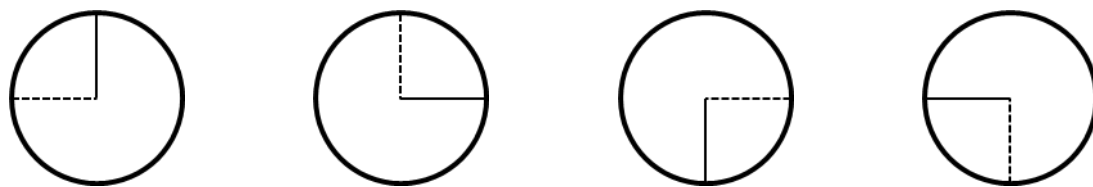
$$\omega_0 = \frac{1}{\sqrt{LC}}$$

Example 1 – transfer to facility management
For the transfer of this first example resonant circuit to the world of facility management it is possible to replace the capacitor by a building which is charged by capital. The inductor corresponds to the operation of the building which creates attraction or in other words attraction force.
The building considered by itself can receive a certain amount of capital and is thereby charged. When a flow of capital runs through the operation, an attraction force for the specific building arises. Both 'components' cannot be found standing alone in reality. Nevertheless it is imperative that – like for the resonant circuit – only the combination leads to a dynamic system.

Once the resonant circuit is being activated by erection or restoration of the building (Condition 1), an interplay between the building and its operation starts, which continues endlessly as long as no 'losses' e.g. in form of profit seeking by the involved parties exists. After the buildings construction phase initially the operational costs start to rise almost linear. At the same time the operation of the building leads to an increase of the buildings attractiveness. Over the time the value of the building will decline until it is reduced to an average level (Condition 2). Through the originated attractiveness the intensive use of the facility will continue. At this point the asset value is not in a balanced relation with operation, attractiveness and market value. Through this the loss in value continues beyond the average level. The attractiveness starts to decline and the asset value will fall to a minimum (Condition 3). At this minimum of the asset value the facility gets an almost negative attractiveness which is indicated in rental prices below the average. This continues until a minimum of the rental price or in other words a maximum of negative attractiveness (Condition 4) is reached. This relationship between the tied up capital (voltage) and attractiveness (magnetic field) again can well be depicted in a circle (see Figure 4).

Figure 5: Conditions of the resonant circuit with _____ for capital and _ _ _ _ for attractiveness

The image resembles strongly the so called property clock. This picture can also be transferred into the plane and leads to a sine or a cosine curve respectively. In this the sine curve would correspond to the rental price as an indicator for the attractiveness and the cosine curve to the tied up capital (see figure 6). Both oscillate around an average value.
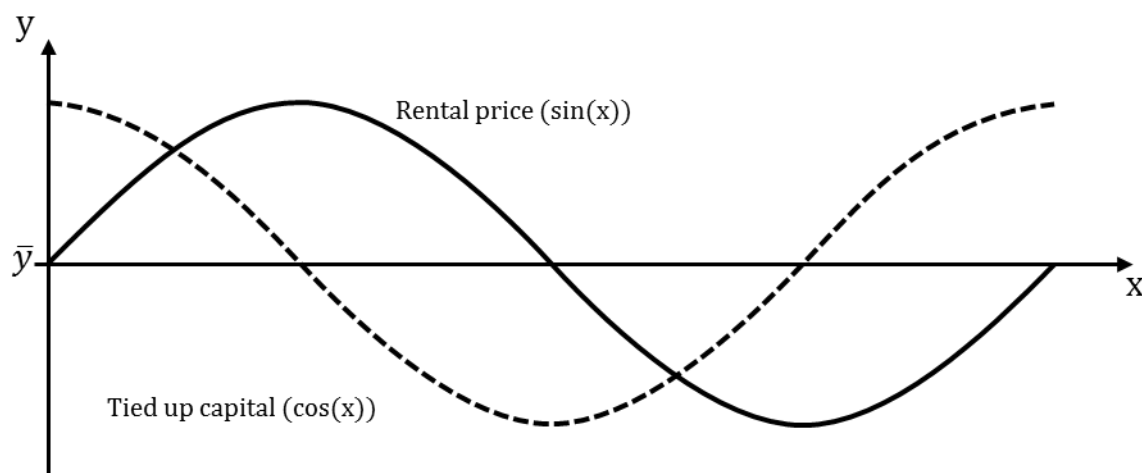
Figure 6: Resonant circuit of a facility

The oscillation can be subdivided in four segments. The heading for each segment according to the rental price would then be:

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1. Growth of rental price
2. Decline of rental price
3. Decay of rental price
4. Recovery of rental price
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Only as a question in this paper the question shall be posed whether there is an analogue facility specific 'resonant frequency' that would be according to the resonant circuit:

$$\omega_0 = \frac{1}{\sqrt{operational\ factor \cdot tied\ up\ capital}}$$

The unproven thesis would therefore be that facilities that are capital intensive and have high operational costs have a higher resonant frequency. The values of rental price and asset value would fluctuate faster between minimum and maximum.

Example 2 – Thermo physical properties

Out of the observation of a single oxygen molecule its temperature cannot be determined.
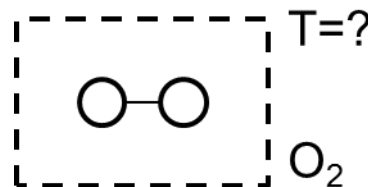

Figure 7: Observation of a single oxygen molecule

Only by observation of multiple oxygen molecules (see figure 8) it becomes possible to determine the temperature of the gas as well as other thermo physical properties of the considered system.
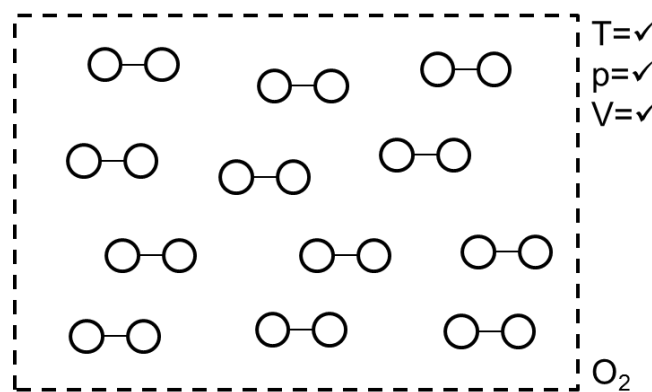
Figure 8: Observation of oxygen as a volume

All three thermo physical properties temperature (T), pressure (p) and volume (V) depend on each other. Thus temperature is a function depending on pressure and volume. If one of the three parameters changes, this has an impact at least on one of the others. These relationships find expression in the ideal gas law (cf. Cerbe Hoffmann p. 57):

$$p \cdot V = m \cdot R_i \cdot T$$

For example when the pressure increases while volume and mass (m) remain constant (isochoric compression), temperature increases in equal measure. This simple equation is only valid within limited parameters. Is the pressure to high, this direct correlation is no longer true. In this case the ideal gas becomes a "non-ideal (real) gas" (Cerbe Hoffmann p. 57 – translated by the author). In the equation R_i stands for a constant that has a specific value depending on the observed gas (specific gas constant).

Example 2 – transfer to facility management

For the transfer first of all the question what the market value of a facility is, shall be posed.

Figure 9: Observation of a facility

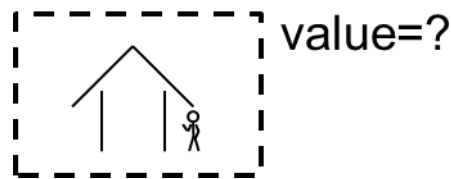Within the transformation the pressure *p* shall be replaced by the income per capita. The Volume *V* shall be the number of inhabitants of the observed region. The mass *m* shall be the space of the observed facility. Further shall be *Ri* the construction value of the facility.

The above describe isochoric compression in the transformation corresponds to an increase of wealth (income per capita) at constant number of inhabitants and unchanged space. In this case the market value of the facility will increase. At the point where the construction value equals the market value, *T* takes the value of 1. The temperature corresponds therefore to a market indicator. In current language this analogy is well established, if we speak of an over-heated market. The searched market value of the facility corresponds to the term $R_i \cdot T$ which would be the construction value multiplied with a market indicator.

Only by consideration of purchasing power and population the construction value becomes a market value (see figure 10).
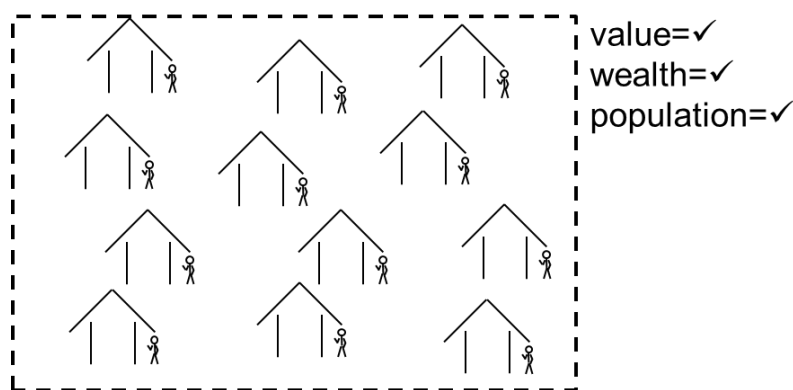
Figure 10: Observation of a facility in the context

The basic principle can easily be expanded to real estate portfolios, cities and municipalities or regions and countries. This means for the facility manager that his duty reaches far beyond the sole consideration of the construction value. Corporate social responsibility means to have the market temperature in sight and influence it by adjusting the level of construction value added to the system or adjusting the amount of available space when appropriate.

Atomism

The atomism assumes that all phenomena can be explained by underlying material principles. This finds expression in Democritus' thesis more than 400 years before Christ: "Sweet exists by convention, bitter by convention, colour by convention; atoms and Void alone exist in reality." (Freeman (1948) p. 142). Each characteristic shall thereby be explainable through knowledge of the inner connection. In modern physics it is well known that the 'impartible' atom is not the last level. The list of elementary particles as the lowest known level is said to be complete since the CERN's report of success about the proof of the Higgs-Boson in the year 2012. This elementary particle explains already since the 1960s the connection between weak and the electromagnetic force (cf. CERN). The atomism assumes that all existing fundamental forces can in the long run be explained by one single "Theory of everything" (see Figure 11).

Electricity	Magnetism	Weak interaction	Strong interaction	Gravitation
Electromagnetic interaction				
Quantum electrodynamics			Quantum chromodynamics	General relativity
Electroweak interaction				
Grand Unified Theory				
"Theory of Everything"				

Figure 11: Steps towards a "Theory of Everything"

The thesis of the atomism therefore is that in the long run all connections can be explained through knowledge about the lowest details and its interactions. The last remaining question would then be if the future would therefore become predictable.

Without considering the last question about the prediction of the future, the quest remains to find explanations as comprehensive as possible – however through knowledge about the lowest detail.

Atomism – transfer to facility management

Transferring the thesis of atomism to facility management or the built environment would mean that a minimum detail in a single specialty of FM would contribute to explain so far inexplicable correlations or irreconcilable differences. Let us take the apparently unbridgeable differences between engineers and economists as an example. On the one hand the engineer and his own particular way of maintaining the built environment the best way possible and the economist on the other hand with his ambition to find the economical optimum. The conjunction between both worlds – between maximum availability and minimum costs – is the consideration of the lifecycle. The connection between technical and commercial facility management is therefore not explainable through an unknown detail but a result of a higher ranked requirement. Although an analogue transformation of figure 11 into the world of facility management is possible (see figure 12) the direction of explanation is inverse compared to the example out of the world of physics.

Technical FM	Infrastructural FM	Space-management	Property Management	Asset Management
				Portfolio Management
Engineering science	Home economics	Architecture	Economics	
Building Services		Commercial FM		
Facility Management				

Figure 12: Facility Management and subdivisions

The connection between technical and commercial facility management is not explainable through new knowledge on economic theories. The connection is deducted from the higher ranked demand for an optimal lifecycle. Same is true for the theory of sustainability. The demands on the systems are changing, as not only a single aspect shall be optimized but the overall system shall be well balanced in all dimensions. From this value all requirements on the subsystems are deducted and translated into the detail level such as the appropriate construction material.

The construction of an analogy in this case did not lead to a result. Within the field of facility management there is no minimum particle existing which is capable of explaining the connection between the different subdivisions. In fact it becomes obvious that the connection between the different subdivisions is a result of a higher-ranking principle.

4.2   Assessment of the analogies

The example analogies out of the emergence field confirm that facility management is more than the sum of its parts. Both examples show that the value of a facility arises from the context of operation and utilization. Out of the interplay the attractiveness of the facility arises. Only because of this fact it appears to the user. The resulting characteristics of the facility constitute the real offer.

The failed attempt of creating an analogy regarding the theory of atomism is as well to be seen as a confirmation of the basic principle of facility management. It is not possible to identify or explain the connections by the knowledge of details. It gets the other way around visible that the higher-ranking principles are necessary in order to deduct the requirements on the detail level. They must be seen in sense of the value or vision for a long-term development of a facility.

In the aggregation of the findings the one analogy leads to the resulting offer of a facility and the failed analogy leads to the incoming demands on a facility (see figure 13)
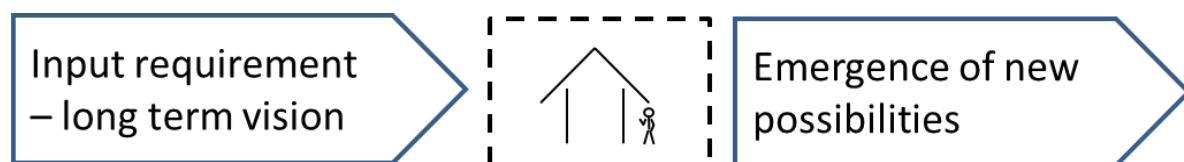

Figure 13: Aggregation of the findings

5   CONCLUSION

Already the roots of facility management show where the emphasis lies or has to lie on. It is all about relieving the awarding authority of duties which are of major importance to it but cannot be accomplished by it. A bond of trust between contracting body and contractor plays a decisive role in this.

The main function of a facility manager is to uncover the options of a facility and to merchandise them actively. At the same time he must be capable of defining the future requirements on a facility in the form of visions and deduct the resulting specifications for the various subdomains.

Facility management has to stick to its basic principle to combine all disciplines that are needed during the lifecycle of the built environment. A fall-back in the delimitation of various segments like it can be seen in the differentiation into asset, property and facility management equals to the loss of the added value of facility management.

The facility manager is well prepared for the future if he combines the following qualities:

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1. Long-term and holistic thinking
2. Interdisciplinary knowledge
3. Trustworthy action
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This must therefore be the main focus in practice and education as well as in research and development. Facility management is a discipline that is absolutely unique and cannot be assigned to a specific branch of study.

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Gaps in perceived quality of facility services between stakeholders in the built learning environment

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ABSTRACT

Purpose - This paper aims to identify perception gaps on the quality of facility services among different users of educational buildings, and provide possible explanations for these perception gaps, and discussing the consequences regarding Facility Management (FM) governance.

Design/methodology/approach - This paper is based on the first preliminary analyses of a national online survey among members of the Board of Directors (n=17), education managers (n=211), facility managers (n=76), and lecturers (n=1,755) of 18 Dutch Universities of Applied Science. We used Mann-Whitney U tests to analyse the data.

Findings – The results seem to indicate a misfit between the perceived quality of facility services of Board of Directors and facility managers of the different institutions on the one hand, indicating an above average quality level, and the education managers and lecturers on the other hand, indicating an under average quality level. FM likely acts in accordance with the Board and both seem dissociated from the primary process and users' support needs.

Practical implications – Based on the research findings, we propose that, when it comes to determining service requirements, FM aligns more with the users of the built learning environment and puts their interests and needs first. Following a user focus approach may contribute to the value-adding capability of FM.

Originality/value - This study is the first to find that FM (implicitly) is aligned with the Board, which however seems to result in users' needs to be underestimated.

Key words: Perception gaps, Built learning environment, Facility management, Alignment
Paper type: Research paper

1   INTRODUCTION

In supporting the primary process of teaching and learning in education institutions, Facility Management (FM) holds responsibility for a broad spectrum of tasks and functions, which according to literature (Friday and Cotts, 1995; Barret and Baldry, 2003; Booty, 2006; Rondeau *et al*., 2006; CEN, 2006) varies from the design and management of buildings and technical systems to catering, cleaning, and security. Obviously FM also has to deal with a

variety of building users, like lecturers and students, but also (top)management, office workers, and other support staff, all with different tasks and possibly corresponding support needs. The challenge is then to maximize the interests of all these groups with an adequate supply of facility services. Therefore FM could bring various methods and instruments into play to determine these needs and then to act accordingly. For this purpose, the use of customer satisfaction surveys is omnipresent. According to facility managers there is also a substantial need to 'sit at the table' with the Board in order to employ FM strategically. Mainstream is, however, that FM in particular puts the needs of end users first and provides services accordingly. On the other hand, there is also a strong tendency of FM to standardise services. The importance attached to benchmarking, to especially compare efficiency with peers, is also indicative for this. FM acts within a force field and balances between the interests of top management to cut costs, the user who wants predictable and adequate performances, and its own interest to create a manageable situation.

Given this complex situation, the question arises about how FM manages to cater to the needs of the various stakeholders. Standardisation, as well as inadequate alignment, may even cause actual or potential FM-performance gaps in terms of not meet users' needs. Determining these gaps, as the difference between the observed situations between different stakeholders, helps to investigate the underlying cause and promotes common understanding in the process of aligning facility services to organisational goals and needs. This may become important for there is substantial evidence of the effects of the built educational environment on academic outcomes (Schneider, 2002; Higgins *et al*., 2005; Temple, 2007; Blackmore *et al*., 2011). The congruence of perceptions of the quality of their physical environment of different user groups then indicates the level of internal fit between FM and education, as operationalized by Fortuin (2007) studying R&D-business alignment. This alignment of FM with organisational needs optimizes the use of resources and is the key to effective FM (Atkin and Brooks, 2000; Green and Jack, 2004; Kaya *et al*., 2004; Then and Tan, 2006). Possible perception gaps may then indicate misalignment between FM and users' needs resulting in inefficiencies and ineffectiveness. To ensure an overall satisfactory quality level of facility services first of all requires an exploration into these possible differences between the quality perceptions of different user groups. Secondly, if perception gaps exist, what measures should FM take leading to a built learning environment that performs best for all its different users? No empirical examination has yet identified and compared the quality perceptions of different educational building user groups. This study does, and by doing so aims to determine whether position within specifically Dutch higher education institutions has an effect on the perceived quality of facility services. The following research question was formulated:

RQ: To what extent do differences in perceived quality of facility services of different users in Dutch higher education institutions relate to their organisational position?

Considering the possible effects of facility services on organisational performances, one of the challenges of FM and school administrators then becomes to create a built learning environment that contributes to the success of the education institution. The present paper will first theorise on quality perceptions gaps and the interrelationships within education institutions. Then the methods and data collection will be described, followed by results, conclusions and discussion. This paper will finish elaborating on implications of findings and limitations.

2   THEORY AND RESEARCH MODEL

The evaluation of a service encounter, as the interaction between users and the built learning environment, is an individual comparison between the services experienced with some set of expectations (Woodruff *et al*., 1983; Parasuraman *et al*., 1985; Brown and Swartz, 1989; Zeithaml *et al*.; 2009). Depending on the results of the comparison, the experience is assessed to be equal to, better than, or worse than expectations. Because of their subjective response to their observation, different users perceive the same built learning environment differently. This may lead to perception gaps. Gaps have been related to the actual use and design intentions of buildings (Zhang and Barret, 2010). In literature we also find perception gaps about the FM added value between organisational managers and FM managers. Managers generally regard FM as a cost centre rather than as value adding for their primary processes (Alexander, 1996; Price and Akhlagi, 1999; Barret, 2000; Hinks, 2004; Kaya *et al*., 2004). Furthermore, FM is often overlooked as a source of competitive advantage (Alexander, 1996) and tends to be undervalued by primary process management (Barret, 2000; Nutt, 2004a). This may mean that if services are not determined according to users' needs, the services actually delivered could significantly differ from their expectations. Since the internal customer typically does not have any choice in terms of alternative products and suppliers, this may cause dissatisfaction (Gremler *et al*., 1994).

Users of the built learning environment are diverse, being employees, students and guests. We expect them to evaluate the outcome of the service encounter differently due to different use purposes and expectations. This raises questions as to which user group FM should address to determine the required service quality and to possibly adjust in response to feedback. Within the existing FM literature the importance of aligning with the primary processes has been recognized (Nutt, 2004b; Green and Jack, 2004; Barret, 2000; McGregor, 2000; Sarshar *et al*., 2010). Yet, previous studies are not clear about the organisational level of alignment between FM and the primary processes.

According to management literature (e.g. Mintzberg, 1979) and the European standard EN15221-1 (CEN, 2006) there is a clear distinction between three organisational levels of decision making and tasks being the strategic or corporate level that consists of top management (i.e. Board of Directors), the tactical level or middle management that comprises the managers of profit centres (i.e. faculties or education units) and the operational or functional level that comprises the executive staff members (i.e. lecturers as primary actors and other staff). Given the interrelationship between FM and the three organisational levels, six possible gaps may exist, of which a graphical representation is given in Figure 1. Since fit depends on the degree to which there are adequate linkages among organisational parts (Kok, 2012), it is difficult to make a ruling about theoretical expectations in this regard. However, both Barret (2000) and Jensen (2007) argue the necessity of a close collaboration and alignment between top management and FM to achieve the necessary orientation on the primary process. Kaya *et al*. (2004) found that due to a weak relationship between FM and their customers (i.e. EM) the latter perceive only FM's operational significance. For lecturers, as end users, a high level of operational responsiveness (e.g. to technical issues) is the most important feature of FM (Barret, 2000). In the relationship between Board and education management, there is the delegation of responsibility for education to the manager in exchange for resources (budget) and a certain degree of autonomy. The education manager most probably is in solidarity with the needs and discomforts of lecturers. Between the Board and the lecturers, there is a large hierarchical distance which is likely to cause mutual misunderstanding and a different view of the contribution that the built learning environment may have to the primary process.
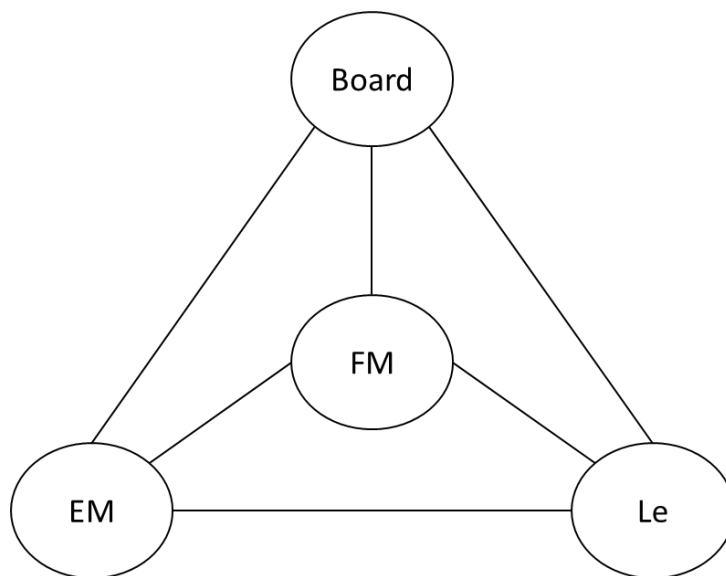
Figure 1. Interrelationships between FM and key stakeholders within the higher education institution (adapted from Coenen *et al*. (2012) and Kok (2012)).

Given the different relationships that FM has to maintain, there is an obvious importance of good communication and coordination to (changing) needs to establish and manage expectations. The quality of communication may well contribute to the quality perception of stakeholders regarding the built learning environment. A gap-analysis could shed light on whether the different user groups share the same degree of perceived quality of facility services.

3   METHODS AND DATA COLLECTION

For the comparison of the quality perceptions of facility services to be informative, our study population was drawn from educational institutions of the same academic level, being Dutch Universities of Applied Sciences. The research first identifies facility services quality attributes for the learning environment. Second, this study measures the similarities and differences of viewpoints between the four groups and examines the six possible gaps. Finally, recommendations for filling gaps, if they exist, would be set forth.

Of all thirty nine Dutch Universities of Applied Sciences that were invited for participation, eighteen institutions agreed to participate. The sample population varies in size from 504 students for the smallest institution, and 34,765 students for the largest. An online survey was employed to obtain information about the perceptions of four identified professional user groups with regard to the use of facilities, being Board members, education managers, lecturers, and facility managers. In order to minimize any time bias, the data was collected from the four groups as much at the same time. All user groups answered the same service quality items, which were formulated as statements. From the variety of facility services of importance for a good conduct of education (Kok *et al*., 2011), as we found in literature, we selected forty items as our independent variables. Items ranged from classrooms (e.g. availability, lighting conditions, and furniture), indoor climate, ICT, print, cleaning, reception desk, catering facilities, maintenance (e.g. maintenance condition, and concierge tasks), and building and environment (e.g. layout, fitting out, atmosphere, workplaces, and meeting rooms). All items were measured using seven-point Likert-scales from 1, very poor to 7, very good. Also some demographic data were gathered with regard to gender, age, the number of

years respondents are in their current position, and the number of years respondents are working within the education institution.

4   RESULTS

A total of two thousand two hundred and seventy seven questionnaires were returned. After deleting incorrect and insufficient answered questionnaires, two thousand and fifty nine questionnaires could be analysed. The response was, according to the differences in numbers of employees per function within the participating organisations, unequally distributed among Board of Directors (17), education managers (211), lecturers (1,755), and facility managers (76). This corresponds with a total of 38% of the Board's population, and 13% of the lecturers. To establish differences in their perceived quality of facility services, data were aggregated at the position level, disregarding the higher education institution. First we calculated mean item scores and item category means for the four user groups. The overall average perceived quality score was 5.04, with FM (5.21) and Board (5.48) indicating an above average quality perception, and education managers (4.72) and lecturers (4.74) an under average perception. The Board reported the highest perceived quality with all category means well over 5.0 (moderate). Education managers reported the lowest perceived quality; however, their overall mean score was practically the same as lecturers. The judgment of FM tended towards that of the Board. The overall reliability of the questionnaire was very good, with Cronbach's α values well over .9 for each of the four respondent groups.

Then, to identify perception gaps between the different user groups, we used the Mann–Whitney U tests to analyse the specific sample pairs for significant differences. We found that the least statistical significant gaps in perceived quality relative to the total number of sampled items (40) exists between Board of Directors and facility managers, who only disagree on the quality regarding five items (12.5%), followed by education managers and lecturers, whose quality perceptions were equal except for eight items (20%), Board and lecturers (57.5%), and Board and education managers (62.5%). Most gaps existed between facility managers and lecturers (75.0%), and facility managers and education managers (67.5%). All the results of our statistical analyses are shown in Table 1 (Appendix A). Based on the gaps found, it appears there is predominantly a difference between lecturers and education managers on one hand, and FM and the Board on the other hand.

5   CONCLUSIONS AND DISCUSSION

Our exploration into possible gaps in the perceived quality of facility services among different stakeholders in Dutch higher education institutions, yielded two different groups: FM and Board, who have a corresponding more positive picture of the quality of the built learning environment, and education managers and lecturers who are more negative. The similarities between the perspectives of FM and Board and consequently the misfit between the FM perspective and that of the education managers and lecturers were unexpected. In contrast to the facility managers' need to 'sit at the table' with the Board, yet mainstream of FM putting the end users' needs first, FM seemed to act in accordance with the top management. Would this be an indication that FM has lost sight on the primary process? Given the corresponding assessment of education managers and lecturers, which is probably from an operational position as representatives of the primary process, the question then is whether FM and the Board have such a good idea of what is going on in the classroom in terms of (necessary) support of education with facility services. Does FM miss out on a great opportunity by failing to respond to the needs of the primary process and thus contribute to the educational performance? Considered the perceived quality gap with respect to 35 of the 40 items, there seems a misalignment between FM and Board as responsible actors for and education managers and lecturers as the end users of the built learning environment. Possible

reasons for this may be that FM not manages their relationships with end users effectively, or the perception gaps result from service standardisation that does serve the purposes of both Board and FM, but fails to satisfy users' needs. The observed perception gaps may also indicate a flawed expectation management, resulting in unrealistic, or just too high expectations of end users.

Their overestimation compared to users may also indicate that both Board and FM are dissociated from the primary process and users' support needs. As opposed to the claim of Barret (2000) and Jensen (2007) of the importance of a strong strategic linkage between Board and FM, this does not seem conducive to the primary process. Answering our research question; we found different levels of perceived quality of facility services, depending on the organisational position of the respondent in Dutch higher education institutions. This misalignment may also reveal the existence of different interests of employees in Dutch higher education institutions, and that, as regards FM, not the needs of the primary process are central, but the views and preferences of the Board and FM.

6   IMPLICATION OF FINDINGS

This study gives an early indication that for FM it is insufficient to only align with the Board, and when it comes to determining the service requirements, this may even be a poor choice. Provided that the users know what is best for them, we suggest that FM subsequently adapt the facility services to their needs. Most probably Board and facility managers are too distant from the operations to know what the ideal setting for this would be, and therefore are not the suitable informants when it comes to determining a successful learning environment. As argued by Amaratunga and Baldry (2000) and Nutt (2004b), at the operational level there is evidence of the direct and critical impact of FM on the relative success or failure of an organisation. For lecturers', and to a certain degree education managers', role as core actors, their needs should drive the process of creating a satisfying and performing learning environment. Acting on their feedback could contribute to the value-adding capability of FM.

7   LIMITATIONS AND FUTURE RESEARCH

For we aggregated data at the position level, disregarding the higher education institution, there is no telling whether possible (mis)alignment of user groups exists within the different higher education institutions. For education institutions with small gaps between different stakeholders' quality perception, we assume are more holistic in their approach to engage in facility management, and subsequently having adequate governance mechanisms in place in order to align and coordinate facility management activities to their different user groups. Further research may provide evidence for this. We also propose to identify whether the perceived quality gaps are the result of a standardisation approach towards service offering by FM.

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Item category	FM (76)	BoD (17)	EM (211)	Le (1,755)	Item mean	FM-BoD	FM-EM	FM-Le	BoD-EM	BoD-Le	EM-Le
Classrooms (10 items)	4.97	5.22	4.56	4.57	4.83		5	7	4	4	1
ICT-equipment (3 items)	5.57	5.62	5.03	4.96	5.29		3	3	2	1	
Repro and print (2 items)	5.82	5.85	4.99	5.00	5.41		2	2	2	2	
Cleaning (3 items)	5.16	5.18	4.51	4.76	4.90		3	2	2		2
Reception desk (2 items)	5.81	5.71	5.49	5.65	5.66		2	1			1
Coffee and catering facilities (5 items)	5.51	5.92	4.96	4.96	5.34	1	5	5	5	5	
Maintenance (4 items)	5.39	5.56	5.09	5.19	5.31		1	1			1
Building and environment (11 items)	4.93	5.43	4.40	4.36	4.78	4	6	9	10	11	3
Identified gaps[1]						5	27	30	25	23	8
Percentages[2]						12.5%	67.5%	75.0%	62.5%	57.5%	20.0%
Overall mean	**5.21**	**5.48**	**4.72**	**4.74**	**5.04**						
Cronbach's α	0.94	0.97	0.95	0.96							

Table 1. Means and gaps of perceived quality of service and space elements of different user groups.

[1] Identified gaps shows the number of items relative to the total number of category items indicating a significant ($p < .05$) difference in perceived quality between the two groups concerned using Mann-Whitney U tests of sample pairs.

[2] Percentages calculated as the number of gaps found relative to the total number of sampled items (40)

Note. FM, Facility managers; BoD, Board of Directors; EM, Education managers; Le, Lecturers.

Reconstructing the image of the cleaner

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ABSTRACT

Purpose: The article shows the relevance of an insider's perspective on workers in the cleaning industry (cleaners). It explains how the ways in which cleaners create meaning in their work can be explored. These findings help to create added value for FM.

Theory: Organisational theory describes a paradigm shift towards positivity. This shift implies an insider's perspective. Self-determination theory and the theory of lived spirituality help to understand this reconstruction of the image of the cleaner.

Method: Literature review. The findings lead to the conclusion that qualitative research contributes to the create added value.

Findings: In the cleaning industry the focus on Taylor's organising imperatives is no longer desirable. The industry lacks flexibility and risks crossing moral borders. Focus on meaning in work may contribute to better performance and help the industry adapt to new trends like flexible workspaces, hospitality and sustainability.

Originality: The focus on cleaners and the use of self-determination theory and spirituality theory.

1   INTRODUCTION

At the end of the closing ceremony of the 2012 Olympics in London, football legend Pele appeared on stage. Since the 2016 Olympics will be held in Brazil, Pele took of his coat and showed the famous yellow shirt worn by the Brazil national team. He was assisted by a man wearing orange fluorescent clothing. It was Rio's most well-known street-sweeper, Renato Sorriso.

Back home, in Rio, the street-sweeper has status. A colleague of Sorriso described his profession as follows: "I think I have a real job. Like a nurse, engineer, technician or a great intellectual. I am the street-sweeper who cleans my city ".[1]

A year earlier, in the Netherlands Dutch politician Bolkestein commented on the strikes in the Dutch cleaning industry as follows: "There are also people who [...] get opportunities but don't seize them and then descend the social ladder and have to stay alive by cleaning office buildings".[2]

The contrast is clear. Is a cleaner someone who can be proud of his/her work or is the work (in most cases) a sign of failure? The answer to this question is of course relevant: from the perspective of the cleaner's well-being and from an organisational point-of-view. After all, the experience of pride leads to better performance at work. Service-oriented organisations need people like Sorriso.

Facility Management (FM) is a relatively young discipline that is evolving and that is in the process of self-definition. Its environment is dynamic as organisations feel the need to cut costs and FM is faced with trends such as flexible workspaces, hospitality and sustainability. Still, FM tries to change its focus from cost reduction to value creation. FM should not be all about operating as efficiently and as inexpensively as possible, but much more about creating added value for businesses (Drion, 2012). Furthermore "FM value is relationship value", (Jensen et al, 2012), which means that this added value is created in a network of stakeholders such as clients, customers, users, suppliers and employees. Since FM operates in and with organisations that function more and more as open systems (Schoemaker et al, 2006; Karakas, 2009), interaction with these stakeholders increases and becomes more complex. Hence transparency in this cooperation has become more important. Creating added value means increased dependence on human capital in organisations and knowing the people you work for and with.

One of FM's most important and (as we will see in section 4) unknown stakeholders is the cleaner. In total, just over 164,000 people are employed the Dutch cleaning industry and the FM sector spends 4 billion euros on cleaning services (12.6 % of FM's total spending ex. CREM). The cleaning industry is an important stakeholder because 95% of the facility managers work with cleaners (Bekker et al, 2012) and the outsourcing rate is 85%. (Spil et al, 2012).

Cleaning is characterised as a commodity and the market is competitive. Hence cost reduction and efficiency (inspired by the principles of Taylor) determine the market. As a result cleaners get less time to clean, the supply of cleaning materials is limited and the cleaning frequencies are lowered. This paper argues that the unilateral focus on reducing costs has had its best time. It provides two arguments (organisational and moral) for a different view on organising the cleaning services. In contrast to a Taylorist approach that

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[1] http://nos.nl/koningshuis/video/443106-moeilijk-zakendoen-met-brazilie.html

[2] http://omroep.vara.nl/Vrijheid-gelijkheid-broeders.10996.0.html

advocates a strict distinction between manager and worker, this article proposes a perspective that dwells on the ways in which workers themselves experience their work. This leads to the following research question:

"In which ways do cleaners create meaning in their work?"

The article describes the relevance of this question and in the end examines how this question can be answered.

The structure of this paper is as follows. In the first part, Taylor's principles of organisation are discussed. This part recognizes two possible caveats. The second part describes a paradigm shift to a more inclusive approach of organisation. The self-determination theory (SDT) and the theory of lived spirituality also are discussed. The third part illustrates that this shift is relevant in the context of FM. The fourth and last part starts with the proposition that an insider's perspective is essential. It then describes how qualitative research can reconstruct the image of the cleaner.

2 ORGANISING EFFICIENCY: TAYLOR'S SCIENTIFIC MANAGEMENT

In his book *Images of Organizations* (1997), Morgan describes how the famous military innovator Frederick the Great was fascinated by mechanical toys. This fascination undoubtedly inspired Frederick when he transformed his army into an efficient and reliable unity. Innovations like ranks and uniforms, military language, hierarchy, rules and the principle that a soldier should have more fear for his commander than for the enemy, are now taken for granted. These innovations changed the army he had inherited - an 'unruly mob' - into a disciplined unit that undoubtedly resembled an army of toy soldiers.

This Frederick the Great in turn fascinated another Frederick (Taylor) who, in a time of increasing organisation and mechanisation of society, searched for the best way to organise. He eventually developed his method of scientific management which consists of five key principles (Morgan, 1997):

• Shift all responsibility for the organisation of work from the worker to the manager.

• Use scientific methods to determine the most efficient way of doing work.

• Select the best person to do the work thus designed.

• Train the worker to do the work efficiently.

• Monitor the worker to make sure procedures are followed and thus results are achieved.

Taylor's method has had a huge impact on modern organisations. Thinking in pre-determined goals and carefully planning and continuously monitoring and adjusting the steps to achieving them have undoubtedly contributed to the success of many organisations. History however has shown that Taylor's method also has downsides. The first type of disadvantage has an organisational nature and has to do with a lack of flexibility of organisations that focus on efficiency. The second argument is moral and deals with the dehumanising aspects of organisations.

A lack of flexibility

Environments become dynamic when demand becomes unpredictable due to demographic, economic, social, technical, ecological or political (DESTEP) developments or due to increasing competition. Under these circumstances organisations need flexibility in order to adapt. Organisations that rely too much on Taylorist principles tend to lack this. After all, the

environment requires the adjustment of goals, which is not easy because this implies changing all the processes.

Furthermore, organisations that focus on routine, tend to lack the talent for creativity and innovation. Change is therefore not only difficult due to fixed and imposed structures, change is also not a 'natural' option. The lack of creativity and innovativeness is related to the fact that according to Taylorist principles workers do not have to think: "[...] the fact that mechanistic definitions of job responsibilities encourage many organisations to adopt mindless, unquestioning attitudes" (Morgan, 1997).

Dehumanisation in organisations

Organisations that are designed according to Taylor's principles tend to be confronted with the limits of what is morally acceptable. Research on work motivation for example, points out the inability to act from a sense of autonomy ("I experience that what I do has importance") has adverse effects on the mental health and well-being of people (Deci and Ryan, 2008). Organisations also systematically create distance between people (social distance) and between the actions and their consequences (Ten Bos, 2003). Like Frederick the Great told his generals to leave the battlefield, Frederick Taylor banned the manager from the workplace. Hence both became unable to see the consequences of their decisions and in a way lost sight of reality.

3   A PARADIGM SHIFT TOWARDS POSITIVITY

Since Taylor, theory and practice have evolved in ways that acknowledge the human factor in organisations. These ways, however, still approach the human factor in an instrumental way, as a resource to achieve defined goals (Schoemaker et al, 2006). The last few decades both theory and practice of organisation and management have shown a growing awareness of a paradigm shift. This shift acknowledges the increasing complexity of organisations and their environment and hence focuses on the human factor which has to live up to the challenges this complexity implies. It is therefore interested in the ways in which this human factor can reach its full potential. This paradigm is characterised by positivity: "creating organizational contexts that enable human strengths and unlock positive and generative dynamics of vibrant human communities" (Karakas, 2011).

Unlike the Taylorist paradigm, this new paradigm seeks to employ full human potential and acknowledges that an employee is more than a worker. An employee has needs, a heart and spirit, a family and a personal life, all of which should be taken into consideration when creating the organisational context. This perspective on work denies Taylor's first principle of shifting all responsibility for the way the work is done to the manager. Instead human potential itself and the intention to use it to create value in a human community based on shared values, become essential.

By offering a context in which people can employ their full human potential, organisations benefit from an increase in productivity, creativity and a reduction in absenteeism. A classic win-win situation: "these [...] new ways of working aim to be mind-enriching, heart-fulfilling, and spirit-growing for employees, and still be financially rewarding at the same time" (Karakas, 2009).

While Taylorist organising risks to dehumanise workers, this new paradigm explicitly acknowledges the human potential of workers as a key ingredient for success. The increase in productivity and creativity suggests that this focus leads to greater flexibility in organisations. Hence both downsides of Taylorist thinking are now positive aspects of a business model. The following two theories agree with this win-win relation and provide a framework in

which this can be understood. They both claim meaning is an essential aspect for unlocking the potentials of human functioning.

Self-determination theory

The self-determination theory (SDT) is a motivation theory which states that not only the amount of motivation, but also the type of motivation determines the quality of human action. SDT differentiates between controlled motivation and autonomous motivation. The first has an external locus of control, the latter has an internal locus of control (Deci and Ryan, 2000). Various experiments show that autonomous motivation leads to more optimal functioning and to more health and well-being. SDT therefore shows how organisational success can converge with positive effects on employees. "This means that factors that support high-quality motivation also support the worker's self, which is an important win-win situation for managers" (Deci and Ryan, 2008).

Organisations would do well to discover how autonomous motivation can be achieved. The experience of meaning is crucial. In order to be autonomously motivated an individual has to think of his actions as meaningful. This means that the individual must be able to integrate the rationale of his actions into a unified sense of self.

SDT considers the need for autonomy to be a basic (innate) psychological need. SDT states that people also have innate needs for relatedness and competence. This implies that the experience of being part of a social context and the experience of being challenged contribute to autonomous motivation.

The theory of Lived Spirituality

Workplace spirituality is concerned with questions on how the spirit ('inner life') of people is nourished by the work they do (Ashmos and Duchon, 2000). Studies in this field support the existence of a positive relation between human well-being and organisational success. Research suggests that the experience of spiritual meaning leads to an "increase of morale, commitment and productivity" and "decrease of stress, burnout and workaholism" and contributes to the welfare of employees. Moreover, it provides a sense of belonging and loyalty to the organisation (Karakas, 2009).

Meaning is again of importance, but on another level. Contrary to the SDT point-of-view in which meaning has to do with coherence to a unified sense of self, the theory of Lived Spirituality considers meaning as a result of coherence between the self to something outside of the self. For meaning to be spiritual there needs to be an external referent. This 'could-be' reality can be an ideal, a dream, a (religious) belief, or the perspective of one's total life and invites the actual self to transcend towards it (Van den Hoogen, 2010).

This 'spiritual activity' is not strictly reserved for a spiritual moment in everyday life (for instance during set times for prayer or during a retreat) but can be observed as a phenomenon in all of life domains. Spirituality therefore is lived by people, possibly also in the context of one's work.

4   CLEANING SERVICES, THE NEED FOR AN INSIDER'S PERSPECTIVE

In creating added value the facility manager and cleaner share a common goal. However the Dutch documentary 'Schoonmaakwoede' (Cleaning Anger) gives a striking picture of the ways in which cleaning services are organised.

The documentary shows that in procurement cleaning is mainly used to master budgets and therefore pricing is decisive. In reaction suppliers of cleaning services solely focus on the lowest price. As a result the market is dominated by efficiency. Efficiency is achieved by applying Taylor's principles in a correct way. Management sets goals and decides how the goals are to be achieved, the work is organised, and how workers are trained and monitored. However, when goals are unrealistic, the ways in which work is organised, workers are trained and monitored become unrealistic as well. Eventually, it is impossible for cleaners to meet the demands of their managers and it has become impossible to create value for the customer and user. The fact that a cleaner has to clean up to 600 m2 per hour exemplifies how Taylorist thinking has gone ad absurdum. Clearly, efficiency is not the way to adapt to the changing demands of suppliers.

The documentary also shows how the cleaner is dehumanised: s/he is frustrated and dissatisfied because of the impossible demands and has to work under improper circumstances. Eventually this led to The Netherlands' biggest strike since 1933. For nine weeks cleaners in the country laid down their work and introduced respect as one of their major demands: respect for the cleaner as a person who does an important job. The demand for respect also implied an argument for cleaning during office hours. The cleaner as a person that belongs to the organisation and whose work and face have a right to be seen.

In order to create added value in dynamic and competitive markets, organisations need to be flexible and managers need the potential of their employees. The distant perspective that Taylor suggested does not offer managers clues on how they can use the ideas, loyalty and flexibility of his workers. An insider's perspective however, does.

5   RECONSTRUCTING THE IMAGE OF THE CLEANER

This insider's perspective is one of the basic characteristics of qualitative research. Qualitative methodologies help explore the ways in which FM can create added value (Waldburger and Nielsen, 2012). This type of research is interested in reality as it is constructed by individuals: "qualitative research generally starts with the assumptions that individuals have an active role in the construction of social reality and that research methods that can capture this process of social construction are required" (Boeije, 2010).

The reason for the focus on the construction of reality is the assumption that reality itself cannot be an object of knowledge, because as humans we cannot observe and know it. Individuals therefore construct reality and are confronted with reality as it is interpreted by others.

Similarly there is no objective knowledge that can be used to organise cleaning services in the best way possible. When it comes to the question: *what is cleaning?*, there is no truth, but there is an interpretation of cleaning as a meaningful (or non-meaningful) part of a (daily) life. The analyses ('verstehen') of these interpretations can help organise cleaning in ways that meet the demands of both businesses and cleaners, as the paradigm of positivity suggests. Unfortunately, there's little knowledge on these interpretations.

In order to construct these interpretations the researcher has to take an insider's perspective. This is often referred to as role-taking. Role-taking is achieved by using a qualitative survey consisting of in-depth interviews. In these interviews the ways in which individuals (i.e. cleaners) give meaning to their work are explored carefully and in detail. The following questions could be the starting point for in-depth interviews:

• The past: how did you become a cleaner?

- The present: which three moments during your career as a cleaner would you like to share with me?

- The future: how do you see your future?

Role-taking can also be achieved by a method called shadowing. While shadowing, the researcher follows an individual over a certain period of time. By doing so, the researcher has direct access to the context in which reality is created and by asking comments s/he can simultaneously gain insight in opinions and behaviour of individuals (McDonald, 2005; Klungseth, 2012). Shadowing can be used supplementary to in-depth interviewing to induce constructions of meaning in cleaning.

Already during data collection the researcher starts analysing the constructions. In this process of deconstruction the researcher searches for patterns while continuously checking these with new data from the interviews and shadowing. Eventually a reconstruction is made, a coherent theory that is based on the narratives, behaviour and experiences of the respondents. This reconstruction explains how cleaners create meaning in their work.

This reconstruction is confronted with known theory: SDT and LS. With the help of these theories the researcher gains insights into how the work facilitates or thwarts the satisfaction of needs for competence, relatedness and autonomy and in the cleaner's motivational process (SDT). Furthermore LS helps understanding the reconstruction as a means of finding spiritual meaning in work.

CONCLUSION

The paradigm shift towards a more inclusive approach of organisation offers opportunities to the facility manager who wants to create added value. This approach supports the idea that business and personal interests can be mutually reinforcing.

Until now thinking in terms of efficiency and reducing costs have been dominant in cleaning. This line of thinking has gone too far and has created an image of a cleaner that fits perfectly in Taylor's picture: an individual that does pre-designed work that is poorly (not-autonomously) motivated. Despite this picture, we can still imagine that a cleaner who finds meaning in her/his work is a better cleaner than one who doesn't.

For FM this image is worth exploring. In times of economic downturn and confronted with trends like flexible workspaces and hospitality FM needs smarter, more flexible and more service-oriented ways of organising the creation of added value. The reconstruction of the image of the cleaner is a step towards a more sustainable future of FM.

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Section three
FM INNOVATION

Part Two
Workplace innovation

Experience of Places – A Six-dimensional Model for Capturing the User Experience

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Strategies and Methods to improve Spatial Management within Companies

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The influence of facility management on detainees

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A Mathematical Simulation Tool for Increased Space Utilization Efficiency

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Experience of Places
– A Six-dimensional Model for Capturing the User Experience

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ABSTRACT

The user experience of places has been one of the main concepts in research on the usability of workplaces. Later work of CIB W111 researchers has identified key concepts such as context, culture, situation and experience that underlie efforts to understand and improve usability in the built environment. Experience design can provide meaningful insights into future needs with the workplace spreading all over, out of offices.

Based on the identified need to investigate the experience of places, this paper aims to develop a framework for experience of place based on both literature and empirical data. Understanding and defining the concept of user experience is a complex task. In addition to numerous definitions, a number of models and theoretical approaches have been developed to help understand the nature of user experience. These approaches include contributions from distinct disciplines such as design, business, philosophy, anthropology, cognitive science and social science.

The paper aims to contribute to the research to enrich our knowledge of the various dimensions of the person-environment relationship. The paper begins with definitions of experiences followed by a more specific analysis of the proposed dimensions for experience of place. The qualitative interviews conducted during the research project contribute to the literature review findings about the six-dimensional framework. The results summarise the framework and potential use-scenarios for the framework are proposed in the conclusions.

Keywords: experience of place, workplace, experience design, usability

1   INTRODUCTION

User experience has become relevant to many fields of research and industry due to its nature as a commonly understandable, holistic and all-encompassing concept that includes the user, the product and the context of use (Battarbee, 2008). In the context of workplace management, the product is the workplace used by a variety of users. The meaning of user experience has been acknowledged both in user centric design and in experience management as a new agenda for workplace management (Nenonen, 2009). The latter perspective is increasing as a consequence of "new ways of working". This expression is often used to describe today's work that is increasingly digital, loose, informal, and mobile. Today's office spreads all over the city. Because of this, the function of the traditional physical workplace is transforming into a venue for planned and unplanned encounters. As a result, a shared office

(also known as a neighbourhood office, serviced office or networked office) is today one of the rapidly increasing workplace concepts. Shared offices are places for co-working. Co-working is a style of work that constitutes social ecosystems by involving a social gathering of a group of people usually in a shared working environment. The aim of co-working places is to create a sense of community and possibilities for cross-pollination among their users. Creation of space is not simply the arrangement of one's surroundings, but space should enable occupants to experience the place both as physical and social place (Kojo and Nenonen, 2012).

Experience has also been one of the main concepts in research on the usability of workplaces. CIB W111 researchers have focused on understanding the nature of usability and user experience. Early work in the process focused on the dimensions identified in international standards that apply to the usability of consumer products – efficiency, effectiveness and satisfaction. Based on their research findings, one can observe that satisfaction as such is not enough. (Alexander, 2008) In line with these results, environmental psychologist Vischer (2008) states that "However, work environment evaluation studies have tended to focus on occupant satisfaction as the single outcome variable, thus limiting their value in the research arena. Researchers have supported this approach by assuming a connection between environmental satisfaction and job satisfaction, and, by implication, that reduced levels of satisfaction generate stress. As a result, most direct questioning of office occupants has examined either general user satisfaction, or comfort related to a specific ambient condition. While this may work for diagnosing dis-comfort and dissatisfaction with a view to solving building problems, it has added little to our understanding of how people perceive their workspace and the of effects of their social relationships and self-image on these perceptions."

Later work in workplace usability research has identified other key concepts – context, culture, situation and experience - that underlie efforts to understand and improve usability in the built environment. (Alexander 2008) Vischer (2008) contributes to this discussion by identifying three workplace research categories. One of them is environmental cognition, where environment is evaluated according to the ways in which workers perceive and assess their workspace. These studies focus more specifically on the psychosocial impact of interior layouts; they constitute a way of defining the work environment based on workers' assessments (Vischer, 1986; Wineman, 1982). In focusing on cognitive processes, this research orientation links up with a well-established paradigm of social psychology, namely Lewin's field theory (1951). It also incorporates the study of users' perceptual differences and how workers' evaluation of their workspace in turn affects their perception of themselves at work (Somat, Tarquinio & Dufresne, 1999). The other two general categories of studies of workspace include the influence of the work milieu on human performance (e.g. Evans & Cohen, 1987; Dewulf & Van Meel, 2003) as well as the psychosocial dimensions of work environments in terms of human territoriality (e.g. Fischer, 1989).

Understanding and defining the user experience concept is a complex task (Law et al., 2008). In addition to numerous definitions, a number of models and theoretical approaches have been developed to help understand the nature of user experience. These approaches include contributions from distinct disciplines such as design, business, philosophy, anthropology, cognitive science and social science. (Forlizzi & Battarbee, 2004). This paper aims to contribute to workplace research by developing a framework especially for the experience of place. The framework aims to enrich our knowledge of the various dimensions of the experience of place. The paper begins by defining experiences of place. This chapter is

followed by a description of methodology regarding the literature review and qualitative interviews. The results provide a basis for a six-dimensional framework (6D) for the experience of place. The potential use-scenarios of the framework are proposed in the conclusions with recommendations for future studies.

2   DEFINING EXPERIENCE OF PLACE

The difference between the terms *space*, *place* and *site* has over the last decades become a major question in, among others, the fields of sociology, geography, philosophy, and architecture (e.g. by Lefebvre1991, Massey 1994, Soja 1996 and Casey 1998). The term *space* may be held to convey a mental and spatial abstraction with a collective dimension, continuously experienced as well as produced and reproduced by individual and institutional everyday practices. Tuan (1977), as a human geographer, considers the ways in which people feel and think about space, how they form attachments to home, neighbourhood, and nation, and how feelings about space and place are affected by the sense of time. He suggests that place is security and space is freedom: we are attached to the one and long for the other.

Ramirez (1993) describes that place and space are not synonymous concepts. "Space is an empty dimension, a geometrically regarded physicality. Place (which the Greeks called *topos*) has no determined dimensions. A place occurs when something important happens, where human meaning is allowed to come about and be articulated. Lindahl (2001) argues that the place belongs to the activities that are carried out there, whereas space is a tool to plan and design the physical prerequisites to enable something to take place. Therefore, the place is something more than just the spatial references or boundaries. Regarding experience, it is relevant to focus especially on the experience of place in this research.

According to Alben´s (1996) definition, user experience means "all aspects of the end-user's interaction with the company, its services, and its products". The relevant product for this research is place, more specifically workplace. When considering the experience of place, one can still use more the general definitions defined by Forlizzi & Battarbee (2004), who identified three types of experience: 'experience', 'an experience' and 'co-experience'. Experience is the constant stream of self-talk that happens while we are conscious. It means how we constantly assess our goals relative to the people, products, and environment that surround us at any given time. An experience is something that could be articulated or named. This type of experience can be characterized by a number of interactions and emotions, but is schematized with a particular character in one's memory and a sense of completion. An experience has a beginning and an end, and often inspires emotional and behavioural changes in the experiencer. Co-experience, in turn, relates to user experience in a social context. Co-experience takes places as experiences are created together, or shared with others. User experiences need to be approached through the emotions and meanings the users relate to them. Emotion is at the heart of any human experience and an essential component of user experience (Forlizzi & Battarbee, 2004).

It is also important to understand how the experience of place is provided. Affordances can be seen as the way people undertake cognition and action in the world to make meaning. (Forlizzi & Battarbee, 2004). The affordance of place is the basis for the experience design approach, for which e.g. Diller et al. (2005) have developed a classification of the experience. Experience design means "the deliberate, careful creation of a total experience." Experience design is still in its infancy as a discipline. It can be seen in a narrow way only as a field for digital media, while others view it in broad-brush terms that encompass traditional, established, and other such diverse disciplines as theatre, graphic design, storytelling, exhibit

design, theme-park design, online design, game design, interior design, architecture, and so forth. The experience of place as a target for experience design can focus on understanding the six dimensions of experience in the context of workplaces. The dimensions of the experience are

1. Time/Duration
2. Intensity
3. Interactivity
4. Breadth / Consistency
5. Triggers
6. Significance.

3 METHODS

The two challenges of applying the model of Diller to workplace experience were guiding the research design and the selection of methods. The dimensions of experiences were very abstract by nature - they were not suitable and contextually comprehensive as such for the workplace experience. The solution was to conduct a multi-disciplinary literature review. The literature review uses as its database reports of primary or original research scholarship and it does not report new primary research itself. The primary reports used in the literature review may be verbal, but in the vast majority of cases the reports are written documents. The types of scholarship may be empirical, theoretical, critical/analytic, or methodological in nature. Moreover, the literature review seeks to describe, summarise, evaluate, clarify and/or integrate the content of the primary reports. (Cooper, 1988)

As the dimensions of experience in the context of place include aspects from different disciplines, the review strategies were inclusive and attempted to retrieve and examine the literature relevant to all dimensions, rather than being limited to a mono-disciplinary approach. Mapping the ideas, arguments and concepts from a body of literature is an important part of the review of literature (Hart, 1998).

The following place and workplace related terms were used as core keywords for all of the literature searches - 'place' or 'workplace' combined with any of the following terms: time, constancy, functionality, familiarity, senses and meaning. For each dimension of experience, these core keywords were combined with review-specific keywords. The selection criterion for available documents (both published and unpublished) related to each dimension was based on relevancy, how they express the dimensions in the context of workplace and/or place.

The varieties of disciplines were identified for the selection of databases. This literature review is purely descriptive, defining themes instead of being a critical assessment of the literature. The disciplines and scopes are presented in Table 1.

Table 1 The disciplines connected with the dimensions of experience

Dimension of experience	Discipline and scope
Time/Duration is about the offered experiences stretching outside of the timeframe of the provision process.	Cognitive psychology Philosophy of language: chronotypes Consumer behaviour
Intensity is about engagements where customers' attention is present during the experience and becomes a habit with repetitious experiences	Cognitive psychology Place attachment
Interactivity is about the type of engagement people have in an experience, whether passive, active, or interactive.	Architecture Usability

Breadth / Consistency is about the experience of consistency, e.g. about the organization's strategies and messages being appropriate for each experience.	Organizational psychology Marketing and business sciences: branding
Triggers are about redefined design, which results in new solutions and reflects the judgment and preferences of the designers regarding experience	Environmental psychology Ergonomics Cognitive psychology
Significance is about the meaning of the experience to the user: levels of emotions, values, and meaning, which often surpass the set tangible resources such as budget or feature requirements by users.	Organizational psychology: community development Environmental psychology Business sciences: value development

The second challenge was to shift the dimensions of experience from the supply side, experience design to the demand side – to frame the experienced reality instead of the offered experience. The user experience interviews were conducted in "Kafis", the common self-service cafeteria of Aalto Design Factory (ADF) in Aalto University. The place is an example of an informal and social face-to-face learning space. The room is divided into five distinct functions: cafeteria, kitchen, dining room, living room and hallway. ADF was established in 2008 after a successfully conducted demo project called Future Lab of Product Design (Santamäki, 2008). It functions as a matrix unit that combines the expertise of Aalto University in the field of product development. The ADF building is a co-working space in an academic context of over 4000 square meters; it is designed to facilitate collaboration between academic teams, researchers, students, companies and communities.

A number of academic courses, research projects and start-up companies are hosted in ADF. Prototyping spaces, rooms for lectures and seminars, teamwork spaces, and common areas (e.g. a lobby bar and cafeteria) are examples of ADF facilities. The physical spaces of ADF are designed to support easy modifiability of the spaces and interaction and collaboration between the users. In addition to traditional office hours, ADF is open for its users also during evenings and weekends. The ADF building is located in Otaniemi. Otaniemi is a part of the main city area of the capital, Helsinki, and one of the campus areas of Aalto University (ADF, 2010; ADF, 2011).

The interview themes and questions were divided into six sub-themes according to the model of 6 dimensions of user experience. Three test interviews were conducted to develop the interview guide before the actual interviews. The data collection took place during April-May 2011. 16 users of ADF participated in an approximately 45 minutes long, recorded, two-on-one interview. 11 of them were men and 5 women. The sample included an equal number of students attending product development courses (4), researchers (2), start-up entrepreneurs (4), and staff members (6). Half of the interviewees had an educational background in technology. The remaining interviewees had various backgrounds, e.g. design, economics or political science. The majority of the interviewees consisted equally of graduate students and people with the Master of Science (MSc) award. Also doctors of philosophy (PhD) and secondary level vocational school graduates were involved. The interviewees had various occupations, such as project coordinator, product development manager, research manager, managing director, course assistant, teacher, researcher, research assistant, intern, and student. Microanalysis was used as the analysis method in the research. It is an analysis method of grounded theory, referring to a detailed line-by-line analysis that helps with

generating initial categories and suggesting relationships among them (Strauss & Corbin, 2007). The analysis process consisted of two phases. In the first phase the transcribed interviews were read through, at the same time identifying repeating concepts. These concepts became the first-order concepts. On the basis of these, second-order themes and aggregate elements were identified. In the second phase of the analysis, the research material was read through again and the data structure was verified.

3 RESULTS

The first result of the literature review summarizes the six dimensions of experiences under three main categories. Vischer (2007) views comfort as a tripartite continuum. She has created a model that ranks comfort as an ascending continuum of physical, functional and psychological comfort. Physical comfort relates to basic human needs, i.e. safety, hygiene and accessibility. These needs are responded to by applying building codes and standards. Functional comfort is defined in terms of support for users' performance in work-related tasks and activities. Psychological comfort is related to feelings of belonging, ownership and control over workspace. The model roughly parallels with the Kolcaba (2003) model of relief, ease and renewal. Relief is the alleviation of discomfort; ease is a neutral state of contentment; and renewal (later changed to transcendence) refers to strengthening. Research in environmental psychology has considered the influence of the physical environment on social interactions (Barker 1968; Bennett & Bennett 1970), cognition (Rapport 1982), emotion (Mehrabian & Russell 1974; Russell & Pratt 1980), and physiology (Oborn 1987;Riley & Cochran 1984). These three categories are also important in connection with experiences of place – it is all about the emotions, thoughts and mind-sets and sharing in a social context.

The key findings concerning the dimension of *breadth* and consistency make us propose **density and frequency of time** as a dimension of experience of place. The outcome of the literature review indicates that time as a part of the experience of place is connected to three perspectives: Time always has a historical perspective in it, forming the experience (Hall, 1987). The typical patterns of organization of and across activities in space and time are described by chronotopes. The chronotope is a notion to characterize the typical ways in which narrative genres move the scene of action from place to place, and less focally, the pacing of this movement and of typical scenes within it. (Horelli,1982; Bahtin, 1981). Time and breadth in the experience of place seem to refer to activities happening in a certain rhythm and tempo in the place. The interviewees mentioned e.g. the presence of other users as a source of time in the place. The people make the place, but at the same time the social environment of ADF was seen as constantly evolving. Other people were seen as a source for hearing daily the beat and rhythm of the place: "It [ADF] changes quite a lot depending on who is there and what is done; this breaks the routine and conventionality".

The key findings concerning the dimension of intensity make us propose **familiarity** as a dimension of the experience of place. The three most significant findings from the literature review are related to place attachment. Firstly, oyalty to an organisation is increasingly determined by social and place attachment. (Inalhan &Finch, 2007) Secondly, learning in unfamiliar environments appears to be more complex than predicted. Cognitive maps and sketch maps are influenced by experience. (Walmsley &,Jenkins, 1992). Thirdly, there is more research on differences and e.g. workplace changes than on workplace familiarity as such. From the data, the importance of easy physical and social accessibility emerged: coming to the place was described as easy or nice.

The key findings concerning the dimension of interaction make us propose **functionality** as a dimension of the experience of place**.** Summarising the literature review, one can identify four basic streams. Studies on the usability of the workplace discuss largely the interaction between people and buildings (Alexander, 2008). There is also research about environmental control and users' perception of control, which affect workers on at least two levels: mechanical or instrumental control and empowerment (Vischer, 2005). Psychosocial control by means of user participation in the design process has a positive effect on people's response to and feelings about their workspace (Lee & Brand, 2005; Veitch & Newsham, 2000). The concept of 'workplace performance' has come to mean the workspace, with the explicit objective to support the performance of work: a performing workplace is designed to optimise worker productivity (Clements-Croome, 2006). In the interviews, the fact that ADF supports interaction and knowledge sharing among its users was seen as important. It offers a lot of possibilities to get good feedback and hear interesting things. Additionally, the interviewees referred to the possibility to interact with the environment. It is easy to change furniture and create places over and over again so that it supports what people are doing at any given time.

The key findings concerning the dimension of consistency make us propose **narrative** as a dimension of the experience of place**.** The research findings supporting this dimension rise from e.g. Schein (1984), stating that physical artefacts are the most concrete part of expressing organisational culture. Lantolf (2000) explains: "As with physical tools, humans use symbolic artefacts to establish an indirect, or mediated, relationship between ourselves and the world." Paalumäki (2004) points out that artefacts can be a powerful means of influencing people and transforming organisational culture in a constant way. They form narratives. A story or narrative is an old way to transfer knowledge (Greimas, 1990). The interviewees described the narrative of ADF by saying that the place "has a social heart".

The key findings concerning the dimension of triggers make us propose **atmosphere** as a dimension of the experience of place**.** The review found research concerning indoor environment and solutions (e.g. Li & al., 2007; Balazova & al. 2008; Schiller, 1988). Research on wellbeing and human senses, including ergonomics, is also relevant in this connection (Vischer, 2008). Thirdly, cognitive triggers, e.g. way finding, are a potential research topic in this regard. The atmosphere of ADF was seen as encouraging. It allows discussion with other people, whether they are already known or unknown. One staff member emphasized that "the people are the only reason why I go there [ADF]". A researcher noted that "ADF is a natural place to talk to new people". The atmosphere is very social by its nature.

The key findings concerning the dimension of significance make us propose **importance** as a dimension of the experience of place. Appropriation and belonging are psychosocial aspects expressed through territoriality at work. A sense of territory is associated with feelings of belonging and ownership, and privacy is best understood as the need to exercise control over one's accessibility to others (Altman, 1975). Sense of belonging or ownership is a better measure of environmental quality or success than either satisfaction or effective task performance (Fischer, 1983; Sundstrom & Sundstrom, 1986). For ADF users, it was important that the space felt like one's own. A researcher emphasized this by saying, "it [ADF] is nobody's place in particular, and at the same time it is everybody's place". Maybe for this reason, as a staff member stated, "it [ADF] feels like your own because you can use it freely". In addition, one researcher mentioned that "it [ADF] is warmer than many other places" and later called it a "homely space". A staff member mentioned that "it doesn't feel

like an institution – it seems to be pleasant space for people to be – like homes are". A student emphasized the importance of a cosy atmosphere by her comment, "I spend more time here [in ADF] than elsewhere so it is really important that it is like home".

The following Table 2 summarises the results in connection with the six dimensions and it also describes the more specific dimensions, especially for the experience of change.

Table 2 Dimensions of the experience of place

Dimension of experience	Literature review	Interview results	Dimension of the experience of place
Time/Duration	History Chronotopes Tempo and rhythm	Used by diverse users for multiple activities	Frequency is about the use of time, the sense of time and the rhythm of time in the place
Intensity, repetitious experiences	Place attachment Learning Cognitive mapping	Belongs to everyone	Familiarity is about the easiness of using the place as well as about learning to use the place
Interactivity	Usability Productivity Performance	Supports interaction and knowledge sharing	Functionality is about the place supporting activities and performance as well as easiness to change the place for different purposes
Breadth /Consistency.	Organizational culture Artefacts Brand Narratives	Social heart	Narrative is about the continuity and consistency of the story of the place.
Triggers	Indoor Environment Well-being Cognitive triggers	Encourages and allows discussion with known or unknown people	Atmosphere is about the sensory environment and cognitive symbols creating the sense of the place
Significance	Sense of belonging Sense of territory Ownership	Feels like one's own	Importance is about supporting users' identity and values.

4   CONCLUSIONS

The aim of this research was to create a framework for the experience of place. The six-dimensional model of the experience of place was developed. The six dimensions of the experience of place can be clustered like in Table 3.

Table 3 Clustered dimensions of the experience of place

Physical / Relief	Functional / Ease	Psychological /Renewal
Frequency	Familiarity	Narrative
Atmosphere	Functionality	Importance

The framework has captured the intangible elements of the experience of place. The research indicated that the six-dimensional framework of the experience of place is a valid way to analyse the experience. The framework can be used in analysing, developing and designing user orientated workplaces. This research focused on the literature review, mostly discussing

workplace related research. However, the six-dimensional framework of the experience of place is applicable for a variety of space segments as a platform for experiences. The reliability and validity of the research is based on two different methods. The weakness of the research is in the wide, multi-disciplinary approach in the literature review. However, the identified dimensions for the experience of place can now be investigated more deeply in future research.

The results of this research provide a conceptual and structured framework for workplace developers, designers and managers to discuss and develop places that offer a more comprehensive and therefore powerful workplace experience for users in the future. Moreover, the framework translates the user experience for user-orientated workplace management.

ACKNOWLEDGMENTS

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Strategies and Methods to improve
Spatial Management within Companies

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ABSTRACT

The space utilization for office purposes over lifetime within common office organisations is estimated at 5%. The fact that office buildings remain out of human activity about 95% over their lifetime is irresponsible and irrational from an economic and ecologic point of view for each company. Also with respect to governmental aims and corporate social responsibility, which both force the reduction of energy-demand and CO_2-Emissions. As the structure of workplaces changed dramatically over the last number of decades into flexible and internet-working worlds, new strategies for office developments are strongly required. Several ongoing studies under the titel "More-Space" (www.more-space.org) prove the potential for the optimisation of building-space-resources referring to the actual and the modified future users' space-needs. More-Space-Office analysis and evaluates saving potentials regarding workplaces with respect to company size and employee-structure and -behaviour. Know-How from real estate development, facility management and mathematical modelling and simulation are brought together into the More-Space-Office tool. It aims to improve and optimize utilisation of workplaces. Therefore it is a sustainable approach for the optimal use of built (office) environment. The tool evaluates for each company its best possibilities. The model is customizable and supports rapid prototyping – a relevant characteristic for decision makers in companies. The current results of these spatial management studies show impressive saving potentials up to 50% and more of their current workplaces within medium- and large-size companies. Optimized space management supports also the improvement of workplace utilization performance from averaged 35% up to 80%. Structural changes within the company or on the building can be implemented into the simulation anytime.

Keywords

Sustainable Facilities Management (FM) in Organisations; Sustainable Real Estate Management; Innovations in Space Utilization and Management;

1   INTRODUCTION

The development of office-buildings and the structure of workplaces changed dramatically over the last number of decades. Society lives in an age of constant and rapid information and is confronted with innovations more or less daily. The megatrend of flexible working worlds with internet, decentralization, sharing of resources and flexible workspaces requires changes in existing office-assets and new strategies for office developments. Offering flexible space- and workplace-environments is counted as factor of success in many nowadays organisations (Rieck, 2012a).

"The old rules of space are being challenged. The new demands for responsive design and workplace solutions will entail much closer alignment between research, workplace strategy and architectural design. The conventions of procuring, commissioning, developing and delivering space and buildings are being reinvented."[3] Facility management is a main key for a sustainable built (office) environment (Ratcliffe et al 2009). We need to rethink the design of office-organisations and their space management, because:

- studies show that utilization of office space lies at a mere 5% over its lifecycle (Ottomann, 1995);
- buildings which are heated, cooled and maintained but remain largely unused over time are not ecologically efficient;
- our built environment is identified as a crucial area for the realisation of the EU climate goals (Amann, 2010);
- there is an opportunity to save a lot of (real estate and company/organisational) money through an optimized FM;
- the improvement of space-utilization is part of Corporate Social Responsibility (CSR) (Kovacs, 2012);

Wiegand (Wiegand, 2012a) describes the achievement of the potentials of more efficient utilization as needs of interaction between at least four competences:

- Organisational development (necessary changes of processes and organizational structures);
- Space Management (potentials e.g. within intelligent distribution of fixed-term rights of utilization but also within spontaneous occupancy);
- Real Estate Planning/Development (developers and designers must be able to create built infrastructures, which support dynamic usage of buildings);
- Simulation (the high potentials for more efficient utilization often remain undetected until shown by dynamic event-based computer-simulations; the complexity of dynamic viewing of utilisation is extremely high)

In reality the difficulties of successful implementation of an optimised space utilisation within companies are high. The reasons are grown organisational structures, the inertance of socio-cultural changes, the importance to create positive incentives for the key stakeholders (management and employees), Change Management processes etc.. On one hand the optimisation of space utilisation over time is as a social challenge, on the other hand it can reduce costs and support the reaching of governmental goals of reducing CO_2 emissions. Last but not least another challenge is to awake the consciousness in all the people involved in such processes.

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[3] LAING, A., "Financial-Services Firms: Banking on big design changes", in HQ:Good Design is Good Business, http://hq.construction.com/advice_opinions/0912_Financial_services_Firms.asp, accessed December 8 2012

2 RESEARCH- AND DEVELOPMENT APPROACH

The research approach is a higher utilization of Office-spaces – "More-Space-Office". Table 1 shows plausible a 5% usage of space for office purposes over lifetime within common office organisations – which is irresponsible with CSR, that forces the reduction of energy-demand and CO_2-Emissions:

Table 1 Usage of space for office purposes (Wiegand, 2012b)

office purpose	utilisation
use of office space 24h/day	100 %
five-day working week	71 %
public holidays and holidays	63 %
eight-hour day	21 %
recreation and illness	16 %
social and organisational needs	**5 %**

The eco-efficient aspect of optimized utilisation within our built (office) environment is (simplified) evaluated in the course of this research study. It aims to answer three elementary questions:

- Which workplace capacity is actually required in a particular company?
- What is the actual saving potential of workplaces within particular dynamic company's organizational structures?
- Which types of companies are most suitable for high saving potentials of workplaces and how to achieve them?

The relevance of this approach for research and praxis is supported with the following statements:

"Alternative workplaces offer an opportunity for deeper cuts because they represent a shift from thinking about occupancy (how many people a building can accommodate if each worker is assigned a specific seat) to utilization (how many people actually use a building or office at any given time). Companies are starting to realize that instead of being satisfied that their building is 95 percent occupied they should instead be worried that it's only 40 percent utilized, because people are often out of the office (…) A recent Gallup poll commissioned by CoreNet Global, a corporate real estate association, found that 20 percent of large companies expect to have between 25 and 50 percent of their associates working in unassigned spaces in 2012, and by 2020 the majority of large companies are expected to have adopted the practice to some extent." (Durfee, 2006)

"Efficiency is about doing more with less. For over two decades, we've been conducting research that shows that real estate is grossly underutilized. Most individual workspace is only occupied 35 percent of the core working day. We see this as a tremendous opportunity to right-size our clients' portfolios while simultaneously giving them space that better supports their people."[4]

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[4] http://www.aecom.com/What+We+Do/Design+and+Planning/Practice+Areas/Strategy+Plus/Strategy+plus+Efficiency, accessed 10 December 2012

"With numerous individual studies reporting peak utilization of workspace of ca. 65%, more organisations will focus on how to see more of their real-estate utilised for more of the working week"[5]

"The key to Measuring Actual Use of space is to gather use data in a transparent and ubiquitous manner that insures accuracy and is sustainable."[6]

"Many real estate managers and facility managers are interested in developing programs in support of real estate cost savings goals, workspace consolidation plans and GSA's Zero Environmental Footprint (ZEF) initiatives. Organizations due to this approach utilize space planning to get the most out of their workplaces."[7]

"By rethinking office design, companies are cutting real-estate costs by nearly half. (…) Research showed that associates were working somewhere other than their offices and cubicles more than half the time. "Some people were using their offices only 5 percent of the time," Schuyler says. By eliminating most dedicated workspaces (administrative assistants got to keep their own desks), the company has sharply reduced its needs. A building that once accommodated 650 associates, for example, now serves 1,200. Schuyler declines to say how much the company has saved, but real estate professionals say that such actions can produce savings of up to 40 percent. Another factor pushing companies to reconsider office space is the widening gap between what workers need and what workplaces provide. At one time, office associates labored primarily in solitude; today, they spend two-thirds of their time collaborating, according to Gartner. But offices are still set up for the old style of work. "In most companies, you find that conference rooms are overbooked while offices and cubicles are empty," says Mark Golan, Cisco's vice president of worldwide real estate and the chairman of CoreNet. "It's insane. Not only is it wasteful, it doesn't suit the needs of your workforce." (Durfee, 2006)

"Mobilework strategies save space, while fundamental shifts in architecture facilitate collaboration and cut carbon footprint. (...) Our research has shown that in most banks, most workstations and offices are only in actual use between 35 to 50 percent of the typical work day. The opportunity in rethinking the portfolio and the design of the workplace is to break out of the box of "one seat for every person. The motto is to do more with less."[8]

"71 percent of respondent organisations positively support the notion of the corporate workplace as 'strategic asset in the development of organisations'." (BIFM, 2011)

"Studies by the International Facilities Management Association (*remark: IFMA*) show that the cost of providing a workspace to an employee ranges between $8,000 and $14,000 per year. If the average utilization for each space is 50%, then the company is wasting $4,000 to $7,000 per year for each workspace! Multiply that times the number of workspaces and the potential savings are in the millions or tens of millions of dollars.[9]

"The cost of accommodating the average office worker typically runs between $10,000 and $15,000 per employee, per year in the United States. Internationally, more than $30,000 is not uncommon. By measuring actual workspace asset use, the organization knows when use

[5] "The role of workplace environment in a post-recessional British economy". Review, British Institute of Facility Management (BIFM) 2011, http://www.bifm.org.uk/bifm/knowledge/advanced_search/20, accessed 10 December 2012, p. 6
[6] "Measuring Actual Use of Space˘, White Paper, Agil Quest 2012, http://agilquest.com/White-Papers/measuring-actual-use-of-space/, accessed 8 December 2012

[7] cf. "Workspace Utilization and Allocation Benchmark", GSA Office of Governmentwide Policy Office of Real Property Management Performance Measurement Division, July 2011
http://www.gsa.gov/graphics/ogp/Workspace_Utilization_Banchmark_July_2012.pdf, p. 4, accessed 10 December 2012
[8] LAING, A., "Financial-Services Firms: Banking on big design changes", in HQ:Good Design is Good Business, http://hq.construction.com/advice_opinions/0912_Financial_services_Firms.asp, accessed December 8 2012

[9] AgilQuest 2012,"Measuring actual Use of Space", White paper, http://agilquest.com/White-Papers/measuring-actual-use-of-space/, accessed December 12 2012

declines and divests of it as soon as possible. Management compensation programs use this utilization information to reward the efficient and effective use of this expensive asset."[10]

When determining the best way to forecast and allocate workspace and support knowledge workers, today's architects, designers, facilities and real estate professionals, and workplace consultants must consider the following factors: space availability, energy costs; operation and maintenance costs; ever-changing mission requirements; alternative workplace arrangements and the new mobile workforce.[11]

Laing points out: "Among the financial services firms that are introducing or have implemented mobile-work/shared-space programs: American Express, Bank of America, Capital One, Deutsche Bank, Citigroup, HSBC, Royal Bank of Scotland and Standard Chartered. (…) Behind the new thinking on mobile-work solutions and the more open architecture of bank headquarters buildings is perhaps a more important change: Business and real estate leaders in the financial-services sector recognize that research into and measurement of how work gets done and how space is used is fundamental to successful programs of innovative workplace design. Financial institutions rightly expect solid, defendable, data-driven business cases for new workplace strategies and innovative architecture. The old rules of space are being challenged. The new demands for responsive design and workplace solutions will entail much closer alignment between research, workplace strategy and architectural design. The conventions of procuring, commissioning, developing and delivering space and buildings are being reinvented."[12]

These statements demonstrate that the economic value (e.g. saving costs, saving money, cost-effectiveness) of sustainable FM is highly discussed in research and business. Besides the authors would like to emphasize that less space needs less energy and produces less CO_2-Emissions.

Finally Wiegand (Wiegand, 2012b) designs a problem-solving approach. This approach includes new benchmarks and a formular to measure office-space-utilization. The crucial factors for evaluation and verifications are two new dimensions:

(1) the human activity and (2) utilization units.

The formular designs a proposal for the calculation for the demand of energy per user unit within office-buildings:

$$\frac{E_x}{OWH_x} = \frac{E_x}{WWH_{FTA} \cdot FTA_x \cdot (1-CF_E) \cdot (1-CF_H) \cdot (1+CF_O) \cdot (1+CF_R) \cdot 52} - EE_{OWHx}$$

E_x = energy demand of the building x within the analysed year (business or calendar year)
OWH_x = number of office working hours in the office building
WWH = weekly working hours
FTA_x = number of the average full time equvivalent working in the office building x of the analysed year
CF_E = correction factor external work
CF_H = correction factor home office
CF_O = correction faction overtime hours
CF_R = correction factor recreation hours spent in the office building x
EE_{OWHx} = energy demand for one office working hour in the office building x

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[10] Vivadelli, John H. „Next-Generation Facility Management", AgilQuest 2012, White paper, http://agilquest.com/White-Papers/next-generation-facility-management/, accessed December 8 2012

[11] "Workspace Utilization and Allocation Benchmark", GSA Office of Governmentwide Policy Office of Real Property Management Performance Measurement Division, July 2011
http://www.gsa.gov/graphics/ogp/Workspace_Utilization_Banchmark_July_2012.pdf, p. 3, accessed 10 December 2012
[12] LAING, A., "Financial-Services Firms: Banking on big design changes", in HQ:Good Design is Good Business, http://hq.construction.com/advice_opinions/0912_Financial_services_Firms.asp, accessed December 8 2012

Consequently Wiegand sketches new standardised benchmarks (WIEGAND, 2012b):

Savings: **€ / m^2 /utilization-unit**

or

Savings: **CO_2-emission / m^2 / utilization-unit**

or

Savings: **CO_2-emission / human activity**

Based on the author's state of knowledge dynamic and flexible calculation-approaches (models), which measure the real demand of (types of) workspaces within **dynamic** organisations and thereby evaluate the potential savings of workspaces and office-space are not developed yet. As mentioned in the introduction the high potential for more efficient utilization often remain undetected until dynamic event-based computer-simulations prove them. A reason it the high complexity of dynamic viewing of utilisation (Wiegand, 2012a). The presented study illustrates the actual workplace demand within organizations of different sizes (number of employees, different types of employees) and therefore identifies the saving potentials of workplaces within the various companies.

3   METHODOLOGY

The More-Space-Office Tool[13] is able to design these dynamic and flexible processes. The tool demonstrates innovation in space utilization and management for any company. More-Space-Office combines Know-How from several disciplines: real estate development, facility management and mathematical modelling and simulation.

3.1   More-Space-Office model:

The Tool is a hybrid model based on two modeling approaches: (1) Discrete Event-Based Simulation (DEVS) builds the framework. Within this framework the (2) agent-based (AB) approach runs. (Emrich, 2007) Both techniques are proven in various business fields. The agent-based part displays the characteristics of employees and workplaces, with individual behaviour, interests and entities. The statistic evaluation is based on the Monte Carlo Method, which relies on repeated random sampling to compute the simulation-results. The aim of the More-Space-Office Tool simulation is the calculation of the workplace demand with flexible workplace-utilisation within a certain company. Out of it the workplace saving potentials, in comparison to territorial workplaces-utilisation, are identified. The simulation-run requires some basic parameters: Information about the (1) number of employees, (2) types of employees, (3) number of employees within the categories in before, (4) employees' behaviour, (5) rules depending on the aim of the simulation respectively on the designated conclusion through the simulation – e.g. the actual utilization of existing workplaces, or required workplaces for new developments, new demands through organizational chances, the number demand of different workplace types (territorial, non-territorial,…) etc. Estimated data can be adapted with realistic datasets anytime. The here presented simulation for different company sizes is not based on a 100% realistic scenario. The hypothesis is deliberately kept basic. The evaluation for this study was designed under defined (1) basic conditions and (2) certain rules for the appliance:

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[13] GESIM (Gesellschaft für Immobilienentwicklung mbH), www.gesim.ch

3.2 Basic conditions and rules of the presented application:

The study shows the performance of **10 different company-sizes with similar characteristics** (see basic conditions and rules): the size is defined on the number of employees. In this case: 6, 12, 24, 48 99, 198, 501, 1002, 2004 and 5001 employees.

Basic conditions:

(1) 3 different types of employees:

- **Developer** - characteristics: **territorial workplace**, office-presence 5-days a week and 8 hours a day; developers start the business day between 8 a.m. to 10 a.m.;

- **Customer Acquisition** - characteristics: **non-territorial workplace**, office-presence 1-days a week and 4 days out of office, when office-present customer acquisitions stay 8 hours a day in the office; this employee type starts the business day between 8 a.m. to 10 a.m.;

- **Customer Support** – technical customer support on customer's location – characteristics**: non-territorial workplace**, office-presence 5-days a week and 2 hours a day; customer supporter come to the office between 8 a.m. and 5 p.m.;

Each company employees one-third developers, one-third customer acquisitions and one-third customer support.

(2) Employee behaviour: (described in (1) by the characteristics when, how often and for how long they stay in the office = demand for the use of a workplace.)

Rules:

(3) Workplace preconditions:

- Fix/territorial workplaces for each Developer

- Shared workplaces for Customer Acquisitions and Customer Support, shared workplaces can be utilised as required and as available by each Customer Acquisitions and Customer Support

- The simulation creates additional workplaces if required

Note: The case that all Out-of-Office employees appear at the office at the same time is excluded because of the probability bordering on certainty.

(4) Number of staff ill: Based on statistical data[14] equal rules for illnesses for all three types of employees are implemented;

(5) Holidays: Based on statistical data[15] 50 % of all employees consume their 25-days-holidays[16] in blocks (10 to 15 days) and within the main summer-holiday season (the simulations assumes school-summer-holidays 2012 between 10.07.2012 and 23.08.). Data show that the remaining holidays are taken randomly on working days during the year (365 days). 40% of all employees consume one holiday block anytime during the year. The remaining holidays are taken randomly on working days, too. 10% of all employees choose holidays randomly within the business year.

Note: New information regarding the described conditions can be implemented into the simulation any time. (The more exact the better.) The specified conditions and rules (in 3.2) are hypothesis for this study.

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[14] Statistik Austria, www.statistik.at, accessed December 5 2012

[15] Statistik Austria, www.statistik.at, accessed December 5 2012

[16] legal/common holidays in Austria, http://www.bmask.gv.at/site/Arbeit/Arbeitsrecht/Urlaub_Pflegefreistellungen/Urlaub, accessed December 5 2012

4   FINDINGS

Table 2 responds to two of three main questions of the research approach calculated for the ten defined companies:

- Which workplace capacity is actually required in a particular company?

What is the actual saving potential of workplaces within particular dynamic company's organizational structures?

Table 2 workplace demand and saving potential calculated for different company sizes

Company size | number employees	Territorial workplace demand	More-Space-Office workplace demand	Workplace saving potential in %
6	6	6	0%
12	12	10	17%
24	24	18	21%
48	48	32	31%
99	99	58	41%
198	198	110	43%
501	501	260	47%
1002	1002	501	50%
2004	2004	981	51%
5001	5001	2395	52%

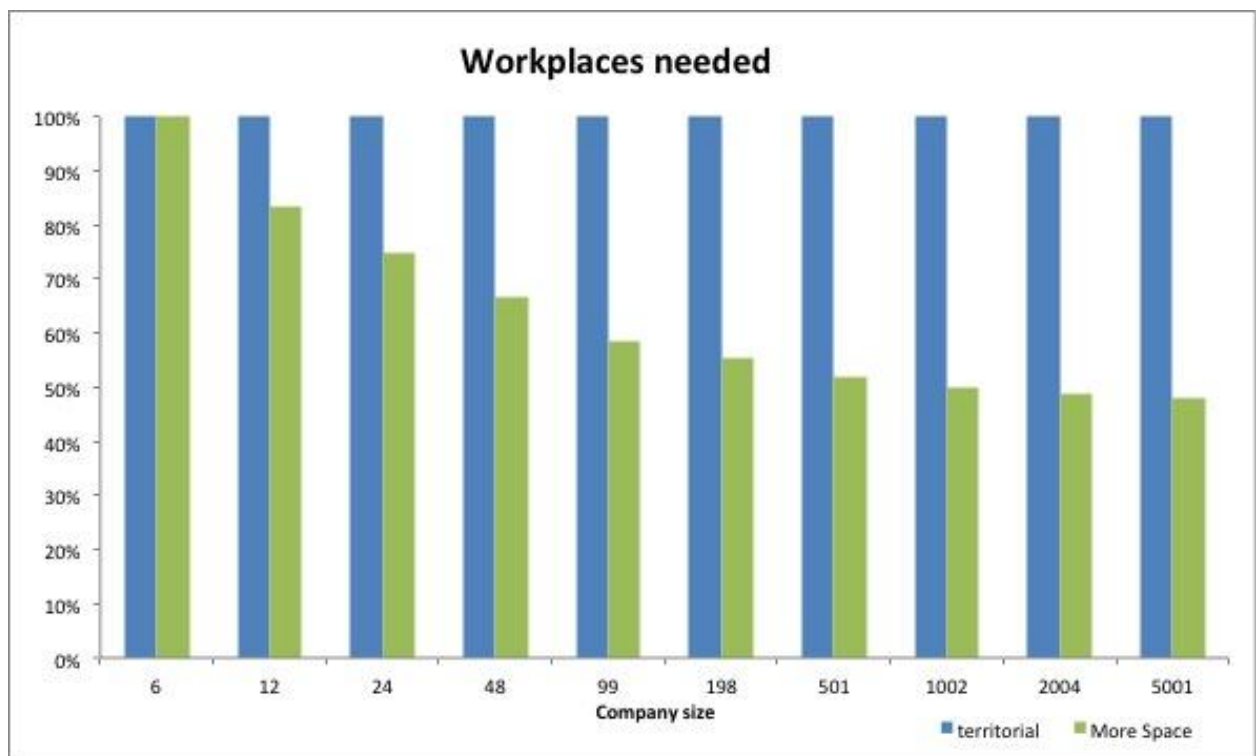Figure a and figure b (see next page) illustrate the findings via vertical-bar charts:

Figure b – Workplace Saving potentials as measured by companies-employee-size

The simulations demonstrate a peak of utilisation up to 80% within the core hours between 9 a.m. and 5 p.m. From a certain degree of efficiency utilisation cannot increase. Nevertheless the performance-peak depends on the company size. The results demonstrate that the bigger the size of the company (with respect to the number of employees) the more saving potential of workplaces the company has. These findings respond to the third main question of the research approach:

- Which types of companies are most suitable for high saving potentials of workplaces and how can they achieve them?

To benefit from the savings effects, a daily constant (more or less) number of employees coming to work is required. Still statistic effects (peaks and fluctuation) can influence the possibilities to activate the potential. The probability for statistic outliers reduces the bigger the company is.

The authors developed a "Screening" for companies to revise their suitability for the implementation of More-Space-Office. (see Figure c, next page)

More-Space-Office ability for Companies

relevance ranking:

O	insignificant
✔	relevant | potential
✔✔	highly relevant | high potential

Company Screening:

1 - Size - number of employees

< 10 employees	O
10 to 30 employees	✔
30 to 100 employees	✔
100 to 500 employees	✔✔
500 to 1000 employees	✔✔
> 1000 employees	✔✔

2 - Types of employees \| type of workplaces

fix | territorial workplace, fulltime employees	O
flexible | non-territorial workplace	✔✔
mobile employees | mobile workplaces	✔✔

3 - Number of mobile and part-time Employees

very few employees	O
approx. 1/3 within the organisation	✔✔
more than 1/3 within the organisation	✔✔

4 - active & dynamic Space-Management aiming the optimization of utilization

interest: optimisation of the portfolio	✔✔
interest: centralisation (of facilities)	✔✔
interest: real estate development	✔✔
interest: reorganisaion of space and/or organisational structures	✔✔
interest: save money, CO2-Emissions and space	✔✔

Figure c – Ability for the implementation of More-Space-Office within Companies

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5   CONCLUSION AND OUTLOOK

The optimization of workspace utilisation within the sketched companies shows impressive saving potentials within medium-size companies (more than 100 employees) and large-size companies (more than 1000 employees). The saving potential is up to 50% and more of their current workplaces. Moreover optimized space management supports also the improvement of workplace utilization performance from averaged 35% up to 80%. Structural changes can be implemented into the simulation anytime and thereby encourage highly efficient organisational (space management) performances. The approach of "More-Space-Office" is effectively considering aspects of actual or future company's requirements. Of course during the early phase of real estate development the including of flexibility within building structures and spaces is most efficient. The more employees, and the more flexible employees a company has, the better More-Space-Office suits to evaluate workplace demand and saving potentials. The tool is able to demonstrate EACH company its maximum benefit. The model is customisable and supports rapid prototyping − a relevant characteristic for approximate results, for quick estimations and decisions. Furthermore the company's workplace performance is evaluated and therefore important aspects of the ecological and economical efficiency. With basic informations like the company's employee-structure, the employees-behaviour, experienced data and/or plausible estimates the tool is easily applicable.

The study *The Smart Workplace in 2030*" (Ratcliffe et al., 2009a) describes suitably the author's study's approach:

"Over time the facilities management industry has shifted from a reactive model to one that embraces complexity and unpredictability… No longer are buildings sustainable by just having green technologies, sustainability is now measured by space utilization efficiency and one advantage of these hubs is the fact that it is reducing the number of vacant and abandoned properties in the cities, which is improving space utilization efficiency. As a result of this 'intelligent growth zones' begin to emerge which represent a fundamental shift in global spatial planning."

Another forecasting conclusions of the quoted study must be considered:

"We will witness a devaluation of Real Estate, as the necessity of having physical location is minimised. Corporations will need to develop both a physical space as well as a virtual space − Corporate Space online is predominant, forming a new Real Estate demand an offer a new Real Estate market − value of virtual space will be higher than the physical space."

It is to hope that in the near future more and more companies will lead the way towards more ecological and economical efficient workplace landscapes and the market demands them. On the long term it is also important that sustainable building performances, as described in the author's study, are inforced by legal regulations.

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The influence of facility management on detainees

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ABSTRACT

Purpose – This paper aims to explore the influence of Facility management (FM) on detainee behaviour and responsiveness. The expected outcome of this research is that FM can contribute to the re-socialization by actively using facility design and detainee activities to positively influence their social behaviour.

Design / methodology / approach – This current explorative study has been qualitative in nature, including desk research, literature study in relation to healing environment, walk through, observations and interviews with prison managers and facility staff. For this study, a comparison has been made between two correctional institutions. One correctional institution is situated in a rural setting with a building design dating from the early 20th century. The second building is located in an urban area and dates back to the 1990s.

Findings - This study shows that there is little to no sources found which describes how FM can actually contribute and add value to rehabilitation of detainees. From the literature study, the observations and exploratory interviews, the conclusion is that FM influences the behaviour of people. Further research could contribute to this emerging area in FM.

Practical implications – At this moment the Custodial Institution - Dienst Justitiële Inrichtingen (DJI) - is developing a master plan which will lead to a reassessment of the housing policy within DJI. Initially, DJI will have to formulate a new definition of the minimum level of humane detention in relation to FM.

Originality / value – This study may support DJI in the upcoming organizational change. It will provide DJI with the opportunity to perform additional research in order to deliver to society evidence on the influence and impact of FM on detainees

Keywords: Building, Cooking, Detainees, Facility Management, Prison Cell, Re-Socialization, Window View
Paper type: Research paper

1   INTRODUCTION

Within the European Community punishment is imposed by the judiciary system. Detention stands for a custodial approach as an almost complete loss of citizen rights. Based on

international and European laws, the minimum level of humane detention is broadly defined. It is also stated that the enforcement of the sentence is carried out in the context of rehabilitation, therefore referred to as the rehabilitation principle. And the detention must be undergoing in 'community' with a focus on rehabilitation rather than isolation. Legislation is described in the Standard Rules United Nation and the European Prison Rules. In addition, each Member State within the European Community can express further elaboration through their own legislation. In the Netherlands this is drafted in the 'Penitentiaire Beginselenwet'. The Custodial Institution - Dienst Justitiële Inrichtingen (DJI) - is responsible on behalf of the Minister of Security and Justice for the implementation of legislation, penalties, and custodial measures imposed by the judiciary system. The Government Buildings Agency - Rijksgebouwendienst (RGD) - provides the housing.

The Netherlands has approximately one hundred prison locations across the country, with approximately 17,000 employees. Annually, the DJI houses 70,000 'guests' for short or long periods. The average stay of a detainee is 109 days (WODC, 2012). DJI is responsible for the detention of people, their accommodation, and daily care. Within the DJI, there is a department of Facility Management (FM), Housing and Purchasing (DFHI), with responsibility for, inter alia, housing, maintenance, cleaning, and catering facilities. The RGD is part of the Ministry of the Interior and Kingdom Relations (BZK). The RGD develops and manages the largest portfolio of real estate in the Netherlands, including the real estate for judicial institutions. The RGD is also responsible for the construction, design, and management of judicial institutions, including maintenance. In recent years, the living conditions of prisoners has changed and, contrary to political expectations, it turns out that, the need for penitentiary capacity has diminished. Furthermore, budgetary targets have been reappraised due to the Euro crisis. However, a political and social debate has arisen regarding the prison system and the rebalancing of the minimum level of humane detention, leading to a call for tougher penalties. Certain centre-right political parties deem Dutch prison regimes as 'soft' and also characterize Dutch prisons as hotels and universities for criminals. This also means that the housing situation of prison buildings has to be reassessed. Namely, a switch from single to multiple cells, where the aim is to quadruple cells. This should lead to a more efficient and effective use of financial flows and staffing. However, it is unclear what impact this will have on rehabilitation.

2. THE BUILDING

The Netherlands has a great diversity in the building design of correctional institutions. From three so-called dome prisons, dating back to 1886 up to more recently built prisons. Every building is unique in design and represents the era in which it was built. There are correctional institutions in rural locations, others located in urban areas, and those built more recently in the 1990s on cheap industrial areas close to highways. Each building has a unique design and its own history. In the design and construction of prisons, it is interesting how the standard for a minimum requirements level of humane detention must be incorporated into the building design. From the literature and research studies it is well known that the physical environment and architecture has an influence on behaviour, health and temperament (Baker, 1992; Aaron, 1996; Novaes, 1997; Redd, et al, 1994; Nilsson, et al., 2001; Robertson, 2001; Caine, 1991; Barton, Pretty, 2010). The question is whether the above research findings are decisive enough in the debate on the formulation of a basic minimum standard of humane detention. What are the minimum requirement standards for humane detention viewed from the perspective of restorative facilities? Moreover, what is the influence of facilities on the behaviour, mood, and health of detainees. How could a basic minimum standard of humane detention possibly be included in the facility design and functionality of the building? Moreover, how could the coherence of such standards and designs be incorporated in a

correctional institution in order to create an optimum contribution to the punishment and rehabilitation of detainees?

3   HISTORY

One of the first people who gave consideration to what we now call FM, was Jeremy Bentham (Bentham, 1787) with his design for the Panopticon: a dome. Although the Panopticon was never actually built, the ideas of Bentham have had a significant influence on modern thought regarding punishment and power (Božovič, 1995; Harrison, 1985). In his thinking, the facility design of a penitentiary was explicitly linked to the regime of the prison. The Panopticon was planned to be a circular building with an inspector's lodge at the centre and prisoner cells in the circumference. The cells had a window for lighting, during the night secured by small lamps outside the window, and light iron grating; all allowing the inspector to view every single movement of the prisoner. The essence in the design was the invisible omnipresence of the inspector; power through the principle of 'seeing without being seen', in combination with the circular form of the building. The ideas of Bentham were based on the concept of deterrence: the prison as a theatre to prevent innocent people becoming offenders. Bentham was also very enthusiastic about the possibilities of applying this concept to other organizations. In one of his letters to his friends he argued:

"… no matter how different, or even opposite the purpose: … penitentiary-houses, or houses of correction, or work-houses, or manufactories, or mad-houses, or hospitals, or schools." *(Bentham, 1787: 32).*

This leads to an important question: if we were to change the concept what would happen to the facility design? For instance, the Panopticon is in concept very different from the penitentiary at Veenhuizen in The Netherlands, built in the 19th century. In 1818 the private Company of Beneficence - 'Maatschappij van Weldadigheid' - an initiative of General Johannes van den Bosch started to operate a variety of facilities for the poor. Veenhuizen was one of these facilities. The penitentiary in Veenhuizen started out as a work institution for the poor and outcasts of society and, over the years, evolved into a place of confinement for criminals (Van der Woud, Elerie & Huussen, 1994). Veenhuizen is very special, with only three such penitentiaries being found worldwide: in Australia, Belgium, and The Netherlands. The penitentiary was, and partly still is, a complete autarkical village directed at re-socialization (as opposed to Bentham's deterrence). The basic principle was to create a community, in contrast to a cell-regime. The institutions were square-shaped with farms close by. Severe labour was supposed to create better men. This supports the conclusion that different strategic concepts about the effects of punishment lead to completely different organizational activities; creating a preventative deterrence as opposed to healing through a sense of community and hard work. Moreover, the architecture was completely different; a theatre of deterrence or a village.

As such, it is safe to argue that added differences do not only influence the regime, but also the choice of the facility design. The ideas of these unique visionaries had a major impact on both the design of organization and space. As such, it illustrates the early sense of a close connection between both long before FM was known as a field of practice and science.

4   THEORY

Already in 1943 Maslow (1943) developed his Hierarchy of Needs Theory. People have a need for shelter, protection, security, and contentment. Everybody is looking for a place where these needs can be united. Within this theory, which has never been supported by empirical evidence, has inspired many researchers. If housing and lodging fulfil an important role in filling those needs, consequently the accommodation unconsciously affects our welfare and the shape of our identity (Van der Voordt & Van Eck, 1998). Science has long

been looking for elements within the environment which can be directly or indirectly related to the health, mood, and behaviour of people. Within FM two aspects were chosen because both have a very direct influence on detainees' lives; being the view from the prison cell window and the degree to which detainees are allowed to self-cook.

4.1 NATURAL VIEWS

Evidence-based design has shown a positive impact of nature on the health and behaviour of people. Wilson (1993) spoke about 'The Biophillia Hypothesis', in which he assumes that there is a relationship between experiencing nature and people's behaviour. Custers & Van den Berg (2007) demonstrated through experimental research that a 'green' experience does indeed have limiting effects on the physiological, affective, and cognitive levels of stress. This study not only looked at the psychological experience of nature on the respondents, but showed that the stress-raising cortisol levels among respondents decreased after exposure to nature. Mobach (2009) mentions three literature reviews in which the influence of nature in healthcare is described. Firstly, in 2006 Joseph carried out a literature review of 250 studies on the influence of the physical environment with regard to measurable outcomes in patients, family, and staff during prolonged stays in a healthcare facility. One of the conclusions is that the physical environment essentially influences the quality of life of residents, the safety of residents, and the stress levels of personnel. Therefore, a positive effect can be expected if thoughtful consideration is given to the design of the building and, subsequently, lead amongst other things to better sleep, better orientation, less aggression and harassment, greater social interaction, higher overall satisfaction, and higher welfare (Joseph, 2006). Secondly, Van den Berg (2005) conducted a literature review of 87 studies on the influence of nature (views, garden visit, and houseplants), daylight and artificial light that mimics daylight, fresh air supply and/or silence (noise reducing measures) on patient welfare. One of the conclusions is that ventilating rooms with fresh air improves the perceived and the diagnosed health. It was also shown that, when other factors resulted in moderate to weak evidence, the visible experience of nature can reduce stress and anxiety.

Finally, Dijkstra *et al.* (2006) conducted literature studies on the influence of environmental factors on patients. However, although the number of studies which they researched was substantial, they concluded that only thirty five out of five hundred selected researches were found to be of conclusive quality. They found inconsistencies in the research methods, but conversely, they also found clearly identifiable positive effects due to the use of sunlight, windows (views), odour, and spatial layout (Mobach, 2009). Moreover, Butler & Biner (1989) demonstrated that the amount of windows desired in a space can be predicted by knowing individual space preferences (e.g., having a view or good ventilation). Veitch & Galasiu did find a relationship between windows, natural light, and views. People in any environment need views and that, especially in living rooms, there is a greater need for windows. Even though the above research was performed in office buildings and healthcare institutions, there are useful parallels with facility design of penitentiaries. For instance, large windows reduce the feeling of confinement (Veitch & Galasiu, 2012), which may also be relevant for detainee behaviour. Tregenza & Loe (1998) state that windows have the strongest influence on the indoor environment. View provide information about the time and the weather and reduces the feeling of claustrophobia. An important prerequisite for view is that windows overlook a foreground and contain horizon (Littlefair, 1996).These findings match with the research of Van den Berg (2007), who argued that a natural view makes people feel safe. She showed that in healthcare facilities people prefer a landscape which represents shelter and safety whereby people can stay in touch with the world. It induces a feeling of calm. Both Van den Berg and Veitch & Galasiu conclude that there is a direct correlation between the size of windows and people's perceived sense of security. Keighley (1973b)

carried out observational studies in relation to the scope and size of windows. The study showed that a preferred fenestration size lies between 1.8 and 2.4 m, of which the height of the window section is greater than the width. Veitch & Galasiu (2012) mention that it is also likely that the preferred window dimensions vary in relation to the view of outdoors, with larger windows being preferred when the view is more attractive or less obstructed.

Consequently, windows may be regarded as more than a practical utility to view through walls, they are a connection with another world outside the building. For instance, when looking at it from physiological aspects light through a window is passing through the eye and sends signals to the biological clock. Light regulates the daily rhythms of many body processes, such as temperature, sleep patterns, cognitive performance, mood, and also the creation or suppression of various patterns. The Research Foundation Light & Health (2012) mentions that light is important for a person's alertness. This alertness diminishes when there is insufficient light during daytime and leads to uneasiness. These complex relations between space and body may also influence moods and behaviours of detainees. In this context, a sole utilitarian dimension, which among other factors was included in the work of Pennartz (1981) can be unleashed. If it can be argued, that sufficient light and views lead to a feeling of wellbeing and good health, then the opposite is also true. Namely, that visual discomfort has a negative effect on a person's feeling of control and wellbeing. The questions remains however, if there is a relationship between visual discomfort of detainees and situational determinants of pro social behaviour? In the 1970s, Milgram (1970) launched his 'urban overload' hypotheses. He suggested that the large amount of stimuli that one experiences in an urban environment, leads to antisocial behaviour. Several follow-up studies have also demonstrated this effect (Levine, Martinez, Brase & Sorenson, 1994; Steblay, 1987). Hence, an interesting question is whether detainees having a view of a rural area without an overload of stimuli generate different behaviours than detainees in an urban environment.

4.2   COOKING

The second research question is whether detainees, who are assigned to a penitentiary having a self-cooking system were more satisfied and developed a more favourable behaviour than detainees in a penitentiary with a cook-chill system, such as in the Netherlands. In the previously cited theories of Maslow 'hunger' and 'thirst' are the physiological needs in a person's life. A shortage of nutrients (energy, protein and other nutrients) leads to reduced biological function and has implications for the physiological aspects. One of the consequences is the effect of malnutrition on a person's behaviour. A lack of food can make a person listless, while another will demonstrate rebellious behaviour due to a negative intake of nutrition. Food is an essential component for healthy living and the behaviour of people and their sense of well-being. Social sciences have a large number of researches in which the importance of nutrition has been shown, as well as the method of preparing and eating. Preparing food and the way of eating is also culturally determined (Bugge, 2003). In many cultures, including Asian and African diet, the role of food has an important social significance. Food and cooking is a form of communication. Cooking together and eating together generates social control within the group and as a consequence influences individual behaviour. Much research has been done on eating habits in hospitals and nursing homes. In the Netherlands, there is a large amount of knowledge about the eating habits in institutionalized settings. Many examples show that eating and cooking together helps to reactivate patients. In this context self-cooking leads to better behaviour (Beck *et al*., 2001). In healthcare facilities, for instance, Sodexo has created autonomous patients with a room service. Patients can order off of their own meal from a menu during kitchen opening hours. The meal is freshly prepared and delivered to their rooms within 45 minutes. Sodexo reports higher patient satisfaction, happier nursing teams, and less wasted food. Dutch scientists

currently explore if the food delivery system has similar positive effects on malnutrition in hospital 'De Gelderse Vallei'. Within childcare, studies also have provided sufficient evidence that self-cooking and eating together with children leads to a positive effect on the behaviour of children. Recent research by Lin (2012) has led to a framework in which current food choices and food behaviour are linked to welfare.

The Dutch prison system has various food systems. In most detention centres there is a cook-chill system. The choice for cook-chill is cost driven and efficient distribution. Dutch detainees are offered three meals per day, taking into account religion and special dietary requirements which they can choose twice a year. However, well-being surveys of detainees show that the taste of regenerated meals is less acceptable. It is well known that some institutions throw away more than half of the food allocated to them daily. Currently, a number of Dutch prison buildings are offering detainees the possibility to cook their own food. This being a form of detainee autonomy within the penitentiary system. Conversely, day to day practical experience shows that detainees who are allowed to cook their own food, become very creative in their ability to utilize the ingredients available to them. There are even special cookbooks available, such as 'Cell's kitchen' with recipes specially created for detainees. The RGD nuances latent positive effects. More incidents, for instance fire and electrical short circuits, have been reported in institutions where detainees can cook for themselves. Moreover, the cost for self-cook is higher than for cook-chill. However, the question is to what extent this detainee autonomy meets the minimum humane detention level in relationship to the level of the punitive measure? Unfortunately, little research has been carried out on the effect of different cooking systems on the behaviour of detainees. The assumption is that self-cooking contributes to more favourable behaviours. However, there is not yet any hard evidence that detainee autonomy for food preparation contributes to favourable intramural behaviours, not to mention a better rehabilitation or reduced recidivism. Further research is needed to determine a possible relation and weigh possible positive and negative effects of cooking systems.

5   METHODS

This current explorative study has been qualitative in nature, including interviews with prison managers and staff. For this study, a comparison has been made between two correctional institutions. One correctional institution is situated in a rural setting with a building design dating from the early 20th century. The second building is located in an urban area and dates back to the 1990s. Since the general objective has been to explore the relationship between FM and detainee satisfaction and behaviour, the most important method of data-collection was interviews, both in-office and during a walkthrough of the prison. Consecutively, the four interviews were conducted, elaborated in a word-document, and analysed. The central topics in the questions for penitentiary staff were the building, the regime, the view from a prison cell and the cooking system. Staff was interviewed at their prisons in order to allow a check of their responses with simple observation at their premises. Photography was not allowed during the visit. Additional general information was obtained from documentation, for instance, approved photographs, general reports drawn up by the DJI and the penitentiary. Each sample was studied with the two main research questions as mentioned above. The answers to both questions were mainly based on interviews and documentation. The answers to these questions were used to derive a relationship between FM, in this case, specifically, space (view from cell window) and organization (regime for cooking), and the reported detainee behaviour.

6   RESULTS

The Netherlands has a large variety of correctional institutions and it is evident from the design in which era a particular prison building was built. The interior of each building has an effect on the view and restorative facilities. In both institutions the influence of natural window view and the restorative facilities has been discussed with FM. In addition, previous surveys, drawn up by the Ministry of Security and Justice, regarding the wellbeing of detainees, have been studied. In these surveys only a few questions were submitted to the detainees in order to question their perception of hygiene and their opinion about the evening meal. All the other facets of facilities services were disregarded in these surveys. One of the findings in the surveys is a possible relation between hygiene and the experienced feelings of security among the personnel. In the literature it is stated that a hygienic environment increases the sense of security among prison staff. The literature study shows that the amount of luminance, the quality of the natural view has an influence on human behaviour. Based on the desk research examined hardly any evidence has been found that both institutions are not making use of this knowledge in the formulation of a prison building design. The management of the rurally situated institution argued that detainees preferred a cell on the outer ring of the building with a natural view of the countryside. Individual detainees often asked for a transfer to the outer ring. Management reported that detainees in the outer ring showed better behaviours. In contrast, in the urban setting the view is everywhere equally gloomy and natural views were almost completely absent. Partly due to the building design and partly due to the use of grey coloured concrete and a limited view on all sides. Within this setting, detainees hardly ever had a preference for placement on the outer of inner ring. Moreover, in this institution, it is the management which always determines the placement of detainees. Another interesting aspect of this urban setting is the changeover of the existing single cells into double occupancy cells. This has the effect that there is a decrease in the level of light in the cells, due to the placement of additional furniture. This coupled with the moderate ventilation in the cells (windows do not open), raises the question what the effect is on the behaviour of detainees? Additional research is necessary to answer this question. The conclusions regarding the restorative facilities are still indecisive and need further research. The literature and evidenced based studies from the healing environment demonstrates that the use of self-cooking and eating together has a direct impact on a person's health, mood and behaviour. Based on the interviews, there is a noticeable difference in behaviour between detainees allowed to self-cook and those receiving chill cook meals. The management of the self-cook system reported positive effects on detainee moods and behaviours. However, various stakeholders, such as the RGD, are also experiencing risks because of self-cooking. The RGD mentioned the high number of kitchen incidents due to improper use of kitchen equipment. The conclusions regarding the cooking system are also indecisive and also need further research.

7   FINDINGS

What is the influence of FM on detainees? This study shows that insufficient research has been carried out on the relationship between the behaviour of detainees and FM. From the literature research, the observations and exploratory interviews, the conclusion is that FM influences the behaviour of people. It may be tentatively stated that an adequate facility policy could contribute to the rehabilitation of detainees. Examination of European and Dutch national legislation shows that a minimum humane detention level is defined without a reasonable formalization of the minimum facility detention level. From the design guidelines for building and housing there is a draft for the maximum size of the accommodation, including the size of the windows. This observation is a fundamental aspect of security and may prevent escapes. There is little to no sources found which describes how FM can actually contribute and add value to rehabilitation of detainees. New research could contribute to this

emerging area in FM. In order to answer the question to what extent a natural view from the window influences the behaviour of detainees, research shows that there indeed may be a relation. However, desk research did reveal well-considered facility designs, such as on luminance or window views, in decisions on window size. Prison building design focuses mainly on safety for society, expressed in confinement and the prevention of escape. Moreover, there is a great diversity between food and beverage supply systems. The assumption of most prison facility managers and the RGD is that self-cooking indeed contributes to a better rehabilitation. At the same time it creates problems with regard to food safety. Furthermore, the cost of self-cooking is higher than that of cook chill.

8   LIMITATION AND SOCIAL DEBATE

The financial and economic situation in The Netherlands compels the need for drastic cuts in central government. This also applies to the Ministry of Security and Justice. At this moment DJI is developing a master plan. The prediction is that there will be budget cuts for cell capacity and thus for housing of detainees. There is pressure to reduce the number of penitentiaries. It seems inevitable that prison buildings will be closed in near future. This master plan will lead to a reassessment of the housing policy within DJI. Initially, DJI will have to formulate a new definition of the minimum level of humane detention. In this definition the relation of FM with detainee behaviour and rehabilitation should also be explored further. This upcoming organizational change will provide DJI with the opportunity to perform additional research in order to deliver to society evidence on the influence and impact of FM on detainees. Such research should demonstrate the value of FM support to the core business of Dutch prisons and the added value of FM to the detention process, and the success of the rehabilitation of detainees. Ideally, with such research FM can show how facility design of penitentiaries can contribute to reduce cost for society by adding value to the primary process of penitentiaries.

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A Mathematical Simulation Tool for Increased Space Utilization Efficiency

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ABSTRACT

In times of economic and ecological crisis utilization of (office) buildings is becoming an increasingly important element for companies, especially as current utilization rates are – at best – somewhere around 15 to 20%. Improvement of space utilization means improvement of space management and, in offices, this usually requires testing, selecting and offering alternative working (time) models.

In order to improve utilization efficiency flexible workplace-models have to be used. Shifting from territorial workplaces to flexible models demands an in-depth analysis of the employee structure, their (workplace) needs and behaviour. This paper describes why static methods (e.g. rules of thumb or statistical analysis) fail, as they neglect dynamic effects.

Subsequently the setup of the "More-Space Office Tool", a discrete event (DEVS) model which dynamically simulates workspace utilization over time, is presented. Via agent-based (AB) implementation it pays respect to the natural heterogeneity of employee populations and differing (employee type) behaviour. Both, DEVS and AB approaches, are techniques proven and tested in various other business fields. Spread-sheet import allows easily modifiable "on the go"-control of the coarse behaviour, while fine tuning is done over model-internal agent state-charts. For close-to-reality results a sickness-function has been developed based on statistical data and an employee vacation function based on expert knowledge.

Finally information regarding the model's performance, versatility and flexibility is provided, as this combination allows it to deploy the simulation tool in a very fast and cost effective way, which enables decision makers to test multiple potential scenarios with respect to their utilization efficiency.

Keywords

Office Utilization Efficiency, Space Management, Mathematical Modelling and Simulation.

1 MAKING THE MOST OF (OFFICE) SPACE

It is no secret that built space is directly – from a certain threshold on almost linearly – connected to costs, as it needs to be built, cleaned, heated and maintained. Moreover this means that built space is also directly linked to green house gas emissions (GHG), originating primarily from construction (embodied energy) and heating. In times of (financial) crisis and of global warming (high) costs and GHG emissions are undesirable. But even without these

external difficulties, competition itself forces to reduce costs and to position companies as socially responsible.

In Vienna (Austria) the annual costs for one square meter of gross floor space lie between 150 and 250€ (see Zitter et al., 2011). Following calculation is shown in figure 1: Zitter et al. state, that *operating costs* account for only 20% of these annual costs (1st bar in figure 1, f.l.t.r.), and provide benchmarks according to which roughly 40% (of the initial 20%!) are capable of being *influenced* – thus 8% of the total costs (2nd bar). It is further possible to *reduce* the influencable costs by 30% (= 2.4% of total costs, 3rd bar). Assuming a *realistic reduction* of 50% in practice, the total costs can be reduced by a mere 1.2 percent (4th bar)! It is thus obvious that Facilities Management (FM) cannot contribute to substantial savings if it focuses only on reduction of operating costs.
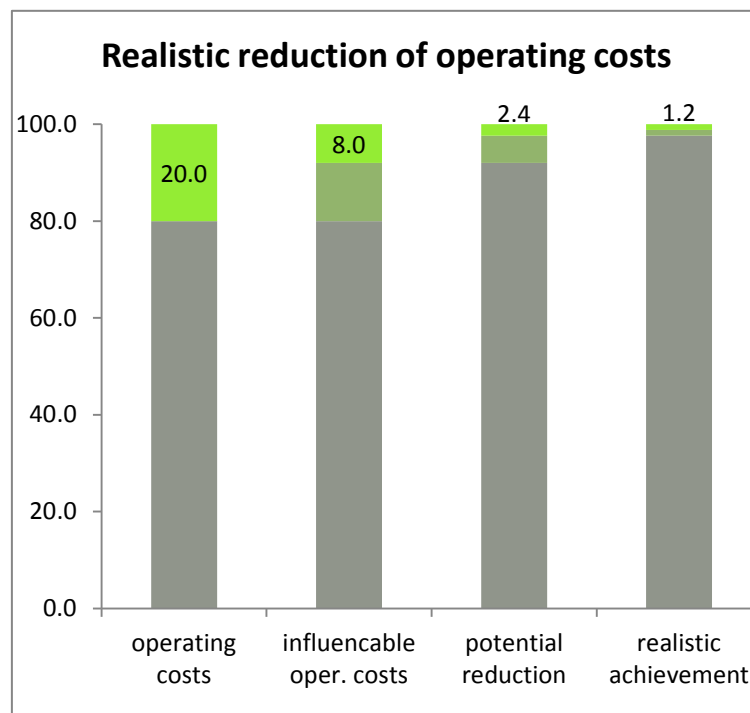
Figure 1: Scope for (realistic) reduction of operating costs

On the other hand buildings are used only for a fraction of their life time. As explained by Ottomann (1994) effective utilization of office space is only around 5%. This includes a working week of five 8 hour work days, holidays and vacation of employees, breaks, sick leaves and social as well as organizational activities.

It is apparent that an efficiency increase in space utilization offers a far bigger potential for savings than reductions of operating costs. A theoretical increase of 5 percentage points (i.e. from 5% to a utilization of 10%) does equal cutting the space required in half – and thus reducing space-related costs by approximately 50%! This is illustrated by following example: A company with 100 offices has a utilization of 5%. Availability of hundred offices per week (7 days á 24 hours) is 16.800 office-hours (100*7*24). Utilization of 5% means that a mere 840 office-hours are actually "consumed" by the employees. As the actual need (840 office-hours) is not changed by a more efficient space-management, a raise to 10% utilization efficiency would require an availability of only 8.400 office-hours (840 = 10% => 100% = 8.400), which calls for (8.400 divided by 7 days á 24h) 50 offices – a 50% reduction of the original 100 offices.

The question that arises is: "How can (office) space be used in a more efficient manner?" - Which is equivalent to that of how much space is *truly* needed.

2   TACKLING THE PROBLEM

For the sake of completeness it has to be added that raising space utilization efficiency is not solely a technical/management issue. Employee satisfaction, their motivation and cooperation is at risk when trying to forcefully change the working environment. Since change of traditions, workplace- and working time models is necessary in order to increase efficiency, any successful modification of the "status quo" will need to take into account psychological aspects. These, however, are not at the focus of this research paper.

Returning to the questions posed above, decision makers need to know how much space is truly needed. This of course is hard to answer without adequate information. Approximations can be derived by rule of thumb estimates customary in the particular trade, although they will remain (rough) estimates. Chances are that the need for space will be over- or underestimated. Both outcomes come with significant costs (see Kovacs et al., 2013 for financial insight on inefficient utilization of office buildings). Either there will not be enough space for all employees, which not only requires renting additional space, but also disrupts workflows and thus decreases overall productivity. Overestimating required work space, on the other hand, leads to suboptimal utilization. The situation improves less than it could have.

Trying to improve the results, more detailed calculations could be carried out. Nevertheless these will become extremely complicated and complex when trying to incorporate different behaviour of employees. For example will sales representatives have needs different from in-house account managers, who will again have needs, working- and vacation times that differ from those of the IT-staff. Getting exact results under such heterogeneous conditions is challenging, to say the least. In addition, even if it would be possible to obtain exact results for this problem, they would be valid only for this one scenario. A change within the employee structure or a different space management strategy would require starting from scratch, as all calculations and consideration have to be applied to the new scenario. Another flaw of this approach is that it neglects the stochastic nature of the observed system (i.e. employees are not robots that have ever repeating, non-changing routines within their work-cycles).

Another approach is to closely monitor and track the employees' actual work place needs and use the data obtained for statistical analyses (e.g. electronic monitoring of workplace activities, collecting information on employee position, etc.). Nevertheless, this approach has some major drawbacks. First it raises issues regarding privacy. And even if legal it is likely to cause bad blood among employees and/or staff associations. Second if monitoring systems are not installed yet, it is costly to do so. Further it takes a long period of time to acquire sufficient amounts of data. Third data gathered is, by definition, always historic – even in real-time systems. Thus it can only be used to explain and analyze (management) strategies, employee structures and office layouts that have existed and been monitored in the real world (i.e. those from which the data comes from). But the data is only of very limited use when trying to understand the effects of alternative scenarios (e.g. modified employee structure, different working times, changed space management, etc.).

These above two methods (rule of thumb and statistic analysis) are regarded *static models* as they do depict the system behaviour, but without any change over time. This is not to be confused with an (in)ability to "predict" the future state of the system. But the prediction does not change over time, as well as the models itself do not change their states.

In order to overcome the limitations of these static methods a *dynamic* model for the evaluation of office space utilization has been developed – the *"More-Space Office Tool"*. With this model it becomes possible to dynamically simulate workplace utilization for a

virtually infinite number of different scenarios. It combines knowhow from real estate development, facilities management and mathematical modelling and simulation. Further it is based on the experience gathered during a 5-year research project at the Vienna University of Technology (TU Vienna, for the project see Emrich et al., 2010) – a research project conducted in order to increase efficiency of space utilization and for evaluation of space management strategies in a large environment (20,000+ students, several hundred lecture rooms and over hundred thousand scheduled events/lectures).

3   DYNAMIC MODELING OF SPACE UTILIZATION

As previously indicated there are several factors that need to be considered when trying to increase space utilization efficiency. All of these have to be included within a model in order to produce realistic simulation results. The main factors are:

- The employee structure, i.e. how many employees of which employee types are working within the respective company/office.

- Employee behaviour, i.e. which working preferences and what kind of behaviour do the employees have (e.g. working times, fraction of field work, etc.)

- The "office environment", i.e. how many offices/workplaces of what type are available.

- The space management in place, i.e. which rules have to be considered when it comes to assignment of work places (these will strongly depend on the objective of the simulation).

In such a setup the individual employee can be regarded as the smallest unit. It is her behaviour that defines the simulation result, and subsequently it is necessary to depict the employees in the most accurate way. For this reason "top-down" approaches (such as statistical methods) are only of limited success: they describe the system as a whole – without giving respect to the interactions of the system internal elements. *Agent-based (AB) methods*, which are used in the *"More-Space Office Tool"*, are producing the system's behaviour via definition of its smallest units and their respective interactions. In this case these smallest units are the employees and their behaviour. AB modelling is treating every instance (i.e. employee) as an independent entity with an individual behaviour (see Emrich 2007a, 2007b). AB models are often implemented utilizing object oriented languages, as these allow for a straight forward implementation of this individual/reproducing concept.

Further, to recreate realistic behaviour, the stochastic nature of *events* has to be incorporated into the simulation model. This is necessary as, for example, employees will not come to work every day at exactly 8:00 A.M. On the contrary they will most often come a bit earlier or later as they have to deal with "unexpected" events, such as traffic jams or delayed public transport. Such events can potentially trigger chain reactions (e.g. missing the first of a series of connections by only a second can lead to a cumulative delay of several hours) and are thus vital for the dynamic nature of the model. Such models are referred to as *Discrete Event Simulation (DEVS)* models.

Both approaches, AB methods and DEVS, are techniques proven and tested in various business fields, ranging from epidemic modelling, over logistics and production up to military and security applications. For a general, detailed introduction to *computer simulation*, reference is made to McHaney (1991), to Fishwick (2007) for a thorough overview of *dynamic simulation* and further, for mathematical concepts used in simulation, to Bungartz et al. (2009).

In order to combine the features of AB methods and DEVS a hybrid model was created using the simulation environment AnyLogic, which is based on the object oriented programming language JAVA and capable of supporting both approaches (AB and DEVS).

	A	B	C	D	E	F	G	H	I	J	K	L
1				**Employee statistics**								
2												
3				arrival at office		time in office				agent color		
4	type	No. of employees	days in office	earliest	latest	shortest	longest	accepted waiting time	vacation	red	green	blue
5			days/week	hour	hour	hours	hours	minutes	days/year	0...255	0...255	0...255
6	Developers	30	5	8,00	10,00	7,00	9,00	0	40	255	165	0
7	Acquisition	50	1	8,00	10,00	2,00	5,50	0	40	245	20	147
8	Forenoon	30	5	7,00	17,00	2,00	2,00	0	40	84	84	84
9												
10												

Figure 2: Import of employee structure via spread sheet file

For fast and flexible adaptation of the model towards virtually any business or company the employee-structure is not programmed into the model itself. Instead the simulation model is importing an Excel-file (or CSV-files which are standardized spread-sheet format files, also supported by Excel), in which the employee structure is defined, at start-up. Through an adaptive algorithm it is not only possible to change the number of employees of each category but also to add, modify or remove employee categories and to change their working times, their arrival at office and average days of vacation/year, etc. As these files can be opened and modified with any spread-sheet program, office suit proficiency is sufficient in order to change the employee population and its behaviour within the model.

In figure 2 an example of such a spread-sheet with three employee sub-populations is shown. Every row symbolizes a distinct employee type (in this case "Developers", "Acquisition" managers and "Forenoon" part time workers). The columns define the behaviour of the employee types. Thus developers and part time staff are in office every working day, while acquisition managers are working outside 4 days per week. The (approximate) arrival times at office and time spent in office can also be set for every sub-population. Accepted waiting time (column H) is used within a shared space environment and defines how long it is tolerated for employees to wait for a free workplace. The last three columns (J, K and L) are for the graphical representation within the simulation. Naturally this (still fairly simple) input-file can be blown up and adapted according to further needs.

While the coarse behaviour (arrival at office, working times, etc.) is specified via this input spread sheet, it does not define the exact "patterns" of the employees. These are controlled via agent internal state-charts. State charts offer several advantages. Two of the most important ones: they help to visually describe the agent (i.e. employee) behaviour, which improves communication between business- and modelling experts and they allow for a fast adaptation of the (overall) model behaviour. It is important to note, that every agent has its own instance of the state chart(s)[17], and thus behaviour is independent of other agents[18].

Figure 3 shows an initial state chart (left) and its modification (right). With the extension from the left to the right the agent (i.e. employee) behaviour has been extended by the possibility to work outside the office (i.e. do field work). As employees working outside of the office do not need a workplace in the office, the "fieldWork" state bypassed the "inQueue" state, which is entered as soon as the employee is waiting for assignment of a proper workplace within the office. Of course such an extension also requires modification of the underlying probabilities and decision rules (algorithms).

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[17] Agents can contain more than one state chart. For example: it is possible to split the state chart from figure ii into two charts (health & vacation state chart and working state chart), where an active health & vacation state would prohibit a change from "idle" to "inQueue" within the working state chart.

[18] Of course dependencies can be added if they are desired and/or necessary.
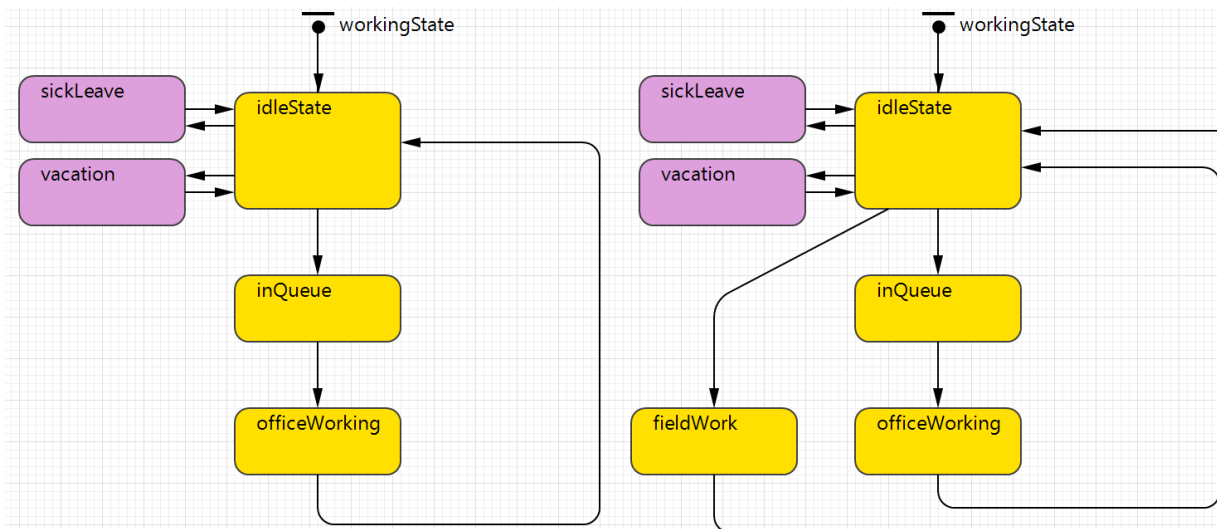
Figure 3: State charts for agent-behaviour without (left) and with (right) the option to work outside of the office (field work).

The state charts are also a very powerful tool when modifications become necessary in order to adapt the model to specific company requirements. Given the necessary information it is possible to incorporate virtually any employee behaviour – which could be a siesta after lunch as well as manager meetings on Monday mornings.

To achieve closer-to-reality results a sickness function has been integrated into the model. This function generates daily stochastic probabilities for every agent to determine whether the employee turns sick and thus cannot come to the office. For this function data from the Austrian Statistical Central Office (Statistik Austria) has been used. The vacation times of the agents are distributed partially randomly during the year and partially located during a specified "peak season", but can be changed and adjusted to any given distributions.

The office environment is also implemented agent-based: every workplace is an agent. While this might seem a bit strange at first sight, agents do not have to be "alive" or (pro-)active entities. Modelling of workplaces as agents opens a wide range of options. For example do agents support implementation of different states (e.g. "workplace taken" or "free")via state charts and addition of valuable properties, such as "workplace fixed assigned to employee X" or "for flexible use". In addition it is possible to reproduce agents during simulation, which opens the opportunity to add as many (in this case workplaces) as necessary for a given employee structure – depending on the dynamic model behaviour. While this is not "realistic" system behaviour of a built office, this option can be exploited to identify the maximum number of required workplaces[19]. It also enables tracking of statistics for every agent (i.e. workplace) such as utilization evaluation of every workplace or identification of workplaces that are used most (or least) frequently.

Space management itself is not explicitly implemented. This means that there is no managing entity within the model. Instead the models entities (employees and workplaces) communicate with each other. Thus space management is implemented implicitly. For example it is possible to label all workplaces as "fixed assigned" which allows employees to only use their personal workplace. Another scenario could assign fixed workplaces to a certain employee type while others are using shared spaces. Nevertheless, if necessary, implementation of explicit space management (e.g. a centralized booking system) is possible.

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[19] Such an approach of course needs to respect the system's stochastic nature and thus modes to cope with it have to be found (e.g. Monte-Carlo simulation).

4   BENEFITS OF DYNAMIC MODELING

The *"More-Space Office Tool"* created is based on two very powerful modelling approaches and is thus not only capable of simulating heterogeneous employee structures, but also very flexible and versatile. Thanks to data-driven model generation (spread sheet input) it is possible for people outside the field of mathematic modelling and simulation to not only run simulations, but also to modify and adapt the system behaviour. This empowers them to conduct experiments with the simulation model on their own.

Table 1: Runtimes for two model variants and differing employee structure
(simulation interval: 365 days)

Employees	Model 1	Model 2
500	18 sec	109 sec
1000	32 sec	154 sec
2000	58 sec	280 sec

The runtime of the tool allows testing space management strategies and workspace needs in a very short time. In table 1 runtimes[20] of two models, adapted for different company requirements, are compared. Both have been used to simulate a one year interval (365 days, including weekends) with different employee structures (500, 1,000 and 2,000 employees). While the runtimes vary greatly between the two models, runtimes are not even linearly increasing with the population size. Even the complex model is capable to finish a 365-day simulation run of a company with 2,000 employees in less than 5 minutes. This gives decision makers a great tool for fast testing of strategies – at very low costs.

Due to the AB nature of employees and workplaces it is possible to not only evaluate the whole system, but also individual entities and aspects of interest – according to Shneidermann's (1996) information seeking mantra ("overview first, zoom and filter, then details-on-demand"), a vital aspect for data interpretation and visualisation. For example is it possible to analyze at which times workplace-demand is highest, as seen in figure 4. The left chart visualizes workplace utilization with the left bar (*sim-total*) showing absolute utilization (24h, 7days a week, accumulated over the whole simulation), the middle bar (*core time*) utilization during core working hours (10 hours per workday) and the right bar *current* utilization (i.e. real-time). The histogram on the right hand side tracks the time when additional workplaces had to be "added" in order to satisfy demand. Such information can be used to fine-tune the system. For example: loosening of starting times for part-time workers could distribute the morning demand peak more evenly throughout the day.

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[20] Runtime tests were conducted on a 4 year old standard consumer laptop. Subsequently improvements of runtimes are very likely if a modern or even dedicate machine is used.
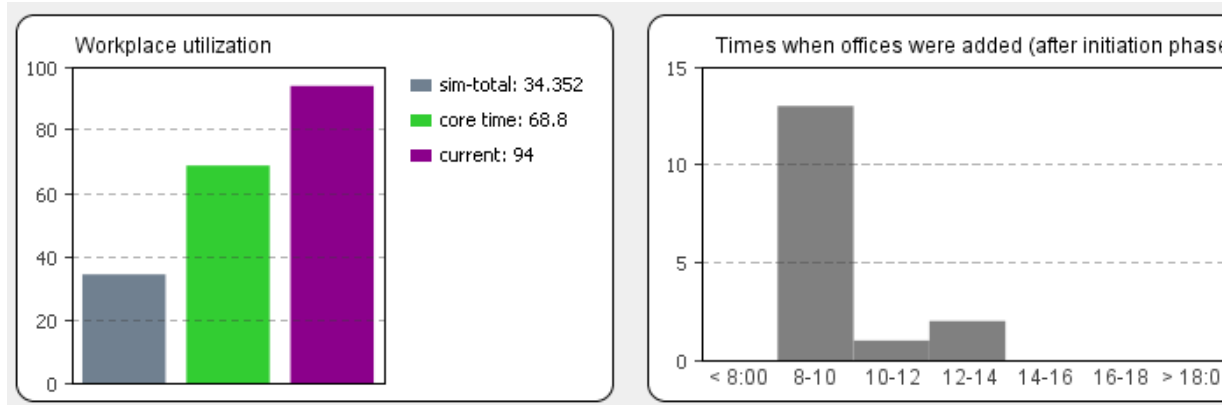
Figure 4: Statistic information on workplace utilization during model runtime

The modular nature of the *"More-Space Office Tool"*, the model's entities are implemented as independent agents, allows for rapid prototyping (rapid application development, as it is referred to in software development). This makes it possible to come up with first results for any given model setup (company/office environment) within a remarkably short time. This is of special interest to (business) users that need results fast.

Finally the amount of data required is very low compared with that necessary for static methods (e.g. statistic analysis, which requires big data – see section 2). It is even possible to conduct primary experiments without hard data based only upon the knowledge of decision makers[21]. On the other hand the quality of results produced is much more detailed. Plus, results can be derived for scenarios that have not been monitored or tested in reality, which opens a big spectrum for decision makers.

Thus the advantages of dynamic modelling over static models are:

- No need for collection of big data
  thus no problems with privacy issues and costly
  installation of monitoring systems
- Modular model structure, allows for:
  - incorporation of as much information as available
  - fast adaption of model for virtually any
    company/business
- Short runtime of simulation
  makes quick comparison of alternative and hypothetic
  scenarios possible
- Employee behaviour is incorporated into model
  (respecting different employee types and stochastic
  influences)
- Database-driven setup allows user to experiment without
  need for expert-help
- Scenarios that could not be tested in reality (e.g. too
  costly) can be simulated and thus evaluated
- User-friendly model interpretation & analysis of results:
  model uses real-world objects (work places, offices,

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[21] Such results will have only qualitative and no or very limited quantitative value. However, they can serve as a starting point for further adaption, rapid prototyping or research.

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employees, employee-types, etc.) instead of abstract
figures & terms
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Concluding it can be said that harnessing mathematical modelling and simulation can be of great value for decision makers in the field of facilities management. Applied correctly it can serve as unprecedented decision support tool for strategic and operational decisions. As such, the *"More-Space Office Tool"* makes it possible to test management strategies, office environments and employee structures in order to (greatly) improve space utilization efficiency. Hence the tool can help to reduce space driven costs as well as GHG emissions, which can be used by companies as a social corporate responsibility (SCR) asset.

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Section Three
SUSTAINABILITY IN FM

EuroFM WG3 - Sustainability in FM

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Environmental Management

FM, risk and climate change adaptation

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The effects of interventions in an innovative office on satisfaction, perceived productivity and health complaints

Iris de Been and Marion Beijer
Center for People and Buildings, TU Delft, The Netherlands

FM towards zero emission buildings: learning and professional development among energy operators of large buildings

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The Research Centre on Zero Emission Buildings, NTNU

Comparison of a flexible and inflexible approach to the evaluation of building intervention strategies

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Introduction

Global developments in climate change, information and communication technology, economic and financial crisis, global competition, technological and political developments, force organisations to rethink the future organisation of work, to rethink special requirements for workspace and rethink the sustainable use of scarce resources in competitive organisations. The dynamics and the complexity of these developments force facility managers to re-define their role in the future. The EuroFM research network group (RNG) recognises these challenges in the context of (1) the added value of facility management (2) workspace management and (3) sustainable facilities management. The working group sustainable facility management (WG-SFM) recognises the need for new knowledge to better understand, explain and test the role of facility management in making valuable contributions to sustainability strategies of organisations.

European Challenges for Sustainable Facility Management

In the 2011 policy document on a Resource Efficient Europe the EU's 10 year growth strategy highlights the need to achieve a 20% increase in energy efficiency to support a low carbon economy to achieve sustainable growth. Thus in Europe *sustainable growth* is a major objective. This raises a number of questions for SFM: How can FM contribute to *sustainable growth*, to the design, (re-)development, construction, use and recycling of spaces for work? What are best practices of SFM in Europe that make a significant contribution to both efficiency (i.e. sustainable use of resources such as energy, materials and ICT systems) and effectiveness (i.e. job satisfaction and perceived productivity)? Since 2011, an informal SFM group, has explored the possibilities of collaboration between researchers and practitioners and embarked on action research projects on SFM and on case studies to generate fresh knowledge on SFM in the EuroFM-Research Network Group and beyond.

Objectives, deliverable and expected scientific impact

The WG will establish a unique SFM network of researchers, practitioners, their clients and policy makers. The objectives of the network are to: (1) Identify, collect, organise, consolidate and disseminate best practice in SFM between researchers, practitioners, business clients and policy makers across the EU and world-wide. (2) Review the best practice to identify gaps in SFM knowledge and support the development of research programmes to scope innovative solutions and new business models to address these gaps. (3) Identify drivers/barriers/enablers/inhibitors to the wider uptake of best practice in SFM across Europe and share these with the business community and policy makers.

The WG-SFM will deliver the following in the period 2013-2017 to benefit FM practitioners, researchers and policy makers:

• Best practice case studies, conferences on future research challenges to create new solutions and models for achieving greater change.

• A website to host the best practice case studies, textual material (newsletters, guidelines and reports) and webcasts of conferences and workshops.

• A state-of-the-art report on current best practice and future research challenges in SFM.

• Recommendations for EU agencies, national and provincial governments, the scientific community, the practitioner community, and the education sector on the future challenges of achieving a SFM future.

Paper Session
Environmental Management

As a contribution to the work of WG SFM, the session on Environmental Management presents four papers on aspects of theory and practice, and make recommendations for future research.

Jones, Mulville and Brooks (2013) at the University of Greenwich (UK) report on action research to gather understanding of climate change impacts on in-use buildings, risks, adaptation and the role of FM.

De Been and Beijer (2013) at the Centre for People and Buildings (Netherlands) report on a time series design of post-occupancy evaluation of a building before and after a range of interventions to increase satisfaction in the work environment. The building combines energy efficiency targets with targets to support new ways of work.

Esders, Adey and Lethanh (2013) of the Department of Structural, Environmental and Geomatic Engineering , at the Institute of Construction and Infrastructure Management , ETH Zurich (Switzerland) recognize the uncertainties in future planning for SFM through comparing systematic evaluation of building intervention strategies, i.e. maintenance and modification. These uncertainties in future demand can be addressed by using a flexible approach to the evaluation of intervention strategies as opposed to an inflexible approach; that means it is directly considered that decision makers adapt intervention strategies to new information about demand changes as they are revealed in the future.

Gansmo (2013), Department of Interdisciplinary Studies of Culture, NTNU, and
The Research Centre on Zero Emission Buildings, NTNU reports on case studies on in-house facilities management, learning, energy operation and efficiency in existing large buildings.

These workshop contributions provide an overview of current challenges in SFM-research and practice. We invite you to join the debate on SFM and contribute to the research agenda of SFM with best practices in SFM research in your country. We aim to expand our network of practitioners, researchers and policy makers in SFM.

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FM, Risk and Climate Change Adaptation

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ABSTRACT

Improving the sustainability of built assets in the light of uncertain futures is a major challenge facing the Facilities Management profession. A changing climate poses significant challenges to the performance of built assets in-use and could potentially render many built assets prematurely obsolete. How business clients plan for such changes formed the focus of a research project undertaken by the authors. This paper presents the findings of a 12 month Action Research project that sought to identify the impact of future climate change on the performance of a new £75m education building over the first 60 years of operation. The Action Research project involved a series of meetings and workshops between the building's design team (Architects, Engineers and Cost Consultants) and the Client's Facilities Management Department where the impact that a range of future weather scenarios could have on the buildings performance in-use were evaluated. Technical and operational adaptation solutions were developed for those scenarios that were deemed 'high impact' and selected interventions were integrated into the building life cycle as pro-active adaptation steps in the built asset management plan. This paper will describe the adaptation framework used to inform the development of the various scenarios/adaptation solutions and discuss the role of the Facilities Manager in the process. The paper concludes that the presence of the Facilities Management Department in the design team was critical to the development of viable climate change adaptation solutions.

Keywords

Risk, Adaptation, Climate Change, Resilience, Facilities Management

1. INTRODUCTION

There is a tendency in the construction industry to design and deliver new buildings based around the requirements of the 'here and now'. However, buildings are developed on a design life of 60 years plus and clients' needs from their buildings will change over time. Failure to address this issue places the building at risk of premature obsolescence (Jones, 2002). Whilst this issue has been known for many years, it is compounded by the potential impact of climate change on the physical performance of buildings in-use, and in particular the need for building owners to consider how they might adapt their buildings to different future weather patterns. These concerns are in turn being relayed to design teams who are increasingly under pressure to consider the implications of their design decisions through the whole-life of a building. This paper presents the findings from an Action Research project that used an adaptation framework, supported by future scenarios and back-casting, to inform the development and evaluation of adaptation solutions as part of the built asset management process.

2. BACKGROUND

There is broad scientific consensus that the global climate is changing in ways that will have a profound impact on both human society and the built environment. In addition to average global temperature rise, the frequency and severity of extreme weather events are expected to increase (IPCC, 2007) and impact on the performance of buildings in-use (Jones, 2002). In response to climate change, the UK has implemented The Climate Change Act UK (2008), setting legally binding targets for the reduction of greenhouse gasses by 2050. However, even if the rest of the world follow suit, and the targets are met, there will still be a need to adapt to the consequences of inevitable climate change bought about by current Greenhouse Gas levels. Whilst adaptation does not solely affect the built environment, it does pose a major challenge to those responsible for its operation and renewal. Indeed failure to adapt buildings to climate change could render many prematurely obsolete (Jones, 2002). The challenge facing Facilities Managers is to recognise the potential impact of climate change on their built assets and develop adaptation solutions that ensure the assets continue to perform their required function. However, current approaches to asset management rarely address this issue.

Over the last decade, the UK has experienced significant increases in extreme weather events (EWEs). Heavy rainfall (Fowler & Kilsby, 2003) resulting in both localised urban flooding and more widespread fluvial flooding resulted in £500M worth of insurance claims in the UK in 2000 (RMS, 2000) and £2.2 billion in 2004 (OST, 2004). In addition to flooding the incidence of heat waves (Good et al, 2006) and associated droughts (Blenkinsop & Fowler, 2007) have increased with, in August 2003 over 2000 premature deaths being attributed to the heat wave in southern England alone (Kovats et al, 2006). As a consequence the UK Government established the Adaptation Sub-committee to undertake a UK climate change risk assessment and develop an adaptation programme for England (ASC, 2009). In an assessment of the preparedness of the UK for flooding the Committee identified the need for greater uptake of property-level measures to protect against floods both for new and existing buildings. However, the requirement to consider these issues only applies where development is planned in an existing flood plain, even though the report identified pluvial flooding as a significant problem for the future (ASC, 2012). Thus, given the risks, how should building clients address this issue?

The ability to effectively respond to an EWE depends upon the vulnerability, resilience and adaptive capacity of the building under threat. Whilst there is considerable debate over the precise definitions of the terminology (Gallopin, 2006), from a built environment perspective: vulnerability is normally considered to be the likelihood of exposure to hazards (EWEs) and the adverse consequences resulting from them; resilience, as the ability of the building to prevent, withstand and recover from the impacts of the hazard; and adaptive capacity, as the ability of the building to change (adapt) to meet the new conditions brought about by any permanent changes to the original operating conditions (Jones & Few, 2009). However, organisation's find it difficult to recognise their vulnerabilities let alone assess the resilience of their buildings and develop adaptation solutions to address them (Berkhout, 2004). Organisation's need to consider the likelihood of an EWE occurring and the impact that it could have if it does occur. Also, hazards need to be interpreted relative to a frame of reference that the individual and business can relate to and solutions need to be measurable against clear operational indicators.

Assessing the impacts of hazards on an organisation normally involves the assessment of the risk of an event occurring and the development of contingency plans to deal with the consequences. Whilst risk based assessments are not new to Facilities Managers, using them as part of future climate change scenario planning is. Whilst generic climate change risk

assessment models have been developed (Willows & Connell, 2003; UKCIP, 2008; Sustainable Homes, 2012) they are primarily awareness tools that assess whether a management action has been taken, rather than providing practical guidance on how to assess vulnerability, resilience and adaptive capacity. This paper addresses this shortcoming by describing the development of a series of practical steps that can be used to ensure that new buildings are designed in a way that allows for future adaptation to climate change.

3.   A CLIMATE CHANGE ADAPTATION FRAMEWORK

There are a number of risk models (UKCIP, 2010; BCI, 2007) currently available to assess vulnerability, resilience and adaptive capacity to EWEs. Whilst each model addresses the problems of risk in slightly different ways, they all follow the same generic methodology. An initial scoping exercise contextualises the system being studied and identifies system boundaries. Once the system boundaries are established, the types of risk (what is at risk, whom is at risk, the causes of the risk, the impacts of the risk, and the threshold levels at which the risk becomes unacceptable) that can affect the system are identified. For each identified risk, a risk appraisal is undertaken where the consequences of the threshold being exceeded are examined and strategies for managing the consequences considered. This process invariably involves the use of scenarios to both identify the potential consequences and evaluate alternative management strategies. Once the risk appraisal is complete, a risk evaluation takes place where the various options are prioritised. Finally the highest priority options are instigated and their performance is monitored. Unfortunately, whilst this generic approach to risk assessment is fairly well understood, its application, particularly in the UK, is patchy and its use at the design phase of new buildings is largely missing. In this paper the generic approach is combined with future climate change scenarios to develop an adaptation framework for assessing the impact of EWEs on the performance of existing buildings and integrating this into the built asset life cycle (Figure 1).

The first Stage of the framework establishes the impact of antecedent EWE hazards on the inherent vulnerability of the building. This should ensure acceptance of the risks by the organisation as they will have first-hand knowledge of the impacts. The second Stage of the model extends the range of EWEs to take into account the impact of future climate change on the type, nature and intensity of events. This phase inevitably involves the use of future scenarios to develop a range of weather patterns that can be superimposed onto the building and its surrounding area to allow specific hazard impacts to be developed for each scenario (e.g. flooding, etc.). These impacts can then be related in relative terms to the antecedent assessments carried out in Stage 1. In this way stakeholders can assess the relative significance of an EWE scenario against a frame of reference that they are familiar with. Once the currency of the scenarios has been established, the impacts of each EWE on the building can be assessed and those components which are highly vulnerable and have low inherent resilience (coping capacity) can be identified. For each of these components adaptations can be developed, either to reduce the vulnerability of the components or improve coping capacity. These can then be prioritised and introduced into the design, at either the initial design phase, or where the impact is expected to be delayed (e.g. not expected to occur until 20 years into the life cycle), as part of the built asset management plan. The operationalization of the adaptation framework model and its ability to integrate effectively with the building life cycle was examined in this study.
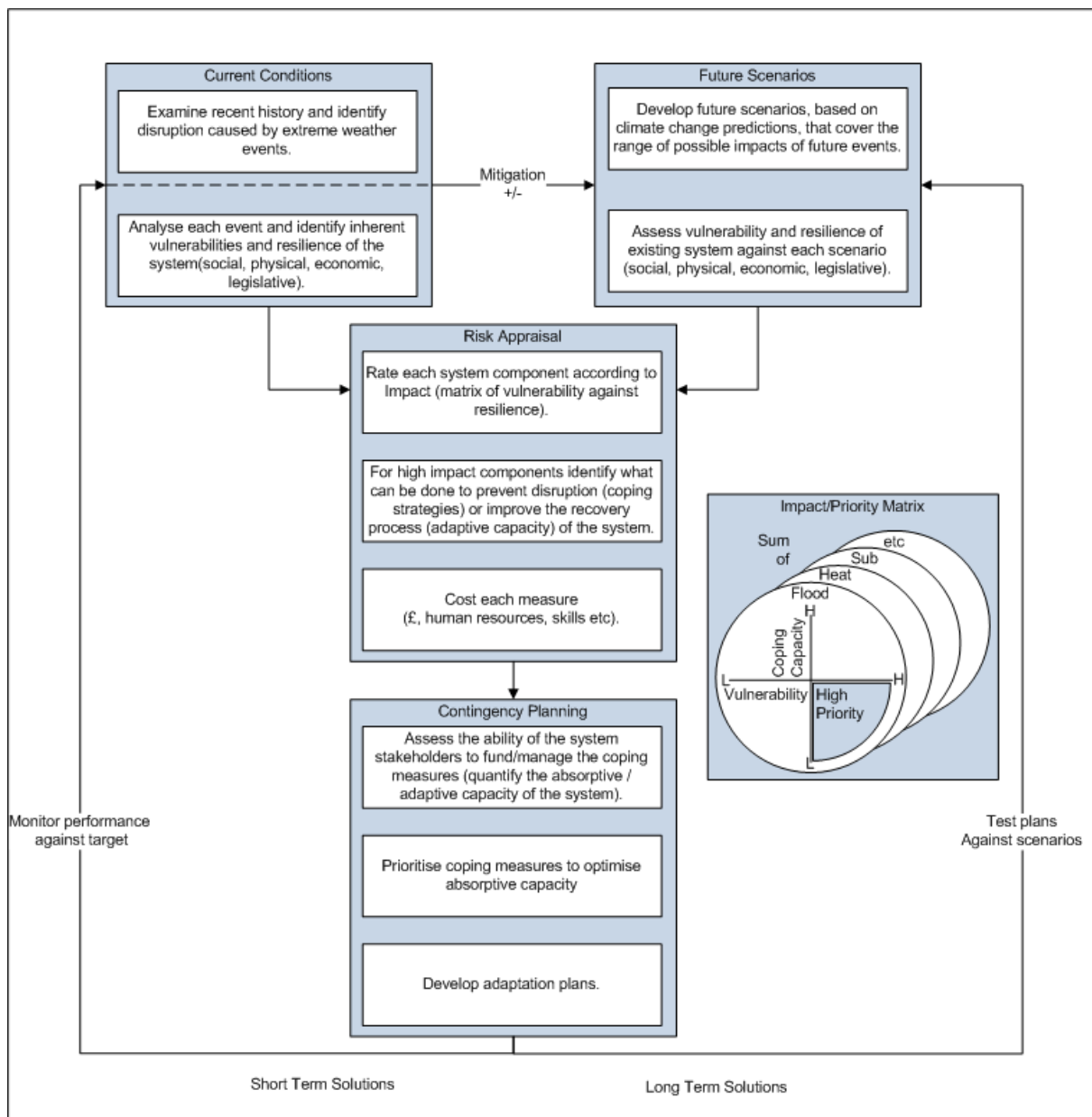
Figure 1. Climate Change Adaptation Framework Model

4.   RESEARCH METHODOLOGY

This project applied an Action Research methodology that involved a team of researchers and practitioners examining the issues associated with the implementation of the climate change adaptation framework model to the design phase (RIBA Stage D) of a new £75m educational building being developed by the University of Greenwich. Action Research seeks to use theory to drive changes in practice by studying the impact that context has on the journey towards an end-goal. Through a series of iteration cycles (Planning; Implementation; Reflection; Review) the impact of theory is assessed and refined until the end-goal is achieved or the journey is abandoned. (Lewin & Cartwright, 1975; Heron & Reason, 2001). This approached fitted well with the research challenge of this project.

The Action Research project commenced in October 2010 and was completed in June 2011. The Action Research team comprised representatives from the Architects; Building Services Engineers; Structural Engineers; Quantity Surveyors; the Client (represented by the Facilities Management Department); and the authors to this paper. In addition, specialist input to the project was provided by a climate change expert who developed the climate impact models.

The Action Research team met formally on 4 occasions. Each of these meetings was in the form of a 1 day workshop. Between workshops members of the team worked in small groups to develop, test and refine their inputs. The first meeting established the focus for the project; developed a set of questions for the partners to investigate; agreed procedures for data gathering/analysis; and outlined a set of deliverables for the second meeting, which were mainly concerned with an assessment of the antecedent EWEs (Current Conditions in Figure 1) and the identification of future climate change risks (Future Scenarios in Figure 1).

At the second meeting the Action Research team received a climate change risk report that identified current and expected risks aligned to the predicted first and second refit of the building (2020 and 2040) and design life (2080). The risk reports were generated using the UKCP09 (median prediction emissions scenarios) to produce likely weather scenarios and associated building impacts on: Internal Comfort & Building Façade; External Comfort; Structural Stability; Infrastructure; Water Supply; Drainage & Flooding; Landscaping; and the Construction Process. Although a wide range of EWEs were examined, due to limitations in national data sets the final analysis was limited to issues of thermal performance, where a 3.8-4.8^{o}C rise in annual mean temperature above the control period was predicted by 2080 and pluvial flooding, where an increased risk was identified to the basement areas and attenuation tank capacity.

Once the weather data had been presented, the Facilities Management members of the Action Research team developed performance specifications, in terms of operational expectations for 2020, 2040 and 2080, and the design members analysed how their design solutions would perform against each specification (Risk Appraisal in Figure 1). In particular 4 questions were considered: 1) Would rooms overheat in the future? 2) What will be the impact on the annual energy loads? 3) Can the chiller specification cope with the increased load? 4) How will solar gain change in the future? These analyses were presented to the whole Action Research team at the third workshop. As this project was solely concerned with the impact of climate change no account was taken of other future scenarios (e.g. economic, political etc).

The third Workshop examined the design implications of the questions outlined above. The performance specifications provided the 'operational targets' from which costed adaptation solutions were 'back-cast' to ensure that the building would meet its targets over its life-cycle (Risk Appraisal in Figure 1). This process identified twenty five adaptation measures which were tagged as 'do now', '2020', '2040' or '2080'. Each adaptation was evaluated against the following principles:

1. Measures that required structural alteration were recommended to be undertaken immediately irrespective of their actual required implementation time.
2. Measures that required changes to system or component capacity were only to be implemented when required but consequential structural and space planning issues were implemented (as 1)
3. Each measure was considered in terms of its impact on the current design and modifications introduced to facilitate a future retrofit.
4. Those measures that were identified but for which the UKCP09 weather data provided no firm direction were assessed on their merits. This particularly applied to the risk of flooding where preparation was undertaken even though the likelihood of future events was uncertain.

At the final workshop each of the detailed adaptations were considered and either adopted or rejected by the client team (Contingency Planning in Figure 1). Of the 25 detailed adaptations developed through this process, seven were adopted immediately and included in the final detailed design. The remainder formed part of the future asset management plan. The full list of adaptation measures can be seen in Table 1.

Table 1. Adaptation measures and implementation schedule

Risk	Adaptation/ Comment	Implementation			
		Now	20 20	20 40	20 80
Overheating	Alter the current glazing system to allow for openable windows to be easily installed in future			•	•
	Install additional chillers on the roof		•	•	
	Future thermal design modifications should be based on an adaptive comfort model		•	•	•
Overheating and Energy Use	Introduce a 'siesta'. Behavioural adaptations were seen as benefitial and could limit the predicted thermal issues. However it would impact on the usability of the building.		•	•	•
Reduced Heating Load	Replace boilers with an increased number of smaller sized units			•	
Insufficient comfortable external areas	Allow all building users to access the roof areas Introduce shading to external spaces Introduce external water features	•			
Increase in cooling load	*Allow for an increase in plant and riser space	•			
Infrastructure failure (electric)	*Add access control to the standby generator	•			
Infrastructure failure (gas)	Include for an electric back-up form of heating (GSHP)			•	
	Increase hot water storage			•	
Infrastructure failure (water)	Increase the cold water storage			•	
Infrastructure failure (drainage)	Increase size of Attenuation tank				•
Increase in storm activity	Increase capacity of rainwater pipes & drainage Increase roof capacity to store rainwater				•
	*Permanent flood protection measures to basement areas *Include adaptable door frames for door dams Increase the height of the retaining walls	•			
Failure of drainage system	*Connect drainage system to the BMS	•			
Increase in groundwater level	*Provide adequate build-up above the tank to avoid flotation	•			
Increase in water costs	Introduce waterless urinals Add a rainwater recycling system			•	
Waste from refurbishments	Upgrade facade systems with recyclable materials	•			
Insufficient cycle storage spaces	*Increase the cycle store capacity	•			
*denontes that the adaptation identified was approved and preparatory work was implimented at the design stage to allow future upgrade when the need became critical (e.g. in 2020, 2040 or 2080)					

The adaptations generally fell into three categories; immediate implementation of the adaptation solution as part of the original build; implementation of preparatory work as part of the immediate build to allow for a planned future upgrade; or operational changes to the building. An example of an immediate implementation was the inclusion of a backup

generator to run essential services in the event of a flood. Although the building was not currently at risk of flooding, the future flood risk assessment had identified a potential risk to the critical power infrastructure that supplies the building. This risk, whilst unquantifiable at present, was never the less considered serious enough for the Facilities Management team to advise the client of the need to build in a contingency against this possibility as part of the initial design solution. Examples of preparatory work include an increase to the plant and riser space within the building to accommodate a future increase in chiller capacity for cooling (circa 2020) and allowance for a change to a modular based boiler installation to accommodate a reduction in installed heating capacity as demand reduces over time. Examples of operational changes were adopting a relaxed dress code (staff) and not programming classes for the middle of the day to encourage behavioural adaptations to the thermal environment within the building. The changes were expected from 2020 onwards.

5.   DISCUSSION

There is an emerging body of work considering the likely impact of climate change on building performance that are based on simulated predictions and risk based decision making. This study outlines how such an approach could be applied in a systematic manner and embedded in the building design/asset management process. The study aimed to consider the likely climate change impacts to the building on a whole-life basis, identifying adaptations that could be included in the original design, or/and implemented with the 2020, 2040 or 2080 interventions. Such an approach will help to produce a more realistic picture of the buildings likely resilience to climate change. The focus of this paper was to test an adaptation framework and identify the barriers to its application in the design/built asset management process. An Action Research approach was used to refine the original theory in light of the barriers encountered.

The original theory envisaged a 4 stage model to assess and plan building level adaptations to climate change. A number of difficulties/issues arose at each stage of the model.

At Stage 1: There was limited information available to assess the current impact of EWEs on the performance of the building. As such, creating a realistic frame of reference from which to explore the impact of future climate change proved difficult. Indeed, there was considerable scepticism amongst the design team as to the impact that future climate change would have on the building and resistance to considering these impacts at the design stage. These concerns were heightened at Stage 2 of the model where the inability of the UKCP09 projections to produce quantifiable weather patterns at the building scale (UKCP09 is based on a 5km^2 grid and scaling this down to a particular site is difficult) made it difficult for design professionals to develop specific adaptation solutions. This was especially true of predictions relating to rainfall intensity and flood risk which potentially will have greatest impact on the usability of the building going forward. At both these Stages it was the presence of the Facilities Management team in the group that drove the project forward, constantly reinforcing the importance of this project from the client's perspective and ensuring that the design team took the scenarios seriously and didn't simply play lip-service to the development of adaptation solutions. To reinforce the scenarios the Facilities Management team developed a series of future performance specifications for the building that required detailed adaptation solutions to be developed, tested and programmed into the built asset management strategy. These specifications effectively set the end point (e.g. system requirement in 2020, 2040 or 2080) from which the various design teams had to work their adaptation solutions back from. In this way interim solutions that would be required on the adaptation journey could be clearly identified and, where necessary, changes made to the initial design to accommodate the adaptation solution. This approach represents a change to the traditional forecasting model of built asset management.

At Stage 3 of the model the main issue to arise was timing of adaptations. The professional design team working on the research project were also working on the main building project. As such, they had a detailed understanding of the building and were able, once they had accepted the climate change projections, to develop technical adaptation solutions (although there was some resistance when their previous decisions were revisited or called into question). What the design team found more difficult was to visualise how these adaptations would be implemented at the 2020, 2040 and 2080 points of the buildings life-cycle. This was particularly true where future adaptations required preparatory work to be included at the initial design stage. For example, the potential need for a larger attenuation tank by 2080 was identified but providing the infrastructure for this at the design stage would significantly increase building cost. The members of the design team responsible for this area did not want their solutions to appear expensive and were very reluctant to change their design to accommodate a future upgrade. Again, it was the presence of the Facilities Management team, and the reassurance this gave to the design team that the increased costs would not be held against them should they bid for future work, that insured the design team took the issue seriously and developed a planned upgrade route should a larger attenuation tank ever be required.

Stage 4 of the model proved the least problematic (probably because the decisions could not be tested until the adaptations were required), with the Facilities Management team able to identify those adaptations which they believed would have the greatest potential impact on the building. Those measures that would not have an immediate impact were scheduled for later building upgrades unless other steps were needed to enable the later adaptation. In addition, a series of thresholds were identified as triggers for inclusion of adaptations into built asset management plans. Whilst quantifiable triggers were not set as part of this project, the built asset management strategy that will inform future maintenance and refurbishment planning does contain specific upgrade routes that can be followed should the climate impacts be realised.

6.   CONCLUSIONS

This project tested an incremental approach to developing building adaptation plans that address future climate change. An Action Research approach was used to test and refine the theoretical model underpinning the approach and to identify practical barriers to the application of this approach at the design stage of a new building. The project confirmed the applicability of the approach and identified the proactive role that the Facilities Manager played in ensuring the project success. The Facilities Manager ensured that whole-life considerations overrode the short term considerations of the design team. Without the Facilities Managers setting future performance targets it is unlikely that the design team would have produced detailed adaptation based solutions for 2020, 2040 or 2080. Whilst this may not be a traditional role for a Facilities Manager, if adaptation to climate change is to be taken seriously then the authors would suggest that they should be key members of the design team.

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The effects of interventions in an innovative office on satisfaction, perceived productivity and health complaints

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ABSTRACT

Sustainability becomes a more and more important goal in the Netherlands when it comes to designing and building new offices. The DCMR Environmental Protection Agency in the Netherlands moved into a new A+ labelled office building with thermal energy storage in January 2010. There are fewer desks than there are employees, so people share workplaces. People can choose several types of workplaces that are suitable for specific activities (e.g. communication, concentration). Nine months after moving into the new building an employee satisfaction survey was conducted to measure satisfaction with the office building and perceived support of productivity (377 respondents, 75% response rate). Although the results pointed out that people are in general satisfied with the office environment, several issues with the indoor climate, acoustics and IT were revealed. Following the results, the organisation has undertaken numerous interventions in the indoor climate, acoustics and IT to increase employee satisfaction. Exactly two years after the first measurement a second employee satisfaction survey was conducted to measure the effects of the interventions (389 respondents, 73% response rate). The results show improvement in most satisfaction scores. Furthermore, the results of the second measurement are compared with a benchmark which shows that the DCMR office environment performs very well compared to other organisations. The outcomes of this case study can lead to more insight into the appraisal of innovative offices with workplace sharing in general and specifically the effects of the interventions that were undertaken within the office environment on satisfaction and perceived productivity support.

Keywords: work environment, satisfaction, benchmark, post occupancy evaluation

1 INTRODUCTION

Considerable research has been conducted on the influence of office environments on well-being, employee satisfaction and productivity (De Croon et al., 2005; Bodin-Danielsson & Bodin, 2008). Such research is important, as satisfaction with the physical working environment appears to be directly related to job satisfaction and productivity (Carlopio, 1996; Veitch et al., 2003).

In the Netherlands there is a shift going on from more traditional cellular offices towards a more open and diverse office lay-out with shared use of spaces (Van Meel, 2000). The combi

and flex offices have a much more open character and a great variety in workspaces. Nowadays, not only the more traditional individual and small shared room offices but also the innovative flexible offices are a very common office type in the Netherlands (Van Meel, 2000). Research on the influence of the office environment is extra important, since the impact of this innovative lay-out and way of working on satisfaction and productivity is not always clear.

One of the organisations that developed a new office building with a flexible office concept is the DCMR Environmental Protection Agency (DCMR). DCMR was founded in 1972 in order to improve environmental protection in the Rotterdam-Rijnmond region in The Netherlands. This region is a heavily industrialised area with refineries, waste incinerators, several waste dumping sites, many large chemical plants, metallurgy, food processing plants and about 19,500 smaller companies. The tasks of the DCMR include regulation of the industries, monitoring and assisting authorities on developing environmental policy. With a growing number of employees over the years, the organisation decided to develop and build a new office building.

Following the activities and responsibilities of the organisation, sustainability and efficiency were important goals for the new building. This resulted in the development of an A+ labelled building with thermal energy storage. To be able to use the office environment as efficient as possible, an office concept with desk sharing was introduced. Another goal was to develop an inspiring and attractive work environment. For the new office environment, different types of open and enclosed workspaces were designed (e.g. for concentration work, interaction, administrative work and meetings). There are less work desks than there are employees (0,9 desks per employee). This means that in the new work environment people would not have their own, assigned workplace anymore but that they have to share all the present workspaces in the building with each other.

In January 2010 the organisation moved into their new office building. To get insight in how the employees experience the work environment and whether the work environment supports the productivity of the employees, an evaluation research was conducted. In November 2010, nine months after moving into the new building, a first employee satisfaction survey was performed. The results of this evaluation were used by the organisation for improving and optimising the work environment. Exactly two years after the first evaluation a second employee satisfaction survey was conducted to measure the possible effects of the improvements and habituation to the new work environment and the flexible way of working.

The results of this case study are important for other organisations because it gives insight into the experience of this particular sustainable office building with flexible use of workspaces. It is useful not only to other Dutch organisations, but also organisations from other countries in Europe who are thinking about introducing new office concepts. Secondly, this paper gives insights into the possibilities to improve and optimise the work environment.

Figure 1: Impression of the DCMR work environment

2 METHOD

2.1 Respondents

In November 2010 all 503 employees who worked in the new building at that moment received an invitation to fill out the questionnaire by e-mail. 377 employees, 75% of the population, filled out the questionnaire. In November 2012 533 employees received an e-mail invitation to fill out the questionnaire. This resulted in a response rate of 73% (389 respondents). The sex, age and level of education distribution of respondents are shown in table 1.

Table 1. The distribution of the respondents in 2010 and 2012 over sex, age and level of education categories.

Sex	2010	2012
Male	60,2%	58,6%
Female	39,8%	41,4%
Age	**2010**	**2012**
< 31 years	6,6%	5,7%
31 - 40 years	26,0%	25,7%
41 - 50 years	40,1%	34,2%
51 - 60 years	21,2%	26,7%

> 60 years	6,1%	7,7%
Level of education	**2010**	**2012**
Primary education	0,0%	0,3%
Secondary education	5,0%	3,1%
Vocational secondary education	13,8%	15,2%
Undergraduate (Bachelor level)	50,9%	48,1%
Postgraduate (Master level)	29,7%	32,6%
Other	0,5%	0,8%

All of the employees ate the organisation are knowledge workers. The respondents performed mostly general desk work (approximately one third of their time at the office), around 12% of their time was spend on desk work that requires concentration, 14% on desk work that requires interaction and approximately 19% of time on planned and unplanned meetings (see table 2 for an overview of the activities performed in 2010 and 2012).

Table 2. The mean percentage of time at the office that is spent on various work activities in 2010 and 2012.

Distribution of activities/mean percentage of work time	**2010 measurement**	**2012 measurement**
General desk work	32,7%	34,7%
Concentrated desk work	12,1%	12,6%
Interactive desk work	14,1%	13,8%
Planned meetings	11,7%	13,1%
Unplanned meetings	7,1%	6,1%
Telephoning	6,5%	6,0%
Reading (> 30 minutes)	5,7%	5,0%
Archiving/document management	5,3%	5,3%
Other	4,8%	3,4%

2.2   Questionnaire

The Work Environment Diagnosis Instrument (WODI) was used to evaluate the new DCMR office. WODI Light is an online questionnaire developed in order to measure employee satisfaction with the work environment and the perceived support of productivity (Maarleveld et al., 2009). The questionnaire consists of 41 items, containing questions about the satisfaction with the work environment, the activities employees perform in the building, the importance of certain aspects in the work environment and the support of productivity by the work environment. Since the indoor climate is an important aspect for DCMR, several questions regarding this aspect were added to the questionnaire.

29 questions regarding the satisfaction with the work environment were selected for statistical analyses. These questions were scores on a 5-point Likert on satisfaction ranging from (1) very dissatisfied to (2) dissatisfied, (3) neutral, (4) satisfied and (5) very satisfied. Furthermore, 3 items regarding the perceived support of productivity were selected for the

analyses. These items were scores on a 5-point Likert ranging from very unsupportive (1) unsupportive (2), neutral (3), supportive (4) to very supportive (5). The 5-point Likert scale is a very commonly used scale worldwide that offers respondents the possibility to express themselves when they feel positive, negative but also when they feel truly neutral about a given topic.

People could also make remarks about the work environment at the end of the questionnaire in an empty field. In total 273 additional comments were made in 2010 and 202 additional comments were made in the 2012 measurement. This input is used for a further explanation of the results.

2.3   Data reduction

The 32 items regarding the satisfaction with the work environment and perceived support of productivity were combined to form 8 factors. In each factor 3 to 6 items were combined, resulting in a Cronbach's alpha ranging from 0,601 to 0,911 (table 3). The average item scores were calculated resulting in factor scores.

Table 3. An overview of the factors that are used for analyses, the items that the factors are comprised of and the Cronbach's alpha of the combined items.

Factor	Items	Cronbachs alpha
Organisation	Organisation Content and complexity of work Sharing own ideas about work environment	0,601
Subdivision office	Subdivision office Number, diversity and functionality spaces Positioning of office spaces	0,745
Architecture	Architecture and appearance building Openness and transparency Interior design and atmosphere	0,668
Functionality workspace	Functionality and comfort workspace Privacy Possibilities for concentration Possibilities for communication Acoustics	0,757
Facilities	Archive and storage facilities Facilities and facilities management IT facilities Possibilities for working somewhere else	0,635
Productivity	Support of own productivity Support of team productivity Support of organization productivity	0,874
Indoor climate	Indoor climate (general) Temperature Ventilation Air quality Indoor climate personal control	0,911
Lighting	Lighting (general) Access of daylight	0,807

	Control daylight	
	Control artificial lighting	
	Lighting work surface	
	Reflection on computer screen	

2.4   Analyses: comparison first and second measurement
The average factor scores of the first and second measurement were compared by conducting independent samples T-tests.

2.5   Analyses: comparison with the benchmark
Because WODI was used for several other evaluations by the Center for People and Buildings and the data are collected in a larger database, it was possible to create a benchmark to compare with the DCMR scores. The benchmark was created based on the data of all cases within the database with similar office concepts (a mixture of open and enclosed spaces and flexible use of workplaces). The benchmark represents the average satisfaction and perceived support of productivity scores of 4088 respondents derived from 36 different case studies.

For the comparison 23 items were used. The factors organisation, subdivision of the office, architecture, functionality of the workspace, facilities and support of productivity are comprised of the items that are shown in table 1. For indoor climate and lighting only the two individual items regarding the experience of the indoor climate (overall) and lighting (overall) were used for comparison, since the additional questions about these issues were not always addressed in other WODI case studies.

The average scores on the six factors and two individual items of the benchmark and the DCMR second measurement are compared with an independent samples T-test.

3   RESULTS

3.1   Results first measurement
In November 2010 the employees were in general quite satisfied with the working environment (figure 2).
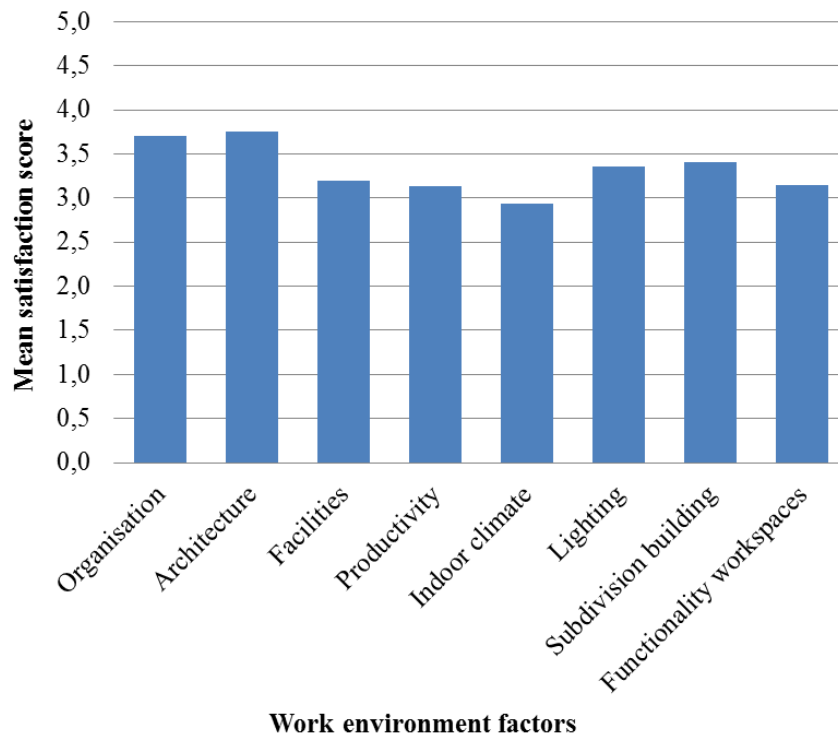
Figure 2: The mean satisfaction scores on a 5-point Likert scale regarding work environment factors from the 2010 measurement.

The mean score for the architecture of the building is the highest among all factor scores (M=3.75, SD=0.67). The indoor climate is rated lowest among all factors (M=2.94, SD=0.88).

To find out what could be the main dissatisfier when it comes to the indoor climate, the scores on the individual indoor climate items were analysed. The results show that employees are generally least satisfied with the control over the indoor climate (M=2.74, SD=0.98).

Additional comments
91 respondents commented on the indoor climate, from which the largest group commented on the lack of sun blinds (14 comments) and not having the possibility to open the windows (12 comments). This could explain the low score on the control over the indoor climate.

When it comes to the facilities, employees did complain about the computer facilities and network access (25 comments), the number of toilets (12 comments) and cleaning (8 comments). 25 respondents commented on noise and auditive distraction within the work environment.

First measurement compared to the benchmark
Compared to the benchmark, the DCMR first measurement scored significantly higher on six of the eight work environment factors (table 4). On the factor lighting DCMR scored significantly lower than the benchmark. There was no difference in scores on the satisfaction with the facilities.

Table 4: A comparison of the average factor or item scores between the benchmark and the DCMR first measurement (on a 5-point Likert scale).

Factor / item		N	Mean scores	Std. Deviation	Significance (2-tailed)
Organisation	Benchmark	3850	3,51	0,708	0,000
	DCMR first measurement	370	3,70	0,614	
Architecture	Benchmark	3876	3,52	0,802	0,000
	DCMR first measurement	372	3,75	0,674	
Facilities	Benchmark	3318	3,21	0,646	0,707
	DCMR first measurement	339	3,20	0,656	
Support of productivity	Benchmark	3526	2,98	0,842	0,001
	DCMR first measurement	360	3,13	0,687	
Indoor climate	Benchmark	2737	2,64	1,127	0,000
	DCMR first measurement	374	3,03	1,077	
Lighting	Benchmark	2686	3,45	0,933	0,046
	DCMR first measurement	376	3,35	0,926	
Subdivision building	Benchmark	3893	3,25	0,906	0,000
	DCMR first measurement	371	3,41	0,660	
Functionality workspaces	Benchmark	2739	3,05	0,796	0,012
	DCMR first measurement	369	3,15	0,731	

The comparison between the results of the first DCMR measurement and the average results of other flexible office users (benchmark) are shown in figure 3.
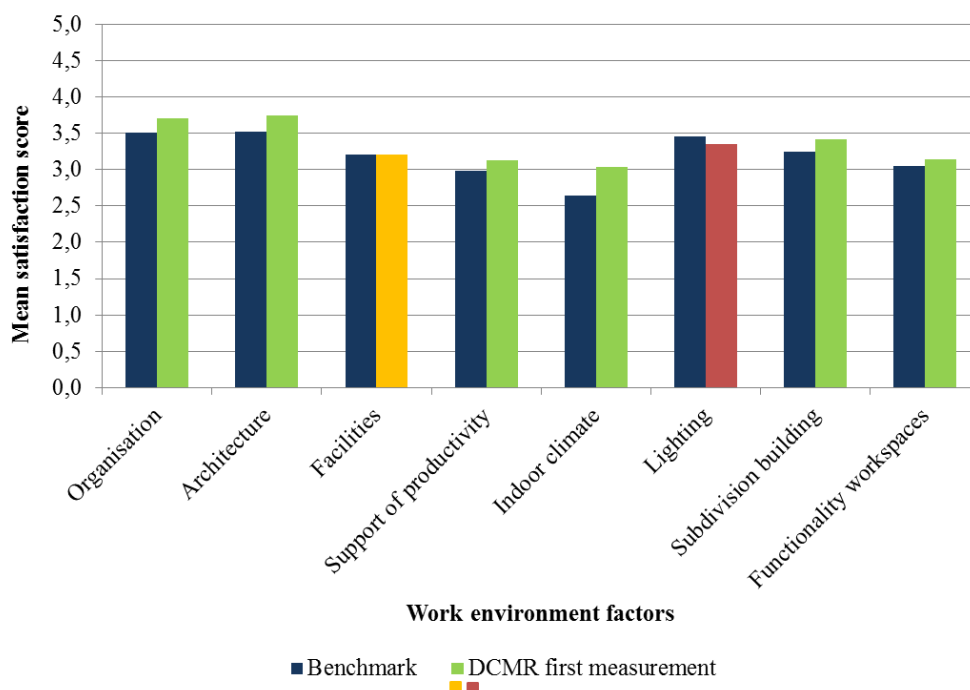

Figure 3: DCMR mean satisfaction scores from 2010 on a 5-point Likert scale compared to the benchmark. Blue = benchmark scores, Green= the 2010 measurement scores significantly higher than the benchmark, Yellow= the 2010 measurement scores with no significant difference, Red= the 2010 measurement scores significantly lower than the benchmark.

3.2 Interventions in the work environment after the first measurement

After the first measurement, the organisation undertook several studies to investigate the quality of the indoor climate. The research focussed on the air quality, the circulation of air and the temperature inside the building. The CO_2 values and amount of fine dust were up to standards. The relative humidity of the air however appeared to be generally lower than 30%. The relative air humidity turned out to be most problematic in the 24-hour helpdesk area where employees are answering questions or handle complaints about environmental issues. Several improvements were made following the indoor climate studies: from that moment the air handling units were turned off at night and several sensors were placed in the building for monitoring the relative air humidity. Control panels for adjusting the temperature +3 to -3 degrees were adjusted by adding the possibility to read the actual temperature on the display, which was not possible before and during the first evaluation.

In a reaction to the complaints on the lack of sun blinds on one side of the building, sun blinds were installed. Secondly, the lighting system was adapted because sensors were observed to be too sensitive; when employees walked through the nearby corridor, lights in the offices went on. The sensors were adjusted so that they are directed to the rooms, instead of to the corridor. A second adaptation regarding lighting was the addition of light switches. The possibility to control whether the lights are on or off in the offices was added, since this was not possible during the 2010 measurement.

Because of the problems regarding noise and auditive distraction within the office, several interventions were implemented to improve the acoustics of the building. Acoustic panels were installed in the enclosed meeting rooms and the open office spaces with a direct connection with the corridor zone. Furthermore, the complaints about the IT facilities in the first WODI measurement were passed on to the IT department and have been embedded in the new IT plan.

3.3 Differences between first and second measurement

Significant differences between the first and second measurement were found for the satisfaction with the organisation ($t(748)=-2.52$, $p=0.012$), the satisfaction with the facilities ($t(667.073)=-6.31$, $p=0.000$), the satisfaction with lighting ($t(650.520)=-3.87$, $p=0.000$) and the perceived support of productivity ($t(723)=-3.561$, $p=0.000$). All significant differences are in favour of the second measurement.

No significant differences were found for the satisfaction with the architecture ($t(747)=-0.33$, $p=0.974$), indoor climate ($t(745)=1.208$, $p=0.227$), subdivision of the building ($t(744)=-1.222$, $p=0.222$) and the functionality of the workspaces ($t(730.708)=-0,979$, $p=0.328$).

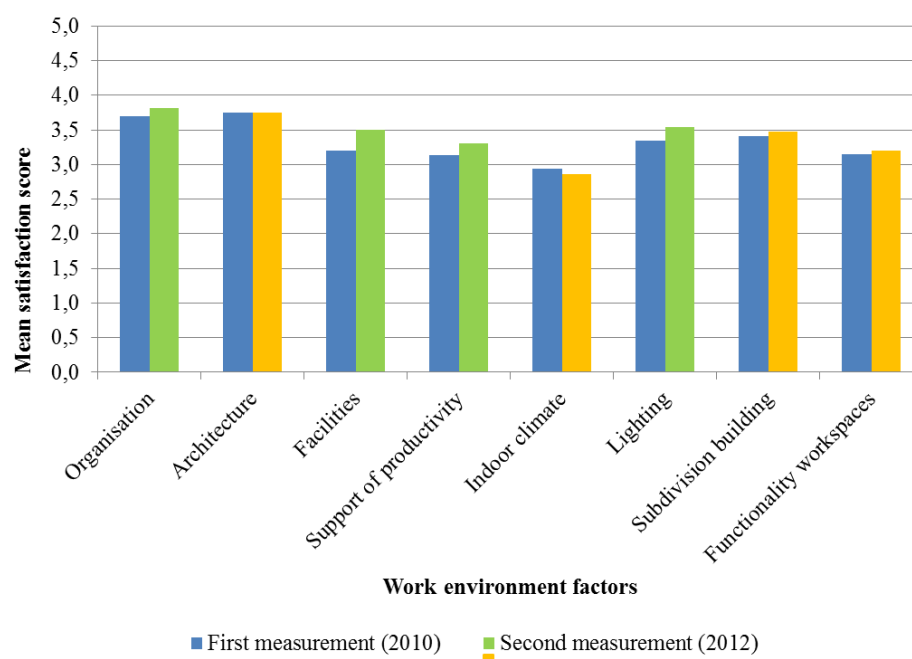In figure 4 the results are visualised.

Figure 4. A comparison between the average factor scores (on a 5-point Likert scale) of first and the second measurement. Blue = the first measurement scores, Green= the second measurement scores significantly higher than the first measurement, Yellow= the second measurement scores with no significant difference.

Additional comments
Despite the adaptations in the indoor climate systems that we done after the first measurement, the open question still resulted in 45 complaints about dry air and in 27 of these complaints the negative effect on their health was specifically mentioned: dry and irritated eyes, having headaches, sore throats and sneezing. Only 5 employees reported a reduction of indoor climate related health complaints.

Noise and distraction were other issues that still existed during the second measurement, in spite of the installation of the acoustic panels. 22 employees made a comment on this issue. Employees remarked that especially the areas with many open workspaces were still too noisy. Fewer remarks were made about the IT facilities in 2012 (9) compared to 2010 (25).

Results compared to the benchmark
Compared to other similar office concepts, employees of the DCMR organisation gave significantly higher satisfaction scores on most office factors (table 5).

Table 5: A comparison of the average factor or item scores between the benchmark and the DCMR second measurement (on a 5-point Likert scale).

Factor / item		N	Mean scores	Std. Deviation	Significance (2-tailed)
Organisation	Benchmark	3850	3,51	0,708	0,000
	DCMR second measurement	380	3,81	0,547	
Architecture	Benchmark	3876	3,52	0,802	0,000
	DCMR second measurement	377	3,75	0,609	

Facilities	Benchmark	3318	3,21	0,646	0,000
	DCMR second measurement	352	3,50	0,566	
Support of productivity	Benchmark	3526	2,98	0,842	0,000
	DCMR second measurement	365	3,31	0,638	
Indoor climate	Benchmark	2737	2,64	1,127	0,000
	DCMR second measurement	388	2,86	1,028	
Lighting	Benchmark	2686	3,45	0,933	0,844
	DCMR second measurement	387	3,46	0,833	
Subdivision building	Benchmark	3893	3,25	0,906	0,000
	DCMR second measurement	375	3,47	0,660	
Functionality workspaces	Benchmark	2739	3,05	0,796	0,000
	DCMR second measurement	375	3,20	0,634	

Satisfaction scores and the score on perceived support of productivity are higher in comparison with the benchmark on all factors, except for the factor lighting, which does not differ significantly with the benchmark. In figure 5 the results are visualised.
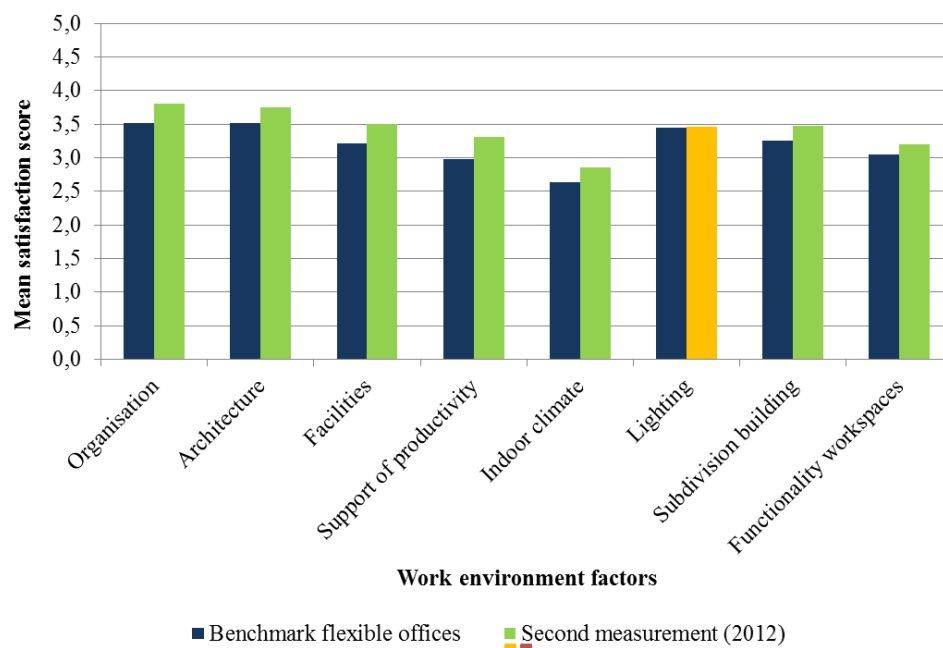
Figure 5: DCMR mean satisfaction scores from 2012 on a 5-point Likert scale compared to the benchmark. Blue = benchmark scores, Green= the second measurement scores significantly higher than the benchmark, Yellow= the second measurement scores with no significant difference.

4   CONCLUSION AND DISCUSSION

Employees are in general quite satisfied with the office environment. Respondents are more positive about the organisation, lighting, facilities and the support of productivity during the second measurement almost three years after moving to the new office building and after the interventions in comparison with the first measurement, one year after moving.

The total of interventions that the organisation implemented after the first measurement could have had a direct or indirect effect on the satisfaction scores and the perceived support of productivity. One other reason for the higher satisfaction scores might be that employees are getting used to the work environment and the flexible use of workspaces after a few years.

The adaptations to the lighting system probably have had a direct positive effect on the satisfaction scores on lighting. Furthermore, the attention from the IT department for the problems with the IT facilities seem to have positively influenced the facilities score. The finding that people are more satisfied with the own organisation during the second measurement, could possibly be explained by the serious attention that the organisation had for the user experience and the attempts the organisation undertook to improve the environment.

However, the two measurements and the attention for the satisfaction of the employees could have caused a form of reactivity like the well-known Hawthorne effect or a social desirability bias. Yet the results on indoor climate, which received a lot of attention during the improvements but did not result in higher satisfaction scores during the after measurement, do not support this assumption.

The improvements on the indoor climate did not seem to have had a direct effect on the satisfaction with the indoor climate, since the satisfaction scores on that factor did not show a significant improvement. Still after the interventions, the respondents complained about dry air and related health problems. Furthermore, people stated that they were still missing the possibility to open a window. The DCMR is planning on communicating the issues regarding indoor climate and other technical factors with their employees more extensive than they did before. They will inform the employees about current investigations and will let them know whether changes can or cannot be made. The information might help employees to understand certain issues and know what to expect when it comes to technical improvements within the work environment.

During the second measurement, complaints regarding distraction and possibilities for concentration also continued to exist. While the installation of the acoustic panels might have had some effect, the results show that the acoustics within the open and half-open spaces still needs some special attention. It is important to try to resolve this issue, because the possibilities to concentrate is a strong predictor for the perceived productivity (Maarleveld & de Been, 2011). It seems to be not only a problem which can be solved by altering the layout of the work environment; behaviour is an important factor in realising a more pleasant environment for concentrated work. The DCMR is planning to communicate on how employees discuss with each other what effects conversations and noise levels have on them to make other employees realise what the consequences of certain behaviours are.

While the results on indoor climate and concentration possibilities seem negative, a positive indirect effect of the interventions on indoor climate and acoustics on the other work environment factors, like the perceived support of productivity, cannot be ruled out. Moreover, when comparing this case study to the benchmark, the DCMR scores above average on indoor climate and almost all the other work environment factors as well. The comparison with the reference benchmark shows that the new office building and flexible concept performs relatively good compared to other organisations that implemented the same innovative flexible office concept.

5   PRACTICAL IMPLICATIONS

Measuring the appraisal of the DCMR office environment will help in the understanding of the experience of employees in a new office building with a flexible office concept. Although combi offices with flexible use of workspaces are still mostly a Dutch phenomenon, it seems that organisations in other countries are more and more considering adapting and innovating their office concepts.

This research also gives insight into the effects of several specific interventions within the work environment on employee experience. A description of more case studies in which interventions are done to improve the experience and the following effects supported by data, will give organisations evidence based knowledge on which they can decide which interventions would suit them best in reaching their goals of higher employee satisfaction and support of productivity.

Other organisations can learn from the specific details of the DCMR concept and the ambition of DCMR to optimise the office concept by focussing on the experience of actual users of the building: the employees.

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FM towards zero emission buildings: Learning and professional development among energy operators of large buildings

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ABSTRACT

Drawing on theories from studies of Facilities Management (FM) and social studies of science and technology as well as explorative qualitative research methods, the purpose of this paper is to examine energy operations of large, existing buildings and how knowledge development and knowledge transfers may provide lessons for how FM of existing buildings may contribute to transition towards zero emission buildings. In this, energy operation of existing buildings is described as an important measure towards sustainability. The relevant actors explored for this study are related to large non-residential buildings (university), and different types of large housing facilities (health rehabilitation and student housing), aiming to provide practical insight to professional development and learning processes related to energy operation of all types of large buildings. The preliminary findings and originality and value of this paper is the emphasis on how in-house FM may be applied to create added economic and environmental value through energy management, and how energy efficiency operation of existing buildings may contribute to transitions towards zero emission buildings. Inspired by literature and the case studies conducted, the paper argues for further research investigating formal and informal meeting spaces and involved actors important for stimulating knowledge sharing and innovations in and among FM actors; and the possibility of knowledge exchange and cooperation between in-house and external FM organisations towards new and improved management of complex facilities and potential zero emission buildings.

Keywords

In-house facilities management, learning, energy operation and efficiency, existing large buildings.

1   INTRODUCTION

Surprisingly little attention has been paid to environmental efficiency of facility management (FM) (Jensen et al. (2012) even though facilities related activities produce the majority of the company's environmental impact (Sarasoja & Aaltonen 2012). In order to contain global warming it is estimated that by 2050 developed countries will have to reduce their greenhouse gas (GHG) emissions by 80-95% compared with 1990 (European Commission, n.d.). The most significant environmental impact of buildings is caused by the energy use (Sarasoja & Aaltonen 2012). The use and characteristics of the built environment accounts for roughly 40% of the total energy consumption and hence a significant share of GHG emissions in most developed nations (Kyrö et al 2012). As environmental objectives are increasingly written into corporate objectives FM has potential to be at the forefront of delivery for sustainability due to the impact FM has on operation of properties (Price et al. 2011).

The on-going research discussed in this article is part of a large national research centre. The Research Centre on Zero Emission Buildings aims to eliminate GHG emissions caused by buildings by developing competitive products and solutions for existing and new residential and commercial/public buildings that will lead to market penetration of buildings with zero emissions of GHG related to their production, operation and demolition. Sartori et al. (2010) find that neither nationally nor internationally is it possible to find any clear and agreed definition: As a minimum requirement for a building to be zero emission, the balance between energy export and import over a period of time must be zero (or positive). Hence the number one priority for moving towards zero emission buildings must be to reduce energy demand, and secondly to generate renewable energy. Sartori et al. (2010) conclude that the best form of clean and renewable energy is the energy not used, also because reducing energy demand may be more cost-efficient than extending the capacity in the energy supply system.

Zero emission buildings may also be achieved through regulations and innovations for new building technologies. But in the building sector most energy is consumed by existing buildings. The replacement rate of existing buildings is only around 1-3% per annum (Ma et al. 2012). In France for instance, 90% of the 2020 building stock and more than 60% of the 2050 building stock, has already been built (Cantin et al. 2012), with similar figures for the UK. Such figures demonstrate the crucial need to enhance energy efficiency of *existing buildings* in order to bring down emissions (Price et al. 2011).

Retrofitting and adaptation of existing buildings may reduce energy consumption significantly but is associated with many challenges such as uncertainties and unwillingness to pay (Ma et al. 2012). This may also be related to the knowledge that even the best designed low-energy buildings will not perform as planned if they are not operated properly (Kyrö et al 2012). The importance of focusing on the operation phase for achieving long-term energy saving is further enhanced by the fact that over the life cycle of buildings more than 80% of the total energy is consumed during the operation phase (Azar and Menassa 2012). The facilities hence present a major energy conservation opportunity many companies appear committed to due to environmental or economic values, which could open new markets for FM (Junnila 2007).

A wide range of technologies which could significantly reduce energy consumption and GHG emissions from new and existing buildings are already available, but the adoption level is low, and technologies to save energy do not travel well from laboratories to a building's everyday life (Berker 2006). Such mismatches between design of smart systems and use of the systems indicate that the potential for energy saving is not realized (Jelsma et al. 2003). Several initiatives hence aim at changing the attitudes of the users of the buildings, but changing users are not straight forward either (see e.g. Janda 2011, Aune et al. 2009). Brown and Vergragt (2008) hence conclude that sustainability will not be reached by technology alone, but by deep learning by individuals, society and institutions.

The operation of energy efficient buildings may be difficult for the users, and if the technologies are experienced as too advanced they are not applied or are misunderstood (Hauge et al. 2010). Energy consumption and comfort management in residential buildings differ from office buildings since users of non-residential buildings usually have no personal responsibility for the energy consumption, and because energy (saving) technologies in non-residential buildings usually are complicated to manage (Aune et al. 2009). On the other hand, new residential buildings are likely to contain complex technologies beyond the operation capacity of residents, which may indicate an increasing importance of energy management operators in all sorts of buildings. In the intersection between buildings, technologies and users building operators have a special position in making buildings work since they negotiate between users, technologies and the building. Their understanding is vital for reaching energy efficiency goals (Aune et al. 2009).

Even though the dedication of FM organizations to new developments seems to be the way to stay in business by constantly adding value to the core business, the innovativeness of FM organizations is seldom studied (Mudrak et al. 2005). The research focus for this article will thus be to explore how to transgress towards zero emission buildings through learning from energy efficiency operation of existing large buildings. The aim is to provide practical insight to professional development and learning processes related to energy operation of large buildings by investigating what and who promotes energy saving behaviour in large buildings, and how. What kind of "in between" actors exist? What stimulates energy efficiency? What energy management processes are developed? How do the "in betweens" learn and share knowledge in order to provide for environmental efficiency of FM?

2 METHOD AND CASE STUDY DESCRIPTION

The most significant environmental impact of buildings is caused by the energy use, and the people who operate the building's energy use have consequently a huge impact on the environment (Sarasoja & Aaltonen 2012). In order to understand FM and provide better knowledge for evaluating and learning about FM and added value, qualitative methods may be beneficial (Waldburger and Nielsen 2012). Whereas quantitative approaches are most valid when technological artefacts and practices have become stabilized, they are inadequate when we want to investigate how the world may function differently from what simple extrapolation of existing practices and expectations would indicate (Russel and Williams 2002). Qualitative interviews are hence advantageous in supporting an explorative approach investigating personal interpretations and reasons for people's behaviour (Waldburger and Nielsen 2012), as well as for exploring new actors not usually associated with energy efficient FM.

The preliminary analysis presented in this article is based on qualitative, unstructured interviews with five representatives of four different cases. The cases were chosen to represent examples of energy operation of large existing buildings with different challenges. The analysis is hence meant to be explorative in order to guide further research, and will describe the main characteristics of three of the cases. The interviews were conducted during the fall of 2012, and lasted between 1 and 2 hours. The interviews were recorded and later transcribed. The interview questions revolved around the organization of the FM, how they conducted the energy management and which actors are central for the energy operation of the buildings and knowledge development.

Table 1 Initial case studies related to energy operation of large buildings

Case	Description	Users	Energy management
The Co-operative Housing Federation of Norway (NBBL)	Resource for housing cooperatives (board members)	Board members of housing cooperatives, researchers, policymakers	"Guidance and lobbying"
Student housing: SiT Student Welfare organization	Provides student housing, cafeterias, day care, sports and health facilities	Students: 0.5 – 5 years (average 1.5 years)	Techno fixes. Excludes "in between actors", relies on users
University: NTNU	Large university, several campuses	Faculty, students, researchers: Daytime	Involves "in between actors" internally and externally. Visual control + central operation system
Health resort: Røros Rehabilitation	Health institution, short term rehab stays (heart, lung, cancer, obesity)	Guests: 3 days to 5 weeks	Same as above

3 ENERGY OPERATION OF DIFFERENT LARGE EXISITING BUILDINGS

3.1 Student housing for "inexperienced residents"

The student welfare organization is a non-profit organization led by students but run by professional employees. In addition to other student welfare tasks they operate 4600 bedsits at about 15 different locations around the city of Trondheim, Norway, offering accommodation to nearly 20% of the student population. The aim for the student housing is twofold: cheap not for profit rent for the students and sustainable housing with energy efficiency measures (also to decrease the rent). Energy efficiency is achieved through two separate strategies: technological measures and various types of information to students. "Our challenge is that students live here maximum 5 years, the average occupancy is only 1.5 years. We constantly have new residents without knowledge about the buildings. It is very demanding to frequently have to educate new residents, so we focus more on the reliability of the technical measures" the property manager explained.

The property manager has hired an energy consultant to audit and improve their strategies. They also aim to involve the operators and housekeepers more in the energy operation and to improve their attitudes towards energy efficiency because they have more long term relations with the bedsits than the residents do. But operators and housekeeping are only present in the private parts of the facilities upon malfunctions or when students move out, so in order to reduce energy consumption the management relies on a mix of technology fixes and awareness rising about environmental values as well as deficit reports from students. Their technical measures are many and varied: The bedsits range from passive houses to old buildings where retrofitting of windows and ventilation provides energy efficiency. They provide eco-showers/faucets, automatic energy saving lights, shared facilities and collective/dense environments to reduce need for heating. They have also developed comfort switches where heating automatically turns to night mode after 3 hours if not activated again.

The facility operators observe that the technological measures are not fool proof. Their energy monitoring system shows that energy consumption varies extremely between similar units. They explain this as a result of students representing the variation of the entire population. They hence look for solutions giving students incentives to save, and believe individual metering will contribute to enhancing energy efficiency behaviours: "The students have never seen an electricity bill before. We serve as the first home away from home. In one way we represent a training institution, but we have a lot of potential to improve our teaching" the property manager explained (see also Janda 2011). "We are missing a link between us and the students. We have exploited the potential in the physical facilities but not in the students, which means this is not working optimally" the property manager argued. He suggested that one way of improving may be to identify all actors in direct contact with the students and utilize them more, for example to encourage the student resident assistants to include energy efficiency attitudes in their work to improve the overall student housing environment.

The energy management strategy with a mix of techno fixes and information to urge residents to save energy yields varying results and is suggested enhanced by delegating more responsibility to human actors operating between the users and the buildings.

3.2 University campus with a wide range of buildings

The energy management strategy of the university case involves more and different types of in between actors operating between the users and the buildings. Norwegian University of Science and Technology hosts 22 000 students and more than 5000 employees at 7 campuses with more than 100 laboratory facilities. The university operates 550 000 square meters of heated area in buildings which are from 2 to 100 years old. The total consumption of electricity and district heating is about 100 GW. The complex university organization aims to reduce its carbon footprint through reduction of waste, consumption and transport, and through energy efficiency measures reducing energy consumption with 20% by 2020 compared to 2010. They recently initiated plans to involve all divisions in this work and to structure the environmental efforts which so far have relied on individual initiatives.

The in-house FM applies a central operation system for daily surveillance. Combined with hands-on observations and local knowledge the surveillance is also used to identify potential efficiency projects. They participate with their local knowledge in project planning/design and are hence able to initiate energy efficiency measures like integrating solutions between new and old buildings. This lead them to develop a closed circuit for the district heating where they manage the supply to different buildings locally rather than to supply district heating directly to each building. This solution is expected to reduce energy consumption at this campus with 3 GW, almost 10%, which will return the costs of the project within 2.5 years. Other efficiency projects initiated internally are described as low cost with high returns because the operation division likes to tinker and develop new solutions on the existing equipment. "In this way we have with low cost improved the efficiency with 25-90% on existing equipment" the head engineer at the operation unit explained.

They only hire external FM resources for project calculations and certain services/maintenance. They rely on dedicated operators who function as beacons and tinkerers to initiate and develop projects based on their knowledge of the local system and the interdisciplinary competence available in the operation divisions. This knowledge is crucial for their utilization of the information from the central operation system, not only to fix malfunctions but to look for potential sites for efficiency measures together with the local site operators.

In this way the operation division constantly aims to include everybody with operation tasks into projects for better and integrated operation, and try to enhance their knowledge in order

to build a better organization with devoted employees and better results. They constantly need to document the effects of their projects to keep central management from outsourcing FM, and find that they have succeeded mainly due to devoted employees who know the buildings and hence see potential for improvements and integrated solutions between buildings. They build networks of "know-hows" in-house and through employing experienced personnel with networks of experts from their prior jobs. They also try to create a feeling of ownership to the operation through high ambition projects and opportunities for interdisciplinary cooperation which again enhances the (local) knowledge of employees related to FM.

3.3 Health institution in challenging climate

The last case strongly relies on the involvement of all employees in their energy management. Røros Rehabilitation is located in an 8300 square meter low, narrow and long building in the World Heritage Site Røros, Norway. The building, finished 2002, was specifically designed for supporting health rehabilitation and fitting into the wild life as well as the low build heritage scenery. The dry climate and challenging temperature range (-40 to +30 degrees Celsius) as well as the requirements of the users impose severe energy challenges for the operation of the building: it was designed with ambitions to use as little energy per square meter as possible at the same time as it was designed to look like a mountain resort with large windows allowing a nice view to the scenery.

The building is connected to district heating and uses less than 1.1 GW a year on heating/hot water. Since patients need a well-lit environment day and night to be able to move about safely electricity consumption for lighting, pumps and other appliances is also about 1 GW a year. This is considered as too high since they only use energy saving or LED bulbs and lighting is automatically adjusted to the outside lux and to different purposes such as ordinary day time, evenings and night time, as well as "well-lit for cleaning". Hence the technical manager has invented "local fixes" like leaving out every second light bulb in order to save more energy.

The rehab is a small organization with about 80 employees in total, including one janitor and the technical manager who applies a standard energy management and control system to control the consumption weekly. He is also member of a technical forum with other technical managers of similar health rehabs. They gather for 2-3 days once or twice a year to share and extend knowledge and hence invite different experts to these meetings. They have suggested, so far in vain, that the owners conduct an energy audit of the buildings, because they find it hard to "reinvent the wheel" after years of technical operation of the same building in a small organisation. "We constantly try to lower the energy cost. That's a goal. We have a balance score to aim for, and I have to clarify all deviances compared to last year. The balance score is determined together with all the employees. We need a goal, a carrot to aim for. We aim to reduce the consumption year by year, so once in a while we offer a prize to the employees if we manage to reach our energy goal!" the technical manager explained.

One of their measures towards lowering the energy consumption is to include all the employees as responsible for the consumption. Housekeeping employees and receptionists (nurses) are through their job descriptions made responsible for turning down thermostats, switching off unused equipment like TVs and computers, and unplugging kettles etc. "Housekeeping observe all the rooms on a daily basis and feel the temperature. They do an amazing job! They are trained by us in the technical division and by each other" the technical manager explained. They also hold daily meetings with housekeeping where the day to day observers report necessary tasks. Small janitorial jobs like shifting light bulbs and fixing small problems are also delegated to housekeeping which always carries the necessary equipment with them.

Even though, or because the technical manager complained that rehab architecture is bad for energy efficiency and that energy saving lighting systems and bulbs are not effective enough, they have managed to create an in-house FM system where local knowledge and daily observations are crucial and where all employees are given responsibility for the energy consumption. The employees are described as taking a pride in their job and as having a strong feeling of ownership to the building and its energy consumption. In addition to stimulating each other in-house, the technical forum for operation managers is important for knowledge sharing. The owners have hired external FM services for the exterior maintenance of the building, and the technical manager argued that "external FM is a waste of money" because he knows the building the best. At the same time he believed that external FM may represent valuable expertise and input to his energy operation – if the owners would hire them for this knowledge rather than for the external maintenance.

4   CONCLUSION: MIX OF TECHNOLOGICAL AND HUMAN MEASUREMENTS TOWARDS ZERO EMISSION BUILDINGS

The energy operation of the investigated case study buildings is conducted in-house mainly without external FM. The energy efficiency management is characterized by different socio-technical systems in between users and technological measures where centralized operation systems combined with observations and local knowledge are crucial. The energy management is mainly driven by "personal" drive from (single) beacons and environmental goals rather than economy. The added value from energy efficiency is mainly returned to the end-users of the core business who do not take part or are not being involved in the measures. The energy operators' main driver is to do a good job. It is important for them to utilize and enhance the local knowledge of the energy operators and potential supporting actors. The FMs of these cases argue that one such supporting actor may be professional FM agencies, but their potential expertise is of low value without the feeling of ownership and local knowledge of the in-house energy operators like janitors, receptionists, housekeeping, local operators and resident assistants. The argument from these cases leads to an interesting irony for further research which is also elaborated on by Jensen et al. (2012b) hypothesising that operating on a competitive market with strong price focus FM providers may be more active in innovations leading to increased efficiency and cost reductions than in-house organisations. On the other hand, in-house FM organisations may be more oriented towards innovations leading to increased effectiveness and improved quality because they are in a much more favourable position than external FM providers to practice relationship and stakeholder management Jensen et al. (2012b) hypothesise. Further research inspired by their hypothesis and these case studies may be to investigate formal and informal meeting spaces and involved actors important for stimulating knowledge sharing and innovations, and the possibility of combining the best of two worlds: the feeling of ownership and local knowledge developed in in-house FM organisations with external FM providers' up-to-date expertise and knowledge from a variety of facilities.

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Comparison of a flexible and inflexible approach to the evaluation of building intervention strategies

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ABSTRACT
In the systematic evaluation of building intervention strategies, i.e. maintenance and modification, there is a significant lack of consideration of the uncertainties in future demand over the planning horizon. These uncertainties in future demand can be addressed by using a flexible approach to the evaluation of intervention strategies as opposed to an inflexible approach; that means it is directly considered that decision makers adapt intervention strategies to new information about demand changes as they are revealed in the future.
This paper contains a comparison of a flexible and an inflexible approach to the evaluation of building intervention strategies. The comparison is done using a fictive case study where a building owner would like to determine the preferred intervention strategy (i.e. timing of a façade replacement) for a building, to maximize the net benefit under significant uncertainty with respect to the future price of heating fuel.
It is shown that a flexible approach to the determination of building intervention strategies can result in different intervention strategies than when using an inflexible approach. Furthermore, it is shown that the use of the flexible approach makes it possible to completely rule out many intervention strategies that would be considered using an inflexible approach; it also provides insight as to when a decision maker should reanalyse a situation, and can result in an increased net benefit for building owners.

Keywords
Strategic decision-making; Flexibility; Evaluation; Uncertainty; Building intervention planning

1 INTRODUCTION

When buildings are built they are intended to provide an adequate level of service over a specified period of time; something that is jeopardized by unexpected deterioration or demand changes. Building managers execute interventions to ensure an adequate level of service, either by maintaining the building at or returning it to the demanded level. It is in their interest to ensure that the intervention strategies (IS)[22] they follow result in the maximum net benefit. The IS with the maximum net benefit is considered an optimal IS; this net benefit includes all positive and negative impacts from the operation of the building over the investigated time period when the given IS is followed, e.g. rental income, operation costs.

One approach to determine an optimal IS is to analyse the situation at t=0 and decide then as to which IS should be followed over the investigated time period. Assuming a fixed IS at t=0, however, the flexibility of management to change their mind and follow a different IS if, at a later point of time, new information is received is ignored.

Another approach is thus to analyse the situation at t=0 and decide then to execute an intervention at t=0 or to do nothing at t=0, i.e. to wait, an postpone the decision to a later point in time. By doing this the flexibility of management to follow a different IS than the one that might be estimated to be optimal at t=0 is explicitly considered, for example, when new information becomes available. The optimal ISs determined using the two approaches are not necessarily the same, and the latter in many cases can result in a higher net benefit. Methodologies for the pricing of financial options have often been used for the evaluation of organisational or managerial flexibility; methodologies that can also be applied to non-financial, i.e. "real" options, in investment planning (Dixit and Pindyck 1993; Luenberger 1998). This Real Options Theory has found numerous applications in the evaluation of flexible strategies in the design (Zhao and Tseng 2003, Kalligeros 2010) and management of infrastructure (Koide, Kaito et al. 2001; Santa-Cruz and Heredia-Zavoni 2009; Ashuri, Kashani et al. 2011; Menassa 2011; Haddad, Sandborn et al. 2011). Menassa (2011) and Ashuri, Kashani et al. (2011) investigated specifically flexible management in building renovation. They employ methodologies based on Real Options Theory to evaluate energy retrofits on buildings. Whereas Menassa (2011) presents several methodologies to evaluate different kinds of options with regard to the net benefit today, this publication does not offer transparency with respect to ISs that should be adopted. Ashuri, Kashani et al. (2011) provide more information about possible timing of interventions and their probabilities of occurrence. However, both papers mentioned do consider flexible management with regard to single investments in energy retrofits, rather than the planning of ISs.

The work presented herein, however, was focused specifically on the evaluation of flexible management in the context of long-term intervention planning for buildings, with the goal to determine preferred ISs under uncertainty; the transparency regarding possible ISs and decision making for the building manager is the main focus.

In this paper, it is shown that methodologies assuming flexible management can result in different ISs than with inflexible management and that, in some cases, this will result in an increase in net benefit from building operation. The methodology employed in this paper is that of a multiperiod option using a binomial decision tree as described in (Luenberger 1998). This methodology allows for the transparency regarding IS, i.e. statements about the timing of interventions and their probability of occurence.

2 METHODOLOGIES

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[22] Intervention = Measure to ensure that a building fulfills the required level of performance
  Intervention strategy = Plan about when which intervention will be conducted in the investigated time period.

2.1 Flexible management

The flexible management methodology assumes that a decision can be made at any time t between today (t=0) and the end of the investigated time period (t=T); this allows for the consideration of new information. The only decision to be made at t (including t=0) is whether to follow an IS with an intervention in t (Group 1) or an IS with an intervention after t (Group 2). The actual IS is not known until the end of the investigated time period, or when there is only one IS left in a group of ISs.

The steps of the methodology assuming flexible management are as follows:

1. Determine possible future scenarios in a binomial lattice.
2. Estimate the impacts for each scenario.
3. Estimate the probability of their occurrence.
4. For each scenario and each decision time t, estimate (recursively from T to t) the maximum expected net benefit at t of
   a. each of the ISs with an intervention at t (Group 1), and
   b. each of the ISs without an intervention at t, i.e. an intervention after t (Group 2).
5. At t, select the group of ISs that results in the maximum net benefit at this point. The difference between the maximum net benefit at t of group 1 and that of group 2 is referred to as the value of the *option to wait*.

The net benefit at t includes all costs and benefits from t to T, discounted to t. This methodology describes the evaluation of flexible management as a multiperiod option using a binomial decision tree as described in (Luenberger 1998).

2.2 Inflexible management

The inflexible management methodology is based on the assumption that the decision which IS to follow is made now, at t=0. In this case, the owner determines the optimal IS now and follows it, considering the estimation of the uncertainty in the price of heating fuel now. For the evaluation, it is assumed that the decision maker does not consider the choice in the future to alter or change the decision.

The steps of the methodology assuming inflexible management are as follows:

1. Determine possible future scenarios in the form of a binomial lattice.
2. Estimate the impacts for each scenario.
3. Estimate the probability of occurrence of each scenario.
4. Estimate the expected net benefit at t=0 of each ISs if each IS is followed from t=0 to T.
5. Select the IS with the maximum net benefit at t=0 and follow it.

3 CASE STUDY

3.1 Problem description

An existing building is to be operated for the next 50 years. The owner is interested in maximizing his or her net benefit considering intervention costs, heating costs, and rental income. One possibility to do this is to replace the existing façade, which has a relatively high thermal conductivity and thus results in a higher heating demand for the building, with one that has a lower one. As there is significant uncertainty with respect to the future price of the heating fuel, there is also significant uncertainty with respect to the optimal IS. The ISs considered are to replace the façade once between [0, 50), and not at all. It is assumed that the probabilities of the fuel price increasing or decreasing are the same over the investigated time period. It is considered that the only uncertainty is the uncertainty with respect to future fuel prices. The other information required for the analysis is given in Table 1 without further explanation.

Table 1: Input data for decision problem of façade system

Parameter	Description	Units	Value
A_H	heated area	m^2	53'000
A_F	facade surface area	m^2	26'000
f_d	fuel demand	l/kWh	10
$c_{r,g}$	rental income with original façade	€/a*m^2 A_H	964
$c_{r,g}$	rental income with new façade	€/a*m^2 A_H	1'084
c_u	cost of installation of new façade	€/m^2 A_F	6'100
d_g	heating demand of building with old façade	kWh/a*m^2 A_H	40
d_g	heating demand of building with new façade	kWh/a*m^2 A_H	15
σ	volatility of fuel price	-	0.23
fp_o	initial fuel price	€/l	0.95
r	risk-free interest rate per year	-	0.03
δt	time steps	years	5
T	investigated time period	years	50
f	inflation rate per year	-	0.02

3.2 Analysis

3.2.1 Fuel price

As it is assumed that the probabilities of the fuel price increasing or decreasing are the same over the investigated time period, the uncertainty in fuel price decreases over time as more information is obtained. This is illustrated schematically in Figure 1, where area A represents the possible range of fuel prices over [0,T] that may occur with a non-zero probability if estimated at t=0, given the range of fuel price, fp_0; the area B in Figure 1 represents the fuel prices over [0,T] that may occur with a non-zero probability if estimated at time t, given the fuel price at t=t is fp_t.
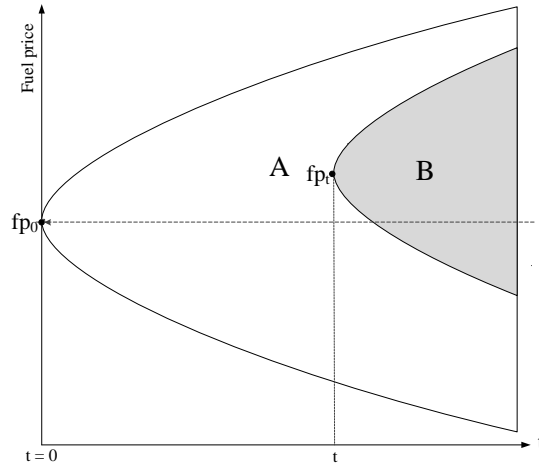
Figure 1: Schematic illustration of decreasing uncertainty of fuel price over time

It is assumed that the fuel price can be modeled as a stochastic geometric Brownian process. A binomial tree method, as described in (Luenberger 1998) or originally in (Cox, Ross, and Rubinstein 1979), is used to capture the stochastic change of the price in discrete way. In the binomial tree method, the price can go up and down with branching factors u and d (for increase and decrease, respectively); these branching factors are calculated using volatility σ. u and d are computed with the assumed volatility σ of 23 % (see equations (1) and (2)).

$$u = e^{\left(\sigma \cdot \sqrt{\delta t}\right)} = 1.691 \tag{1}$$

$$d = e^{\left(-\sigma \cdot \sqrt{\delta t}\right)} = 0.591 \tag{2}$$

The fuel prices fp_t in €/l for year t+dt can be calculated based on the price in year t. The calculation is represented schematically in Figure 2. The values of the fuel prices over T are given in Table 2.

Figure 2: Reconnecting binomial lattice describing development of fuel price

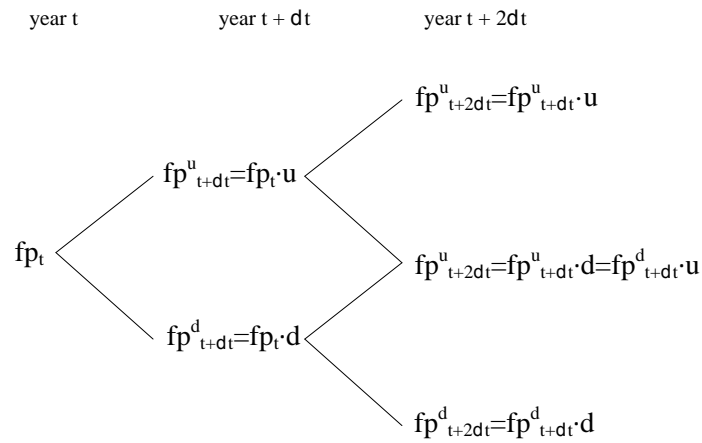|					Year t					
0	5	10	15	20	25	30	35	40	45	50
0.95	1.60	2.71	4.58	7.74	13.08	22.12	37.40	63.24	106.94	180.81
	0.56	0.95	1.60	2.71	4.58	7.74	13.08	22.12	37.40	63.24
		0.33	0.56	0.95	1.60	2.71	4.58	7.74	13.08	22.12
			0.20	0.33	0.56	0.95	1.60	2.71	4.58	7.74
				0.12	0.20	0.33	0.56	0.95	1.60	2.71
					0.07	0.12	0.20	0.33	0.56	0.95
						0.04	0.07	0.12	0.20	0.33
							0.02	0.04	0.07	0.12
								0.01	0.02	0.04
									0.01	0.01
										0.00

The probability of having an increase and a decrease, respectively, in fuel price of one unit is given by:

$$p_u = \frac{e^{(r\delta t)} - d}{u - d} = 0.519 \tag{3}$$

and

$$p_d = 1 - p_u = 0.481 \tag{4}$$

3.2.2 Flexible management

With the flexible management methodology, management has the option to execute an intervention or not at every t on [0, T) if an intervention has not been executed before, i.e. in [0, t). The decision depends on the costs and benefits incurred in each year on [t, T), which in turn depends on the probability of having each possible fuel price value.

The decision to intervene in each t is given by:

$$\max \left[\sum_{g_t=1}^{2} X_{t,fp}^{g_t,k_t} \cdot \delta_{t,g_t} \right] \tag{5}$$

where the net benefit of group 1 ISs, X^1, and group 2 ISs, X^2, at t, given fuel price, fp, at time t, is calculated using equations (6), recursively from T to t:

$$X_{t,fp}^{g_t,k_t} = I_{t,fp} - O_{t,fp} - C_{t,fp} + \frac{1}{(1+r)} \cdot \sum_{fp=fp_{min}}^{fp_{max}} p_{t,fp} \cdot \max \left[\sum_{g_{t+1}=1}^{2} \left(\sum_{k_{t+1}=1}^{K} X_{t+1,fp}^{g_{t+1},k_{t+1}} \cdot \delta_{t+1,k_{t+1}} \right) \cdot \delta_{t+1,g_{t+1}} \right] \tag{6}$$

In equations (5) and (6), two dummy variables are required to satisfy following constraints:

$$\sum_{g_t=1}^{2} \delta_{t,g_t} = 1 \tag{7}$$

$$\sum_{k_t=1}^{K} \delta_{t,k_t} = 1 \tag{8}$$

where

t   denotes the time where the decision is made to execute an intervention or to wait (in this example every five years)

fp   denotes the fuel price

$p_{t,fp}$ denotes the probability of the fuel price, which depends on the t and the fuel price

k   denotes the possible interventions to be executed at each time from each group

r   denotes the discount rate

I   denotes the rental income, which are given by $I = c_{r,g_t} \cdot A_H$

O denotes the operational costs, which are given by $O = d_{g_t} \cdot A_H \cdot fp_t \cdot f_d$

C denotes the intervention costs, which is given by $C = c_u \cdot A_F$

δ_{t,g_t} is a binary coefficient, which varies as a function of t and g, i.e. only one group of interventions can be selected

δ_{t,k_t} is a binary coefficient, which varies as a function of t and k, i.e. only one intervention can be selected

3.2.3 Inflexible management

With the inflexible management methodology, management decides the IS to follow at t = 0, based on the net benefit

$$X_{t,g,k} = \sum_{t=0}^{T} \frac{1}{(1+r)^t} \sum_{fp=fp_{min}}^{fp_{max}} \left(\left(I_{t,g,k,fp} - O_{t,g,i,fp} - C_{t,g,k,fp} \right) \cdot p_{t,fp} \right) \tag{9}$$

where k denotes the IS.

The decision of which IS is then determined based on the k value that satisfies the following equation.

$$\max \left[\sum_{t=0}^{T} \sum_{g_t=1}^{2} \sum_{k_t=1}^{K} X_{t,g,k} \cdot \delta_{t,g_t} \cdot \delta_{t,k_t} \right] \tag{10}$$

where

$$\sum_{g_t=1}^{2} \delta_{t,g_t} = 1 \tag{11}$$

$$\sum_{k_t=1}^{K} \delta_{t,k_t} = 1 \tag{12}$$

3.3 Results

The net benefit of the ISs estimated using the inflexible management methodology and the net benefits of the groups of ISs using the flexible management methodology evaluated at t=0 are given in Table 3. For the flexible management methodology, the probabilities of each IS are given together with the contribution that each IS has to the net benefit of the group of IS to which it belongs, evaluated at t=0.

Table 3: Net benefit of ISs

IS (by year of execution)	Inflexible management	Flexible management		
	Net benefit of ISs $X_{t,g,k}$	Net benefit of IS groups	Probability of IS being followed	Contribution of IS to the net benefit of IS groups
	$(10^6 \,€)$	$(10^6 \,€)$		$(10^6 \,€)$
0	**239.90**	239.90 ($X_{t,fp}^1$)	1	239.90
5	228.82		0	0
10	217.65		0.269	31.68
15	206.38		0	0
20	195.01		0	0
25	183.56	**254.78** ($X_{t,fp}^2$)	0.070	7.03
30	172.02		0	0
35	160.40		0	0
40	148.70		0	0
45	136.91		0	0
50	222.43		0.661	216.07
			$\sum$	254.78 ($X_{t,fp}^2$)

If the flexible management methodology is used, it can be seen that at t=0, if IS0 is not followed, then there are only three IS with positive probabilities of being followed, IS10, 25 and 50, regardless of the development of fuel price. A probability of 0 in Table 3 means that there is no possible development of fuel prices that would make the net benefit of the IS higher than the net benefit of all other ISs. A non-zero probability means that there is at least one possible evolution of fuel prices that would make the net benefit of the IS higher than the net benefit of all other ISs. For example, the value of 0.269 for IS10 is the probability that fuel prices will develop in a way that makes the ISs with an intervention in year 10 the strategies with the largest net benefit of all ISs. It consists of the probability that the fuel price will rise in period 1 and period 2. A probability of 1 means that the IS is followed with certainty.

The last column of Table 3 shows the contribution of each IS to the total net benefit of a group of interventions; it is the sum of the probabilities of each possibile fuel price development so that a particular IS will be followed, multiplied by the net benefit if that IS is followed.

The net benefits for both groups of ISs, using the flexible management methodology, are given for each time t and each possible fuel price in Table 4. From Table 4 it is possible to read out directly the decision that should be made in each year for each fuel price. For example, in year 15, if the fuel price is as high as possible (4.58 €/l), the maximum net benefit from an IS of group 2 is -105 x 10^6 €; whereas the maximum net benefit of an IS from group 1 is -51 x 10^6 €. Therefore, a new façade should be installed in year 15 to minimize losses. Of course, the decision maker would never find himself in this position as he would have already replaced the façade at t=10, i.e. when the fuel price was 2.71 €/l. The decisions that would be made at each t for each fuel price, conditional on reaching t without already having executed an intervention, are given in Table 5.

Table 4: Net benefits for both groups of ISs (in x 10^6 €) when the flexible management methodology is used, at each time t for each possible fuel price fp

					Decision year t					
0	5	10	15	20	25	30	35	40	45	50
254.78	183.59	69.65	-105.28	-362.92	-740.41	-1293.06	-2084.78	-3187.71	-4295.92	-3695.73
239.90	182.46	90.39	-51.18	-262.39	-569.14	-1002.02	-1591.07	-2351.18	-3247.76	-1282.83
	341.12	290.70	211.16	97.34	-64.30	-295.75	-614.47	-1031.56	-1344.48	-1203.25
	279.81	240.74	178.95	86.11	-48.40	-237.15	-492.86	-823.36	-1219.66	-348.15
		401.10	370.98	319.87	242.02	132.58	-8.89	-170.60	-312.14	-331.45
		293.32	259.44	208.01	133.74	30.38	-108.74	-288.96	-510.29	-21.22
			433.20	411.82	375.13	319.93	244.26	150.08	48.94	-26.51
			287.60	250.64	197.44	123.95	25.62	-102.05	-262.17	93.13
				443.98	421.69	385.47	332.81	262.25	175.24	80.14
				265.56	219.73	156.68	72.62	-36.67	-175.38	133.12
					437.98	408.39	363.78	301.48	219.42	117.45
					227.52	168.13	89.05	-13.80	-145.03	147.11
						416.40	374.61	315.20	234.87	130.50
						172.13	94.80	-5.80	-134.41	152.00
							378.40	320.00	240.27	135.06
							96.81	-3.01	-130.70	153.72
								321.68	242.16	136.66
								-2.03	-129.40	154.32
									242.82	137.22
									-128.94	154.52
										137.41
										154.60

Legend for each fuel price fp

$$X^{2,k_t}_{t,fp}$$

$$\underline{X^{1,k_t}_{t,fp}}$$

Table 5: Decisions that would be made at each t for each fuel price fp, conditional on reaching t without already having executed an intervention before

					Decision year t					
0	5	10	15	20	25	30	35	40	45	50
do nothing	do nothing	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE	do nothing
	do nothing	do nothing	do nothing	do nothing	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE	do nothing
		do nothing	do nothing	do nothing	do nothing	do nothing	do nothing	do nothing	do nothing	do nothing
			do nothing	do nothing	do nothing	do nothing	do nothing	do nothing	do nothing	do nothing
				do nothing	do nothing	do nothing	do nothing	do nothing	do nothing	do nothing
					do nothing	do nothing	do nothing	do nothing	do nothing	do nothing
						do nothing	do nothing	do nothing	do nothing	do nothing
							do nothing	do nothing	do nothing	do nothing
								do nothing	do nothing	do nothing
									do nothing	do nothing
										do nothing

Another value that can be observed in Table 4, is the *value of the option to wait*. Note that this value changes with time t and the fuel price fp at each time t. Considering the node in year 5, where the fuel price is 1.60 €/l, the value of the option to wait is 1.13 x 10^6 € (183.59 - 182.46 x 10^6 €). At t=0 the value is 14.88 x 10^6 € (254.78 - 239.90 x 10^6 €).

3.4 Discussion

Using the inflexible management methodology, IS0, i.e. to replace the façade in t=0, would be followed and would be expected at t=0 to yield a net benefit of 240 x 10^6 € (Table 3). Using the flexible management methodology the group of ISs that do not include an intervention in t=0 would be followed and would be expected at t=0 to yield a net benefit of 255 x 10^6 €. The reason for this difference is that the decision to follow a specific IS is only made when certain conditions are reached. This difference is also known as the *value of the option to wait*.

Using the flexible management methodology, it can also be seen that the most probable IS to be followed is IS50, i.e. do not replace the façade at all. This will occur if the fuel prices stay significantly low so that the decision to follow any other IS is not made before time T is reached. However, if the fuel price is high enough at t=10 or t=25, the decision would be made to follow IS10 or 25, respectively, to avoid future losses due to high energy costs. Before t=10, the probability of the fuel price being high enough to warrant the execution of an intervention is negligible. Between t=10 and t=25, there is a probability of the fuel price being high enough to warrant the execution of intervention; but since the only way that the

fuel price could be high enough in t=15 is if it was also high enough in t=10 where it would have already triggered an intervention. After t=25, the probability of an intervention to be triggered is also negligible due to the same reason.

It is also interesting to note that, by using a flexible approach, it is possible for the decision maker to obtain information as to when he or she should reanalyse a situation; even though it cannot be said which IS will be the optimal one until T, certain IS can eliminated. In the presented example, after the decision is made in t=0 to not follow IS0, the decision maker does not have to look at the problem again until year 10 at which time he or she would want to gather more information on the fuel price.

Although not specifically addressed in this paper, there are situations where it is better to determine the IS at t=0 and follow it. This might even be the case if there is the possibility that new information will become available in the future, which could result in different optimal ISs. One example is that the building manager could combine interventions on multiple buildings to take advantage of the synergies from there simulataneous execution, e.g. the reduction of fixed costs of renting a crane.

In this paper, flexible management has a value for the given decision situation; a result that might not hold for different input parameters. If the goal of the paper was to provide a detailed answer to the case study in question it would be necessary to conduct a sensitivity analysis with appropriate variations in values of the input parameters. The most important parameters for such a sensitivity analysis would most likely be the replacement costs, the volatility of the fuel prices and the rental income.

4 CONCLUSIONS

It was shown in this paper that a flexible approach to the determination of building intervention strategies

1. results in different intervention strategies than when using an inflexible approach,
2. makes it possible to completely rule out many intervention strategies that would be considered using an inflexible approach,
3. can result in increased net benefit for the building owners, and
4. provides insight as to when a decision maker should reanalyse a situation.

In the future, it is important to investigate the ability to use a flexible management approach to evaluate intervention strategies where there is uncertainty in more than one parameter (e.g. the replacement cost of the façade can also be assumed as a stochastic variable) and to identify the cases where it is most beneficial to use a flexible approach when compared to an inflexible approach.

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Section four
REFLECTIVE PRACTICE IN FM

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For Facilities Management to advance as a discipline and a profession requires effective collaboration between research and practice in the development of a robust and reliable knowledge base. The purpose of the workshop is to generate discussion about how the inter-relations between research and practice can be improved for mutual benefit.

A joint, plenary session between the business and research streams of EFMC has been organised as a panel discussion, led by three leading practitioners, each of who have also been respected researchers in a University setting. These three regular and respected, participants of previous EuroFM events have been invited to moderate the Research Symposium, to reflect on the relevance of the research presented to practice. In the plenary session, they will present the need for evidence-based FM from their respective positions, and will set out the common mission - to improve the quality of knowledge available for decision making in facilities management.

A recent Nordic Conference (Jensen and Nielsen, 2012), included similar workshops between practitioners and researchers to address the overall theme of FM research for practice. For researchers the title implies improving the dissemination of findings and how to involve practitioners in academic research. A number of leading FM practitioners were invited to reflect on selected Nordic FM research themes and upon work presented at the conference and to comment on its relevance, novelty and usefulness to practice.

The clear feedback from practitioners at this conference was that the current research is often too distant to practical challenges at a tactical/operational level. A recurrent theme in the discussion was the need for better strategies for communication with a broader FM community and beyond committed FM individuals. To improve effectiveness, it is necessary to be clear of specific audiences and to use different channels of communication including social media. The need for researchers to present results in a form that is accessible to practitioners is well-established and often a requirement of funding.

The joint session will seek to stimulate discussion of research with, by and into practice and about action research and reflective practice. The session will provide insights into the production of new, useful, actionable knowledge, co-produced by researchers and practitioners.

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Introduction
EuroFM RESEARCH WORKSHOPS

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For the first time this year, EuroFM has provided an opportunity for a broader range of research papers to be presented and discussed as part of the overall programme for the annual research conference.

The workshops have been organised in response to requests by members of the research network for an opportunity for discussion of more theoretical and methodological issues associated with FM research. They provide an opportunity for presentation of research in progress to provided invaluable feedback for the further development of results and findings. The workshops also provide an important opportunity to support the development of academic staff and for exchange amongst registered postgraduate students.

All papers included in the workshops responded to the general call for papers for the 12th EuroFM Research Symposium and went through the same double-blind refereeing process as all papers in this publication.

The research workshops, locally hosted by Czech TU and Slovakian TU comprises three main elements – two academic workshops, one for research philosophy and one for work in progress, and a postgraduate workshop. In addition there will be an open session for registered postgraduate students to share experience and to identify ways in which EuroFM might provide more effective support for their needs and requirements.

The papers in the Frontiers in FM Research workshop focuses on the improvement of scientific enquiry in FM. Papers in the Work in Progress workshop presents ongoing research to generate discussion about the conduct of current research. The Postgraduate Research workshop presents research being conducted as part of a programme of study for higher degree, at different stages of development.

A further objective of the workshops is the opportunity to meet researchers, academic staff and research students of local Universities and to encourage their involvement in future activities in the network. This year we welcome the opportunity to hear more of relevant work being undertaken in the Czech Republic and Slovakia. We are sure that the contribution will strengthen our understanding of the development of FM in Eastern Europe.

Section five:
FRONTIERS OF FM RESEARCH

Competencies for interdisciplinary and multidisciplinary FM research

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Means for developing more general theories about the added value of FM

Knut Boge
Oslo and Akershus University College of Applied Sciences

Improving the validity of facility management research by use of interrater agreement

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Means for developing more general theories about the added value of FM

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ABSTRACT

Purpose: How to establish research designs and studies that facilitate development of more general theories about added value of Facilities Management (FM), and provide valid results that hold across time, space and contexts?

Design/methodology/approach: This conceptual paper is based on a literature study.

Findings: Random Controlled Tests (RCT) is often considered the "gold standard" in research. RCT is for instance standard operating procedure in clinical trials in healthcare. But it is not always possible to utilize RCT designs in studies of added value of FM. This paper discusses three possible alternatives to RCT, namely use of formal models, multi-level analysis (MLA) and so-called New Statistics. Formal models are based on explicitly stated assumptions and use of mathematical or graphic representations. MLA facilitates studies of the effects of particular organisational and technical measures in different contexts, and is thus a very strong method for comparative studies of added value of FM. New Statistics is more concerned with power, effect sizes, confidence intervals and meta-analysis than null hypothesis significance testing. Meta-analysis is a very useful tool for distinguishing between anecdotic and tenable evidence in studies of added value of FM. Studies based on formal models, MLA and meta-analysis are thus strong supplements to the traditional research of added value of FM based on small N case studies.

Originality/value: Use of formal models, MLA and New Statistics can bring the quest for general theories about added value of FM several steps forward.

Keywords

Facilities Management, Added Value, General Explanations, Formal Models, Multi-level Analysis, New Statistics, Meta-analysis.

1   INTRODUCTION

Added value of Facilities Management (FM) is "a complex concept that can be studied from different perspectives" (Kok et al. 2011, 251). There are several definitions of added value of FM. Jensen et al. (2008, 41) defines added value of FM as improvements with regard to "Effectiveness and productivity, facilities and workplace, customers and end-users, management in general, local area and region, staff, environment and sustainability, risk and continuity, cooperation among companies, services, and economy and costs". This definition which is a mixture of causes and effects became the foundation for Jensen et al.'s (2008) "Facilities Management Value Map" (Value Map), which in turn is based on Kaplan and Norton's (1996) "Balanced Scorecard". Kok et al. (2011, 253) defines added value of FM as "the customer perceived contribution of the different facility services to the organisation in terms of benefits in comparison to costs and risks".

FM can provide added value to organisations at least in two ways. The first is through cost reductions. Reduced costs will all other things equal improve an organisation's economic bottom line. However, the second kind of added value of FM is usually far more interesting, and that is through value creation; i.e. improvements of an organisation's processes and core

business. The effect of value creation is usually of a significantly larger order of magnitude than plain cost reductions. But value creation is often far more difficult to detect, quantify and measure than cost reductions, because value creation is not always immediately noticeable and often far more subtle than cost reductions. There are also often significant lag between implementation of measures to facilitate added value of FM and noticeable and measureable effects of these measures. Measures to facilitate added value of FM are more often long term investments than quick fixes.

Jensen et al.'s (2012a) anthology *The Added Value of Facilities Management – Concepts, Findings and Perspectives* provides a state of the art concerning research about added value of FM. Jensen et al. (2012b, 71) conclude that "FM value research needs both qualitative and quantitative research methods", hereunder "multi-item scales and structural equation modelling (SEM)". Use of quantitative research methods such as SEM is well established practice in Business to Business (B2B) marketing and in Corporate Real Estate Management (CREM). The editors of Jensen et al. (2012a) advocate that research about added value of FM can be understood as a multidisciplinary and in some instances even interdisciplinary research arena.

One of the challenges in multidisciplinary or interdisciplinary research is the lack of common methodology, common concepts and a common analytical language. The absence of common methodology, concepts and language also complicate development of general theories about which measures that actually facilitate added value of FM.

Much of the research about added value of FM is based on Jensen et al.'s (2008) "Value Map", Porter's (1985) "Value Chain" theory or combinations thereof. This research is often more exploratory and descriptive than aiming for development of general theories or explanations about how to facilitate added value of FM (See for instance Jensen et al. 2008; 2012a; Jensen 2011; Jensen and Nielsen 2012). Some of the current research about added value of FM is based on small N case studies that provide details and insight about the individual cases and their context. But small N case studies do not always facilitate identification of common factors that explain added value of Facilities Management that hold across time, space and contexts. Neither are small N case studies always able to distinguish between anecdotic and tenable evidence. There are examples of what Lieberson (1992) describes as "Small N's and big conclusions", or even inconclusive studies.

This conceptual paper is based on a literature study, and addresses some fundamentals and methodological questions. How to establish research designs and studies that facilitate development of general explanations about which measures that facilitate added value of FM, and provide valid results that hold across time, space and contexts? The aim is to initiate development of a comparative research program about added value of FM in different countries, sectors and industries to produce valid research results and general theories that hold across time, space and contexts.

The structure in this paper is first a brief discussion about some foundations and fundamentals concerning research about added value of FM. The entailing chapter discusses statistical inference, and the chapter thereafter discusses use of formal models. The entailing chapter discuss use of multi-level analysis (MLA) which provides some very interesting opportunities for comparative studies about added value of FM. The chapter before the conclusion discusses so-called New Statistics which also provide a very useful toolbox for studies of added value of FM. The final chapter presents a summary and some conclusions.

2 A BRIEF DISCUSSION OF SOME FOUNDATIONS AND FUNDAMENTALS

A traditional understanding of scientific work is development of theories (hypotheses), stating the reasons for these, and testing the theories. Davidsson (2005, 35) claims that a theory at least has to meet two requirements, and ideally also a third requirement. The first requirement is "A set of well-defined abstract concepts". The second requirement is "A set of well-specified relationships among those concepts". The third requirement is "A *deeper* understanding of why those relationships exist, and what they imply". This deeper understanding is often the result of years of scientific studies of the research area in question, such as added value of FM.

How to translate theoretical (and often non-observable) concepts to empirical and observable phenomenon? This is the so-called "measurement problem". Mathematical methods and reasoning, such as for instance use of SEM, can be useful both for clarifying and elaborating theoretical reasoning, to specify the relations between theoretical concepts and empirical phenomenon, and to analyse the measurement problem (Hovi and Rasch 1996, 92).

Another key issue in scientific studies, no matter the researcher's preferences for research method, is the question about validity. "A valid study is one that has properly collected and interpreted its data, so the conclusions accurately reflect and represent the real world (or laboratory) that was studied" (Yin 2011, 78). Studies that provide false findings or wrong conclusions are of limited use. One of the challenges the researcher or team of researchers always have to struggle with is thus how to develop research designs and models that produce valid results. This is not a trivial issue, because added value of FM is "a complex concept" according to Kok et al. (2011, 251).

One of the most important issues for researchers striving for producing valid studies and research results is how to think about the research problem and ask the right analytical and statistical questions. The variables' causal order; i.e. defining what is cause (independent variable(s)) and what is effect (dependent variable) in studies of the relations between two or more variables is paramount (Davis 1985). This is particularly the case for non-experimental research, and most studies of added value of FM are based on non-experimental research. This brings us to a somewhat paradoxical situation: "Although assumptions about causal order are vital for nonexperimental research, they can seldom be checked nonexperimentally" (Davis 1985, 9).

The researcher or team of researchers collect data that show which values the units have on their relevant variables. A unit is the object or phenomenon under study. A unit can thus be an organisation, an individual, a project, a document, a laboratory experiment, a work process, etc. A variable is a property (question, state, condition, etc.) where the units may have different characteristics or values (Hellevik 1988, 1).

A correct understanding of the events' temporal order or chronology is necessary to distinguish causes from effects, because causes with logical necessity have to take place prior to effects. "Chronologies" can therefore be useful for development of correct causal explanations (cf. Yin 1994:106 ff.). However, the researcher also has to be aware of the asymmetry between causes and correlation. All causes require correlation, but correlation is not necessarily causation. A statistical relation does thus not logically imply a causal relation (cf. Gujarati 1995, 21). A statistical relation can be spurious, and spurious relations may lead the researcher astray. Spurious relations are caused by prior variables not included in the model. These prior variables have causal paths to the independent and dependent variables (Davis 1985, 27).

Qualitative data is very often analysed through identification of patterns of variation between the units. This approach is what Yin (1994, 106 ff.) denotes as development of explanations through a "pattern-matching logic". Qualitative data is often transformed or translated to

quantitative data, for instance to facilitate statistical analysis of data from many respondents who have answered a large number of questions. Such translation of qualitative to quantitative data is very common when the respondents are asked about their attitudes or beliefs.

To facilitate analysis of the relations between the units and their variables, the data is very often organised in a data matrix. Each column in the data matrix contains the data about a particular variable. Each line in the data matrix similarly contains data from a particular unit in the study. The data about variable$_i$ from unit$_j$ is thus found in cell$_{i, j}$ in the data matrix (Hellevik 1988, 1-2).

3 STATISTICAL INFERENCE

If we study the entire population of organizations that have organized their FM functions in a particular way, then we don't need any statistical interference. This is because any relationship or difference, no matter how small, is "true" and does exist (cf. Hair et al. 1998, 10). However, in most instances we only have the opportunity to examine a sample of a population. The reasons for only being able to examine a sample from a population may be several, such as for instance time or resource constraints, or organisations or individuals that refuse to participate in scientific studies. In such situations the researchers have to draw interferences from a sample. This sample can either be random on non-random.

Randomized controlled trials (RCT) with randomized assigned experiment (treatment) and control groups (non-treatment) are often considered the "gold standard" for research (Yin 2011, 287-289). RCT is for instance standard operating procedure in clinical trials in healthcare. However, experimental designs are not always possible when studying added value of FM. In studies of added value of FM and most other empirical studies that take place in a work life or business context, the researchers have to study those organisations or individuals that are willing and able to participate (self-selection). Such samples clearly represent a risk for bias compared to studies based on RCT designs.

Most multivariate techniques are based on statistical interference of a population's values or relationships among variables from a random sample of the population. The population may for instance be each organization in a defined geographical area, or in private, public or non-profit sector that have organised their FM functions in a particular way.

Before drawing statistical interferences the researcher has to specify the acceptable levels of statistical errors. The researcher usually starts with specifying the level of the so-called **Type I error** or **α**, the probability for rejecting the null hypothesis (H$_0$) when H$_0$ is true. The Type I error or α is thus the risk for a so-called "false positive"; i.e. establishing a statistical significant relation when there is no such relation present. When the researcher has decided the level of Type I error, the researcher also has decided the level of so-called **Type II error** or **β**, the probability for rejecting H$_0$ when it actually is false (false negative). **Power** or **1 - β** is another very interesting statistical measure. Power is defined as the probability of correctly rejecting H$_0$ when it should be rejected (Hair et al. 1998, 11). Power is thus the probability that statistical significance will be indicated if the hypothesised relationship exists.

Table 1: The relationship between the different error probabilities

	Reality	
	H₀: No difference	Hₐ: Difference
H₀: No difference	$1 - \alpha$	Type II error (False negative) β
Hₐ: Difference	Type I error (False positive) α	$1 - \beta$

Statistical decision

Source: Hair et al. (1998, 11)

There is an inverse relation between Type I and Type II errors. This means that if the Type I error or α decreases (move closer to 0), then the Type II error increases, and vice versa. Reducing the Type I error or α thus also reduces the power of the statistical test. The researcher's challenge is thus to find an appropriate balance between α (Type I error) and power (1-Type II error or $1-\beta$) (Hair et al. 1998, 11). Use of statistical inference provides exact measures of the findings' strength or weaknesses. Small N case studies of added value of FM do not provide a similar apparatus.

4   FORMAL MODELS

Formal models are based on explicitly stated assumptions, and use of mathematical or graphical representations (cf. Hovi and Rasch 1996). But why bother with formal models and deductive research strategies? The main reason is the ambition to develop results or theories that can be generalised across time, space and contexts. The idea about generalisation is based on the assumption that somewhat different phenomenon can have a common core (cf. Hovi and Rasch 1996, 93-94). One such common core can be the idea that some measures or activities, such as particular ways of organising provision of the services, particular types of contracts or particular technologies or combinations thereof facilitate added value of FM across time, space and context.

Most methods for multivariate analyses require that the researcher develop formal models that distinguish between hypothesised causes and effects. The phenomenon the researcher would like to explain is located on the effect side of the model (dependent variable). The causes the researcher assumes can explain the variations in the dependent variable are placed on the cause side of the model (independent variables) (Hair et al. 1998, 2).

Development of formal models is based on two principles. The first is "skinny" modelling. The researchers start with a vague hypothesis, and develop a very simple but satisfactory model, which further hypothesis can be derived from, through empirical testing (Hovi and Rasch 1996, 94). In other words, there is interplay between empirical observations and theory development. The researchers derive theories from empirical observations and other studies. These new theories are tested against the empirical observations, and so forth. The second principle is parsimony or research economy; i.e. to develop as simple models as possible, in order to maximise the analytical leverage given the hypothesis and available data, and to work incrementally towards more complex models (Hovi and Rasch 1996, 95). One important analytical implication of working from very simple to more complex formal models is that the researchers learn through incremental introduction of more complex assumptions.

So, what are the pros and cons concerning use of formal models in studies of added value of FM? Table 2 provides an overview of some pros and cons.

Table 2: Pros and cons concerning use of formal models in studies of added value of FM

Pros	Cons
- Logical consistency - Cumulative research - Transparency - Clean and simple models - Demarcation of the model's field of application - Compact and condensed presentations - Interdisciplinary cooperation	- Requires skills in mathematics - The real world is usually complex and messy - Often competing explanation factors - Mathematical style and elegance may displace substantial interpretations of the model's implications

Source: Hovi and Rasch (1996, 96-102)

The formal models should be means and vehicles for the thought, not objectives or goals themselves. The researchers should also be aware that formal models in some instances may provide "paradoxical" or "counter-intuitive understandings" (Hovi and Rasch 1996, 101). Such results can be a consequence of a faulty model, but may also represent genuine new knowledge. One example of such counter-intuitive results is Olson's (1965/1971) discovery of actions that are individually rational may produce outcomes that are irrational at the collective level. Finally, there are instances where it is very difficult to find substantial interpretations of the results that "make sense". The researchers should never stop asking about "meaningful substantial interpretations" of the results (Hovi and Rasch 1996, 101-102). The conclusion is that use of formal models provides several advantages for those who would like to carry out systematic studies of means that may facilitate added value of FM. Use of formal analytical models can also facilitate multidisciplinary and interdisciplinary research of added value of FM because the different academic disciplines involved get a common analytical apparatus and language.

5   MULTI-LEVEL ANALYSIS

MLA is frequently used in the behavioural sciences, health sciences and science of education, because MLA makes it possible to isolate and study the effects of stimuli or other means on different groups in different contexts. MLA can also handle nested data. MLA is thus a tenable workaround for the ecological fallacy, where relationships observed in groups are assumed to hold for individuals (Snijders and Bosker 1999; Luke 2004).

MLA provides analysis of intercept and slope for each unit at the different levels of analysis. A 3-level analysis of added value of FM can for instance provide measurements of individual productivity at level 1, the various departments' productivity at level 2 and organisational productivity at level 3 (Luke 2004, 12 Figure 2.1; Heck et al. 2010, 5 Figure 1.1).

MLA also facilitate many other interesting research opportunities for those studying added value of FM, such as comparative studies of the effect of different kinds of organisation of the FM service production (in house vs. outsourcing), similar measures in different sectors (private, public and non-profit sector), in different industries, in different countries, for

different services, and last but not least the effects of the workers' background, such as education level, age, experience, ethnicity, etc. Use of MLA thus facilitates isolation of the effects of particular measures in particular contexts, such as organisation, the workers' education level, etc. Use of MLA in comparative studies of added value of FM can therefore be a strong supplement to research based on small N case studies.

6 "NEW STATISTICS" AND ANALYSES OF POWER AND EFFECT SIZES

Statistics has traditionally been about null hypothesis significance testing (NHST). So-called "New Statistics" emphasise power, effect sizes, confidence intervals and meta-analysis rather than NHST (Cumming 2012). Measures of effect size include raw or standardised mean or median differences, percentage, frequency, various measures of correlation, proportion of variance, risk and relative risk (Cumming 2012, 38-40).

Power analysis provide answers to questions such as "how much statistical power does my study have" and "how big a sample size do I need". There are four main parameters in power analysis, namely effect size, sample size, α and power $(1 - \beta)$. The effect size is a measure of the degree to which the phenomenon in question is present in the population, and is thus a measure of to which degree H_0 is false. The amount of sampling error is dependent of the sample size or number of observations (N). α defines the risk for committing a Type I error; i.e. incorrectly rejecting H_0. α is normally defined to be 0.05 or smaller. The tests are assumed to be non-directional or two-tailed. Statistical power refers to β, the test's Type II error rate, the risk for false negative; i.e. not detecting an effect which is present. If the acceptable β-level is 0.2, then the power $(1- \beta)$ is 0.8 (Ellis 2010, 54, 56).

Table 3: Four outcomes of a statistical test

		What is true in the real world?	
		There is no effect H_0: True	There is an effect H_0: False
What is the researcher's conclusion?	No effect (Effect size = 0)	Correct conclusion (Power = $1 - \alpha$)	Type II error (Power = β)
	There is an effect (Effect size $\neq$ 0)	Type I error (Power = α)	Correct conclusion (Power = $1 - \beta$)

Source: Ellis (2010, 55 Figure 3.2)

Power is also a function of so-called "effect size", which is "an estimate of the degree to which the phenomenon being studied (e.g., correlation or difference in means) exists in the population" (Hair et al. 1998, 2). The α-level or risk for Type I error is usually (by convention) defined to be 0.05 or 0.01. Given the α-level and all other things equal, increased sample size always provides greater power in statistical tests. But increasing the sample size can also produce "too much" power. A side effect of increasing the sample size is that smaller and smaller effects become statistically significant. Almost any effect is statistically significant in very large samples (Hair et al. 1998, 11-12). Cohen recommends a four-to-one weighing between β and α risk (Ellis 2012, 54). The power of any statistical is thus a function of α, sample size and effect size. The power is low if the effect in question is low, if the

sample size is small and α is low. The power is similarly high if the effects in question are large; the samples are large and α are large (Ellis 2010, 55).

Cohen (1988 in Ellis 2010, 41) has established a classification of small, medium and large effect sizes. These effect size benchmarks are shown in Table 4:

Table 4: Cohen's effect size benchmarks

Test	Relevant effect size	Effect size classes		
		Small	Medium	Large
Comparison of independent means	d, Δ, Hedge's g	.20	.50	.80
Comparison of two correlations	q	.10	.30	.50
Difference between proportions	Cohen's g	.05	.15	.25
Correlation	r	.10	.30	.50
	r^2	.01	.09	.25
Cross tabulation	w, ϕ, V, C	.10	.30	.50
ANOVA	f	.10	.25	.40
	η^2	.01	.06	.14
Multiple regression	R^2	.02	.13	.26
	f^2	.02	.15	.35

Source: Cohen (1988 in Ellis 2010, 41 Table 2.1)

Cohen's benchmarks for effect size provide a good starting point for discussions about the strength and quality of research results, even if some scientists oppose the use of "T-shirt sizes" or the "small, medium and large" approach (Ellis 2010, 41-42). But the measured effect size provides a good indication of different means and measures' effect on added value of FM.

Meta-analysis; i.e. combining evidence from several studies, is an analytical method that can provide strong evidence even in situations with seemingly weak evidence in the individual studies. Meta-analysis can in some instances provide strong conclusions even in situations where there are no large scale RCTs (Cumming 2012, 3, 181 ff.; Ellis 2010, 89 ff.). Meta-analysis is thus a method that can be utilized for development of general explanations about added value of FM across time, space and contexts, through identification of common explanation factors in completed studies of added value of FM taking these studies' sample size, effect size and power into consideration. Meta-analysis can thus distinguish between anecdotic and tenable evidence concerning whether and how various means actually facilitate added value of FM.

7   CONCLUSION

This conceptual paper is based on a literature study, and has addressed some fundamentals and methodological questions. How to establish research designs and studies that facilitate development of general theories about added value of FM, and provide valid results that hold across time, space and contexts? The aim is to initiate a comparative research program about which measures that facilitate added value of FM that hold across time, space and contexts.

One of the researcher's challenges is to establish research designs and studies that provide valid research results about added value of FM. This is not trivial, because what is added value of FM is not a straightforward question. There are also often significant lag between implementation of measures to facilitate added value of FM and noticeable and measureable effects of these measures. Much of the current research about added value of FM is based on small N case studies. Small N case studies do usually not facilitate development of general theories that hold across time, space and contexts.

One measure for producing general explanations about added value of FM is use of statistical inference and formal analytical models. Statistical inference provides exact measures of the findings' strength or weaknesses. Small N case studies do not provide such measures. Formal analytical models also provide a common analytical apparatus and language that facilitate multidisciplinary and interdisciplinary studies of added value of FM.

Use of MLA is a very interesting approach for comparative studies of added value of FM in different countries and across sectors and industries, because MLA provides analysis of intercept and slope for each unit at the different levels of analysis. Use of MLA can therefore provide new insights about which measures that actually facilitate added value of FM in various contexts.

Statisticians have traditionally been concerned with null hypothesis significance testing (NHST). So-called New Statistics is far more concerned with power, effect sized and meta-analyses than NHST. The effect size provides a good indication of different means and measures' effect on added value of FM. Meta-analysis; i.e. combining evidence from completed studies, is a very powerful analytical method that can distinguish between anecdotic and tenable evidence.

This paper has thus demonstrated that comparative studies based on formal models and statistical methods can bring research about added value of FM several steps forwards, compared to the traditional approach based on exploratory and in some instances descriptive small N case studies. Research based on small N case studies is not always able to distinguish between anecdotic and tenable evidence. Neither does such research necessarily facilitate development of general theories about measures that facilitate added value of FM in various contexts.

ACKNOWLEDGMENTS

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Improving the Validity of Facility Management Research by Use of Interrater Agreement

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ABSTRACT

In research methodology, epistemology is concerned with the question how humans generate knowledge. In facility management (FM) research, for instance, it deals with the evaluation criteria such as validity and reliability by which researchers discriminate good knowledge from bad. The objective of this paper is to add to the scholarly methodological aspects in FM research. The paper takes a postpositivist stance and pre-supposes that scholars are able to discover what happens in FM through the categorization and scientific measurement of affective responses. It applies a method by which scholars are able to develop good knowledge and by which talented bachelor students are involved in FM research.

In this study 26 semi-structured interviews were conducted at nine different organizations in the Netherlands. Interviews, which focused on office environments and productivity, were conducted in pairs by Honours students. This paper reports on methodological issues of this study. Data collection and analysis by different researchers revealed serious threats to validity and reliability. Consequently an interrater agreement (IRA), measuring the degree of agreement between raters, was introduced to reveal and overcome differences in interpretations.

In this paper the difficulties of achieving good agreement were considered. Adjustment between raters and clear demarcation of constructs are necessary. A synopsis of usage and reporting of qualitative interview approaches is shown.

Qualitative research is a rich information source and adds to the existing body of knowledge in FM and adjacent areas, but only when applied properly. While clinical studies report extensively about IRA, FM lacks this habit. IRA is a good approach to improve validity when two or more researchers are involved in the data analysis. Moreover, it advances involvement of talented students in FM research.

Keywords

Facility Management, Interrater Agreement, Qualitative Research, Researcher Triangulation, Semi-structured Interviews

1   INTRODUCTION

A synopsis of 43 empirical studies on work environment and productivity showed nine studies using interview techniques, one experiment, one quasi-experiment, two observational studies, five case studies, and 25 studies using questionnaires (table 1). In six of the nine studies with interviews the analysis method was not specified. Two studies reported the qualitative analysis method. Two multiple method studies reported coding by a single rater, a mono method study reported coding in pairs and reports agreement, but lacked to report the method of agreement.

Table 1. Synopsis of Research Methods in FM Empirical Studies
on Work Environment and Productivity

Method(s)	Qty. *	Specification
Semi-structured interviews	1	N = 46, coding in pairs, qualitative data analysis, agreement > 98%
Observations and Heuristic Elicitation Method (HEM)	1	N = 89, coding by single rater, qualitative and quantitative data analysis
Quasi-experiment, including semi structured interviews and questionnaire	1	N = 249, coding by single rater
Explorative interviews before questionnaire	2	Interview analysis method not specified
Miscellaneous: cases study, multiple method, including interviews	4	Interview analysis method not specified
Experiment	1	-
Observations	2	-
Case study	4	Multiple method, no interviews
Questionnaires	25	Mono method
Not specified	6	-

*   Number of studies. Numbers do not add up. Full synopsis available from authors on request.

Qualitative research, e.g. by use of interviews as a data collection method, supplies rich information (Berg, 2009). Interviewers and interviewees are no *'faceless respondents'*, but living beings who can learn from each other (Fontana & Frey, 1994, pp. 373-374). This study employs 26 semi-structured interviews to collect data. The purpose of the study is to investigate the relation between the physical environment and employee productivity, and to what extent the possibilities for communication and concentration work mediate this effect. The method of data collection and analysis of the study will be described and discussed in this paper. The purpose of this paper is to add to the scholarly methodological aspects in facility management (FM) research.

2   THEORY INTERRATER AGREEMENT

Since intersubjective reality is postulated, two heads are better than one. Use of two raters reduces researcher bias and increases the reliability of findings (Gwet, 2008; Kratochwill & Wetzel, 1977). An agreement coefficient is established by calculating an interrater agreement (IRA). An IRA is an estimation of the degree of agreement between raters (LeBreton & Senter, 2008). The higher the IRA, the less ambiguous the interpretation of the findings. There are several ways to calculate an IRA. It is particularly important to understand what

causes the size of the value (LeBreton & Senter, 2008). In this current study three different kinds of IRA are used as indication of agreement: p_0, IRA_{NVivo} en Cohen's kappa. p_0 and Cohen's kappa were chosen because both are universally known and relatively easy to calculate (Uebersax, 1987). IRA_{NVivo} is the method used by NVivo (NVivo, 2011) and, although not universally known, it is also easy to calculate. Since all three indices are easy to use it was decided that they can be useful and relevant for FM. Differences between the methods are the proportion and chance taken into account. The method of calculation of p_0, IRA_{NVivo} and Cohen's kappa will be explained next. In this paper all three indices will be reported, because it contributes to a better assessment and provides a broader image of the size of the agreement.

The first method is the most elementary. It is called p_0 and is the sum of the proportion, on which the raters agree upon, related to the total proportion that has been coded (Cohen, 1960):

$$p_0 = \frac{p_1}{p_1 + p_2} \tag{1}$$

where p_0 is the proportion of agreement, p_1 is the proportion coded by both raters and p_2 is the proportion coded by one of both raters. Secondly, NVivo (2011) applies another calculation method, which takes into account, besides the degree of agreement, the total length of the source[23] and the degree of disagreement:

$$IRA_{NVivo} = \frac{N_1 + N_3}{N_1 + N_2 + N_3} \times 100\% \qquad (= \frac{N_{totaal} - N_2}{N_{totaal}} \times 100\%) \tag{2}$$

where N_1 is the number of characters coded by both raters, N_2 is the number of characters coded by only one rater and N_3 is the number of characters not coded by either rater. In this study, the third IRA is Cohen's kappa. Cohen's kappa is the coefficient which in general is considered as the statistical choice for measuring agreement of nominal data (Uebersax, 1987). Kappa takes into account the probability that agreement is coincidental. The formula for Cohen's kappa is:

$$\kappa = \frac{p_0 - p_c}{1 - p_c} \tag{3}$$

where p_0 is the proportion of units in which raters agree and p_c is the proportion of units for which agreement is expected by chance[24].

3   METHOD

Postpositivism relies on multiple methods and traditional evaluation criteria (Denzin & Lincoln, 2011). One such evaluation criterium is validity. This validity increases by using triangulation. Triangulation is the rationale for using multiple sources of evidence (Yin, 2008), it originates from the navigation. Triangulation of data collection and analysis

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[23] 'Source' in NVivo (2012), in this case a source is an interview

[24] The joint probabilities of the marginal proportions (see Cohen, 1960, pp. 37-40)

materializes a postpositivistic approach (Miles & Huberman, 1994). Denzin (1970) identifies four types of triangulation: (1) data, (2) investigator, (3) theory and (4) methodological triangulation. The semi-structured interviews in the study have been triangulated using two different kinds of investigator or researcher triangulation (see figure 1, a vessel as metaphor).

Figure 1. Visualization of triangulation
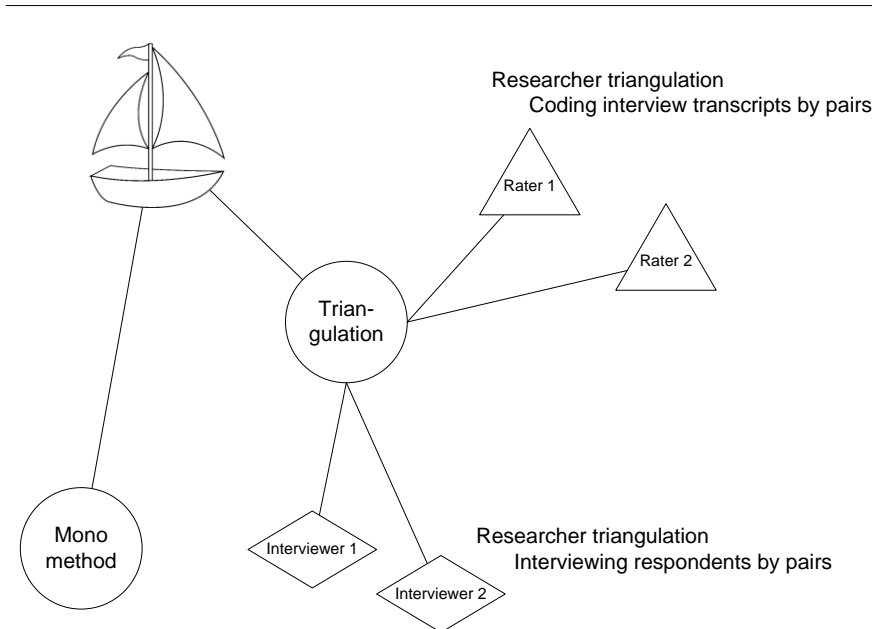
Note: raters and interviewers are members of a pool of researchers consisting of a Master student and and three Bachelor Honours students.

Firstly, researcher triangulation is being used by interviewing respondents by several different pairs of a dedicated pool of four researchers. The pool consists of three Honours students of a Bachelor FM study, and a Master student. During the study, close alignment and feedback between pool members was accomplished. Beforehand, the Honours students were trained in interview techniques. Conducting interviews in pairs reduces researcher effects (Miles & Huberman, 1994). Secondly, researcher triangulation was applied by carrying out data analysis by several different raters: text fragments of the transcripts were coded by members of the pool of researchers and by two other researchers.

The study was deployed in three stages: a pre-test and two main studies. All 26 interviews of the separate studies could be included in the results. The sample of the study consisted of five government institutions and four companies, all situated in the north of the Netherlands. The response rate was 69 percent. Respondents were managers, knowledge workers and administrative workers in traditional and in innovative office environments. Interviews were conducted according to an interview guideline. The guideline has been tested in a pre-test and in study 1 and minor technical adjustments were made between the stages. The interviews were transcribed verbatim and analysed with the Computer Aided Qualitative Data Analysis System (CAQDAS) of NVivo, version 10 (NVivo, 2012).

The unit of analysis of this study consists of five constructs. The five constructs are: work environment, possibilities for communication and to concentrate on work, job satisfaction, productivity and other factors. In the computer aided qualitative data analysis of this study, a coding scheme was applied. The coding scheme of the study consists of the aforementioned

constructs a.k.a. nodes, and relationships between nodes. With the assistance of the CAQDAS, nodes or relationships between nodes were allocated to fragments of the transcripts. Kappa was calculated for each node and each relationship separately. The reported kappa is the average value of the kappas of all nodes and relationships. In this current study, in using the same data set the outcome of the three IRA indices, p_0, IRA_{NVivo} and Cohen's kappa, was compared.

4   RESULTS

The researcher triangulation was conducted during data collection and data analysis.

4. 1.   Researcher triangulation during data collection

The triangulation during data collection entailed interviewing by different pairs of researchers. Interview roles were divided between the two as follows: one interviewer followed the guideline questions, the other interviewer focused on probing questions.

Analysis of the interview transcripts revealed use of interview techniques by the interviewers. The next excerpt of the interview below is an example of summarization and use of a probing question:

Interviewer 1: 'So, you are dissatisfied, is that correct?	< *summarization*
Interviewee: 'No, dissatisfied is too clear-cut, but if I would design [the office] again, I would opt for a different structure. I would opt for an open office [..]'	
Interviewer 2: 'But what would be your most important reason for it, to do so.'	< *probing question 2nd interviewer*
Interviewee: 'Well, I think you, you'll promote interaction. And dynamics also. And you'll encourage people to talk to each other.' (transcript 17)	

Another example is the use of several interviewing techniques by the two interviewers: probing questions in combination with rapport and affective summarization:

Interviewee: 'I tried to work at home, but it did not work out.'	
Interviewer 1: 'No?'	< *probing question*
Interviewee: 'No.'	
Interviewer 2: 'Why not?'	< *probing question 2nd interviewer*
Interviewee: 'I need structure and an organized space, which means that I have to get the whole house in order first.'	
Interviewer 2: 'Very recognisable!'	< *rapport*
Interviewer 1: 'Yes.'	< *confirmation by other interviewer*
Interviewee: 'My house will be clean and tidy at three o'clock in the afternoon. And then the day is over.'	

Interviewer 1: '[..] halfway through the day you think: 'Oops!'   *< affective*
                                                                summarization

Interviewee: 'Yes.' [..] (transcript 25)

4.2.   Researcher triangulation during data analysis

The triangulation during data analysis comprised inductive coding in pairs. Coding based on a coding scheme was performed by raters, separately from one another, by using a CAQDAS. The coding scheme of study 1 consisted of 64 nodes i.e. constructs. Transcripts were fragmented by each rater, during the coding process. IRA in study 1 is diverging: kappa is fair to good, IRA_{NVivo} shows disagreement and p_0 shows lack of agreement (see figure 2).

At the beginning of study 2, a restructured coding scheme was used, composed of five constructs and thirteen relationships between the constructs. Transcripts were fragmented in advance. The aim of our study was to investigate the IRA during data analysis. Measurement of the IRA however, showed that there was weak agreement or no agreement at all between the ratings. Close scrutiny reveals three reasons, viz. insufficient demarcation of nodes, differences in interpretation and errors. The results can best be illustrated by two examples from an interview. The most important and most frequent reason of disagreement is lack of demarcation between constructs and relationships:

> You've got a kind of garden. Which has some practical advantages, that is, we keep each other informed if something happens. Hey, you know, you hear something somewhere of, well, wait a minute: 'It should be like this.' (transcript 11)

One rater assesses this quote as facilitation of communication, the other rater as the relationship of facilitation of communication and productivity. The first nor the second assessment is right or wrong in inductive coding, this must be determined in a tuning process. The second reason is difference in interpretation, e.g.:

> Interviewer: 'To which extend decreases it?'
> Interviewee: 'Annoyance is going to dominate. So, not the content of your work, the annoyance factor.' (transcript 11)

A rater assesses this dialogue as dissatisfaction with the workplace, another rater as unproductiveness of the workplace. Correct interpretation remains ambiguous and was assessed for final determination.

In the subsequent stage of study 2, the assessment of the research framework is solely confined to the relationships between the three constructs work environment, ability for communication or concentrate on work, and productivity. Taking into account the chance to choose one of the three labels by coincidence, IRA is good and almost excellent, kappa = 0.74. Taking into account the length of the transcripts, IRA is very strong, with IRA_{NVivo} = 0.97. And finally, without taking into account the length of the transcripts and chance, IRA is moderate, p_0 = 0.59. This latter IRA is calculated based on the number of characters of the transcripts. The calculation shows agreement on 54,000 characters and disagreement on 38,000 characters. In this stage, reduction is key, yet attention must be paid to oversimplification.

Figure 2. Interrater agreement
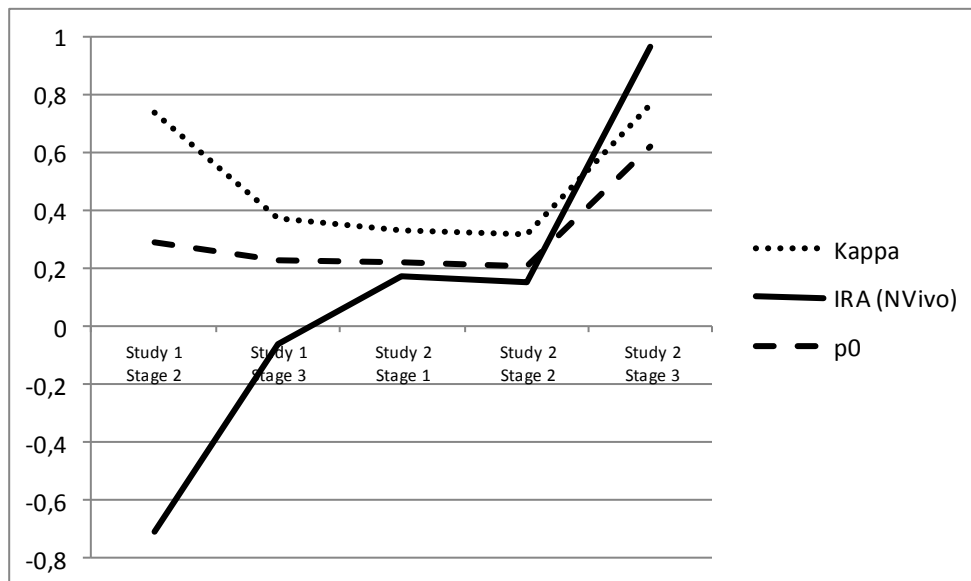
For figures: see Appendix 1, Interrater Agreement

4.3 Honours students

Honours students value a learning context that supports relatedness, autonomy and enlargement of competences (Wolfensberger & Offringa, 2013). These three values have been incorporated in the course of action of the dedicated pool of researchers. At the end of the study, the contribution of the Honours students has been evaluated using a structured evaluation method combined with a group interview. Firstly, in terms of relatedness, although evidence is circumstantial, the students mentioned company visits and relationships in the industry to be valuable, and acquisition of interviewing and people skills to be valuable as well. Secondly, with regard to autonomy, the Honours assignment to participate in the pool was voluntary, and a large part of the data was collected by the students autonomously. Thirdly, as regards to competences, during the research, learning effects[25] were acquired by conducting interviews and analysing of data, e.g. illustrated by two remarks of the last interviewee: '*You are good to talk to.*' and: '*...also how you support each other.*' (transcript 26)

5. CONCLUSION

The main findings of this paper are that researcher triangulation improves data quality. Furthermore, triangulation by assessment of data by several different raters results in fair to good agreement. Also, close involvement of Honours students in research has positive circumstantial effects.

The agreement between raters differs in the subsequent stages. In study 1 the difference is the largest, because fine tuning and alignment were not yet in place. The first and second stage of study 2 were consistent, but did not show improvement. Inasmuch coding was still too complicated and ambiguous for rating by more than one rater. After all, in the last stage all three IRA's arrive at an acceptable level. It is an indication of more conclusive interpretation of the empirical data.

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[25] For learning effects, see also paragraph 4.1, Researcher triangulation during data collection.

Wider dissemination of qualitative research methods and tools will enrich FM research. Notably, the rigor application of contemporary techniques in combination with postpositivistic evaluation criteria will contribute to the enhancement of FM in particular and research in general.

6   DISCUSSION

> In many cases, a researcher is more likely to falsely find evidence
> that an effect exists than to correctly find evidence that it does not.
> (Simmons, Nelson, & Simonsohn, 2011)

Although Simmons et al. (2011) refer to quantitative research; biases lurk in both quantitative and qualitative research. Self-reports, such as interviews and surveys, are an important method of data collection in management research (Podsakoff & Organ, 1986). A multiple method approach is suggested to avoid problems (Denzin & Lincoln, 2011; Podsakoff & Organ, 1986). One challenge is to achieve high construct validity. Construct validity is to investigate what you claim to investigate (Gibbert & Ruigrok, 2010). Researcher triangulation by use of pairs of interviewers, combined with a sample of several organizations, functions and office environments, resulted in high degree of construct validity. Withal, during data analysis of the study in hand, the other challenge is to improve internal validity, i.e. conclusions may be inferred from the results (Gibbert & Ruigrok, id.). At first, only kappa is high, due to the amount of nodes, but the other indices show disagreement. IRA improves by fragmentation and reduction of nodes, a fortiori, structured use of researcher triangulation will provide high internal validity.

Büssing and Bissels (1998) utilize two raters and have reported more than 98 percent agreement; however, they mention neither method nor calculation. Notwithstanding the bumpy road, the coding process described in this paper has ultimately led to the strengthening of the validity of the data and data analysis. FM research may benefit from wider use of semi-structured interviews to gather rich information and test propositions (Miles & Huberman, 1994).

Altogether, can one conduct a mono method study with semi-structured interviews and end with a plea for multiple method research? Of course data convergence is preferred (Denzin, 1970; Yin, 2008), but rigor triangulation which fits in the Honours Program and the research agenda of your institute, can be just as satisfactory.

It was found that the effect of the work environment on ability to communicate and concentrate on work was strong (Lechner & Mobach, in prep.). The direct effect of the work environment on productivity was weak, as well as the mediating effect of the ability to communicate and concentrate on work. However, all effects are more distinct in innovative offices, in comparison to traditional offices. Management attention is advised to an integral approach to office innovation and the ability to concentrate at work. Concluding we advise that future qualitative research in this area should always be conducted by a team of researchers, who perform the interviews and the analysis of data in pairs in order to achieve an as high as possible construct and internal validity of the results.

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APPENDIX 1
INTERRATER AGREEMENT

Study	Stage	Number of interviews	Kappa [1] Value	Interpretation	IRA [2] Value	Interpretation	p_0 [2] Value	Interpretation
Study 1			Coding scheme, 64 nodes, unfragmented [3]					
	1	1	Not applicable, try out coding scheme					
	2	2	0.74	Fair to good	-0.71	Disagreement	0.29	Lack
	3	3	0.37	Poor	-0.06	Disagreement	0.23	Lack
Study 2			Restructured coding scheme based on 5 nodes and 8 relationships, fragmented [3]					
	1	1	0.33	Poor	0.17	Lack	0.22	Lack
	2	4	0.32	Poor	0.15	Lack	0.21	Lack
			Coding scheme based on 3 relationships, fragmented [4]					
	3	26	0.74	Good	0.97	Very strong	0.59	Moderate
			0.79	Excellent	0.97	Very strong	0.66	Moderate

(1) Substantive interpretation Kappa (NVivo, 2011)

< 0.4	Poor agreement
0.4 – 0.75	Fair to good agreement
> 0.75	Excellent agreement

(2) Substantive interpretation IRA en p_0 (LeBreton & Senter, 2008)

0.00 – 0.30	Lack of agreement
0.31 – 0.50	Weak agreement
0.51 – 0.70	Moderate agreement
0.71 – 0.90	Strong agreement
0.91 – 1.00	Very strong agreement

(3) Pairs of the pool of researchers

(4) Pair of students Honours program (1st row) and pair of experts (2nd row)

APPENDIX 2

SYNOPSIS OF RESEARCH METHODS IN FM EMPIRICAL STUDIES ON WORK ENVIRONMENT AND PRODUCTIVITY

author(s)	method(s)	interviews
Batenburg & Van der Voordt, 2008	questionnaire	no
Black & Lynch, 2001	questionnaire	no
Blok, De Korte, Groenesteijn, Formanoy, & Vink, 2009	questionnaire, observations	no
Blok, Groenesteijn, Schelvis, & Vink, 2012	questionnaire	no
Bordass, Cohen, Standeven, & Leaman, 2001a	questionnaire	no
Bordass, Cohen, Standeven, & Leaman, 2001b	questionnaire	no
Bordass, Leaman, & Ruyssevelt, 2001	questionnaire	no
Bradley, 2002	not specified	no
Brennan, Chugh, & Kline, 2002	explorative interviews, questionnaire	not specified
Büssing & Bissels, 1998	semi-structured interviews	yes, N = 46, coding pair raters, agreement > 98%, CAQDAS unmentioned
Cohen, Standeven, Bordass, & Leaman, 2001	explorative interviews, questionnaire	not specified
Davis & Szigeti, 1982	not specified	no
DeMarco & Lister, 1985	experiment	no
Goodrich, 1982	multiple method, review of seven case studies	yes, extensive interviews, group interviews, collection and analysis not specified
Haynes & Price, 2004	questionnaire	no
Haynes, 2007	questionnaire	no
Haynes, 2008a	questionnaire	no
Haynes, 2008b	questionnaire	no
Hedge, 1982	questionnaire	no
Hensley, 1982	multiple methods including fictitious interviews, observations	not applicable
Hill, Ferris, & Märtinson, 2003	questionnaire	no
Hill, Miller, Weiner, & Colihan, 1998	multiple methods including semi-structured interviews, quasi-experiment, questionnaire	yes, N = 249, coding single rater
Ilozor & Oluwoye, 1998	questionnaire	no
Ilozor & Oluwoye, 1999	questionnaire	no

author(s)	method(s)	interviews
Ilozor, Love, & Treloar, 2002	questionnaire	no
Kaplan & Aronoff, 1996	not specified	no
Knight & Haslam, 2010	questionnaire	no
Konar, Sundstrom, Brady, Mandel, & Rice, 1982	questionnaire	no
Kupritz, 1998	observations and Heuristic Elicitation Method (HEM)	yes, N = 89, qualitative and quantitative analysis, one rater, CAQDAS unmentioned
Leaman & Bordass, 1999	not specified, quantitative	no
Leaman & Bordass, 2001	questionnaire	no
Marans & Spreckelmeyer, 1982	multiple methods, case study	no interviews
Moleski & Lang, 1982	not specified	no
Niemelä, Hannula, Rautio, Reijula, & Railio, 2002	multiple methods, case study	no interviews
O'Neill, 1994	questionnaire	no
Stallworth Jr & Kleiner, 1996	descriptive	no
Sundstrom, Herbert, & Brown, 1982	multiple methods, case study	no interviews
Sundstrom, Town, Brown, Forman, & McGee, 1982	questionnaire	no
Van der Voordt, 2004	paper on current research	yes, not specified
Van der Voordt & Maarleveld, 2006	multiple methods, case study	yes, CAQDAS unmentioned
Veitch, Charles, Farley, & Newsham, 2007	questionnaire	no
Vink, Blok, Formanoy, De Korte, & Groenesteijn, 2012	questionnaire	no
Vos & Van der Voordt, 2001	multiple method	yes, CAQDAS unmentioned

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**Section seven:
RESEARCH IN PROGRESS**

Added Value of Facility Management in Institutes for Intellectually Disabled Residents

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ABSTRACT

Within Facility Management (FM) the connection between organisation and space is a well-established topic. This study was made in the context of discovery and explored to what extent changes in organisation and space can contribute to the quality of life of intellectually disabled residents with a severe behavioural disorder (hereafter called residents) and a need for low stimulus intensity.

In scientific literature the influence of the spatial environment on well-being of this specific group of residents has been described extensively by scholars in psychology. However, the joint optimisation of organisation and space is relatively new in FM and relates to studies on evidence based design and healing environments.

This current study explores the relationship between different configurations in organisation and space in real life on one side and aggressive behaviour of two residents on the other. The research design was a longitudinal comparative case study and combined retrospective analysis with analysis of the current situation. The applied methods included document analysis, interview, photography, and walkthrough.

Residents were exposed to different degrees of stimulus intensity in different periods. In periods where residents were exposed to a low stimulus intensity in organisation and space a relatively low number of incidents was reported. To be more precise: in periods where residents were exposed to few peer-residents, a custom-made team, a stable team composition, a standard team approach, and many personal spaces less incidents were reported than in periods where residents were often exposed to peer-residents, a group-based team, changes in team composition, no standard team approach, and many group spaces. These preliminary results suggest that a fit between the needs of residents with organisational and spatial designs can improve the well-being of residents. Further research among a larger

population of residents should reveal if the current results have more general validity and whether these current findings would also be valid for other care institutes.

Keywords

1   INTRODUCTION

"Facility management is the integration of processes within an organisation to maintain and develop the agreed services which support and improve the effectiveness of its primary activities." (CEN, 2006). In this context, facility services can be expected to have effects on organisational performance. Jensen et al. (2012) contend that facility management (FM) is the management of internal and/or external customer supplier relationships and this strongly depends on the customers' perception. Moreover, spatial characteristics that influence the well-being of people in and around organisations is also an important feature of FM (Mobach, 2013).

The last decades much research has been done on the role of space as a part of a holistic treatment of patients in hospitals and residents in institutes for mental health care. Results show a positive influence of space on the recovery of patients or on desirable behaviours of residents. In addition, the last decades the organisation and delivery of care for intellectually disabled residents changed from controlling to preventing behavioural problems. These trends offer a challenge for the facility manager. For instance, he or she needs to define the right organisational and spatial facilities that can prevent or reduce behavioural problems of residents, and by doing so, positively influence residents' well-being.

This study responds to this challenge and explores the relation between organisation and space and their mutual effect on the behaviour of intellectually disabled residents with severe behavioural problems in an institute in the Netherlands. In doing so, this study aims to improve the quality of the delivery of care for intellectually disabled residents and the well-being of these residents (Donabedian, 1988; Schalock, 2002). Moreover, it contributes to the body of knowledge, because the influence of organisation and space has only been scarcely described with FM.

2   LITERATURE

Bitner (1992) has argued that the ability of the physical environment to influence customer and employee behaviours is particularly apparent for the service industries, such as for health care organisations, hotels, and schools. These industries are concerned with both individual behaviours of users as well as with the social interaction between users. Some behaviours are influenced by internal responses of the users to the spatial environment. The management of an organisation, such as FM, has to answer the question which of these environmentally induced internal responses will lead to desirable behaviours and, in addition, how the environment should be configured to bring about such responses and behaviours. Moreover, Bitner (1992) continues to argue that the responses to the spatial environment also influence the interaction between customers and employees. For instance, day-to-day communication between residents and health professionals or, in contrast, undesirable and perhaps even violent behaviours. Consequently, discomfort with the environment can cause stress at

residents and health professionals, and by doing so, become one of the most detrimental variables in the delivery of care (Friedow, 2012).

'The process of basing decisions about the built environment on credible research to achieve the best possible outcomes' is the definition of evidence based design (EBD) as formulated by the Center for Health Design (2008). In this context, Ulrich et al. (2008) performed a systematic review of more than 600 studies which revealed features that directly influence health as well as features that influence health or behaviour via psychological mediated effects. In this latter category, and concerning institutes for long-term health care, studies have shown that facility managers and architects have a number of options to influence the behaviour of the residents and staff. The options may vary from minor adaptations in the interior, for instance, in the use of colours or the arrangement of chairs, to architectural interventions, such as creating larger windows and a natural view (Ulrich et al., 2008). Moreover, a systematic review of Dijkstra et al. (2006) shows that health effects of stimulus intensity appear to be highly dependent on the characteristics of the patient population.

In this context, Christenfeld et al. (1989) compared the rate of violence at fifty chronically psychotic patients that lived in a ward where favourable physical changes were made with a control ward where no such changes were made. The physical changes enhanced control over environmental stimuli and created more homelike surroundings. One of the reported effects was a significant decrease in the rate of resident violence. A review of Karlin & Zeiss (2006) on best practices in psychiatric hospital design reported positive influences of ambient conditions, architectural and interior design, and social topics. The authors advise institutes with residents that suffer from behavioural problems to reduce the institutional feel of the facility and to increase the familiar atmosphere, natural views, and the ability to control the level of social contact. Both Golembiewski (2010) and Gross et al. (1998) advise FM to divide spaces in small units which, by creating clarity for residents, reduces behavioural problems. Consequently, it was expected that a better fit between the spatial environment of health care facilities and the needs of the residents can result in a reduction of behavioural problems.

However, FM does not only deal with spatial issues, but also connects these with organisational issues. In general, both space and organisation have mutual influences on people in and around organisations (Mobach, 2010). Donabedian (1988) describes the influence of organisational aspects on the quality of the care process of health care institutes. He adds to the work of Bitner (1992) by stating that the management of the interaction between staff and resident is the vehicle on which the success of the care process depends. Through interpersonal exchange the patient communicates the information which is necessary for the staff to select the most appropriate care method. He continues to argue that standardisation of the care program is important because it creates clarity for residents (Donabedian, 1988). Hereupon, clarity reduces behavioural problems (Gross et al., 1998). In 2013 in the Netherlands, the Dutch Association of Healthcare Providers for People with Disabilities (VGN) has described standardised care programs which are adapted to the characteristics of residents' quality of life as formulated by Schalock & Verdugo (2002). In this context, different types of methods have been developed to support the care for residents with severe behavioural problems, for instance, Gentle Teaching, a non-aversive method of reducing challenging behaviour that aims to teach bonding and interdependence through gentleness, respect, and solidarity (Jones & McCaughey, 1992; Van de Siepkamp, 2005) and Triple C, a method of co-creating resident competences with a dialogue between resident and health care professional (Van Wouwe et al., 2011). These methods are based on the critical

importance of a good understanding of the needs and desires of the individual resident to enhance the interaction between staff and resident. It is expected that such methods improve the quality of the care process. Such methods demand qualified staff and time for observation, especially because the individual needs of residents are hard to recognize (Van Wouwe et al., 2011).

Since spatial and organisational stimuli influence responses and behaviours of residents it was expected that a better fit between the needs of residents and organisational and spatial designs of institutes housing such residents reduces the intensity of stimuli, which improves the interaction between resident and staff, and the well-being of the residents.

3   METHOD
This research in the context of discovery relates to two residents who need intensive care in an institute for intellectually disabled residents with severe behavioural problems in the Netherlands. The two residents went through the same changes in housing, care policy and care program during the years 2009-2012. For privacy reasons the residents' names have been coded in R1 and R2. Both are male young adults.

Before the start of the research the Medical Ethics Review Board of the University Medical Centre Groningen reviewed this study and concluded that according to Dutch legislation Institutional Review Board consent was or is not needed. Moreover the parents of the residents and the management of the institution gave permission based on a privacy regulation.

For this exploratory spatial-organisational research multiple methods were used to be able to create triangulation in the analysis (Barrett, 2003; Mobach, 2010). The methods used were (1) individual qualitative focus interviews with pre-defined topics at nursing staff, institute doctor, and remedial educationalist; (2) document analysis of: a) care programs and b) lists of incident reports; (3) observation: a) photography of the exterior and the interior of the spaces where the residents live and work and b) walkthrough. Incidents reports consisted of, for instance, problems with aggression, auto-mutilation, medication, and run away. All interviews were simultaneously conducted by two interviewers. The answers were written down and at the same day processed into reports. Respondents gave feedback allowing refined reports after a review.

4   RESULTS
The respondents comprised nursing staff (n=8), institute doctor (n=1), and remedial educationalist (n=1).

The findings showed that living in a group produces too much stimuli for both residents. R1 experiences too many challenges in groups and R2 is very suspicious of others. Control over stimuli is an important and structural issue for both residents although there are subtle differences in the way they deal with stimuli in the current situation.

For instance, R1 is curious and looking for challenges and new contacts and has to accept the strictly pre-defined boundaries by the care program and space. He works in a separated room to do his job and solo coffee and tea breaks are organised for him, in order to keep control over the stimuli.

In addition, R2 is allowed to withdraw himself from over-stimulating and frightening situations. However, he needs guidance to maximise avoidance of such situations which prevent him from experiencing high stress levels. In a group and especially to new people he is very distrustful. R2 works outdoor at the garbage service team of the institute. This service team has an own area for lunch and coffee and tea breaks. During Christmas many stimuli were present in this area (fig. 1). If all of the 20 team-member residents are in this small room and Christmas lights are blinking the stimuli become too much for R2. So sometimes he did take his bike and went home for a while.

Figure 1 Area for lunch and coffee & tea of the garbage team of R2 during Christmas time.[26]

Four periods with different configurations of space and organisation were studied. The periods differ in time from 6 to 13 months. The first three periods were studied retrospectively, the fourth period was the current situation and was also the period in which the study was performed. Three comparisons were made: periods one and two, periods two and three, and periods three and four.

Firstly, a comparison was made between the first two periods. In the first period t_0-t_1 the respondents reported a partly new team with health professionals for seven residents and R1 and R2 lived in a group accommodation. In second period t_1-t_2 the respondents reported a stable team and individual support for residents. In the second period both residents had their own apartment in a big institutional building. The apartment size was meant to stimulate a home feeling, to create an area allowing both residents to compensate for the stimuli rich common meeting rooms. In addition, television and radio were removed from the apartment of R1 to prevent overstimulation; this lack of distraction was compensated with prescribed social activities during the evening, for instance, playing a game, or watching television together (maximum of one hour, two times per week).

Whilst the apartments of the residents were in a 'new' building (from the second period t_1-t_2), the team of health professionals remained in the 'old' building (from the first period t_0-t_1). Team members only came to the new residents' building when a resident called for help or in

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[26] This picture was authorised by the studied health care institute.

case of a prescribed activity in the individual care program. The observations in number of incidents during the two compared periods are presented in table 1 and showed reduction of incidents at R1 and no changes at R2.

Resident	R1		R2	
Period **Observation**	t_0-t_1	t_1-t_2	t_0-t_1	t_1-t_2
Number of incidents	3.6	1.2	2.0	2.0

Table 1 Comparison of mean number of incidents per month, per resident, between a period with team changes, no individual team and group accommodation (t_0-t_1) and a period with team stability, individual not standardised team mainly in another building and individual accommodation in an institutional building (t_1-t_2).

As can be seen in table 1 for R1 the organisational-spatial changes resulted in a decrease of incidents of 66%. For R2 no decrease in the number of incidents can be observed. The reason mentioned by all the respondents is that in the second period t_1-t_2, R2 suffered from a resident with severe aggressive behaviour that lived above him. Consequently, R2 could not sleep and he was not able to recover from the stimuli he experienced during daytime in the lunchroom where he had his breaks (figure 1). This spatial proximity of another, in this case violent, resident may have provoked these behavioural problems.

Secondly, a comparison was made between the second and third periods. Be reminded that in second period t_1-t_2 the respondents reported a stable team and individual support for residents and that both residents had their own apartment in a big institutional building. Next, in the third period t_2-t_3 respondents reported a move to a new individual apartment in a small unit, only for residents R1 and R2. The individualised nursing team was present from 8 a.m. till 10 p.m. in the building where both residents lived. However, the team composition changed often and the conduction of the care program was not standardised and was reported to deviate on personal preferences of team members. The observations in number of incidents during the above two periods are presented in table 2 and showed reduction of incidents at both R1 and R2, but a highest reduction at R2.

Resident	R1		R2	
Period **Observation**	t_1-t_2	t_2-t_3	t_1-t_2	t_2-t_3
Number of incidents	1.2	0.9	2.0	0.8

Table 2 Comparison of mean number of incidents per month, per resident, between periods with team stability, individual not standardised team mainly in another building and individual accommodation in an institutional building (t_1-t_2) and a period with team changes, individual not standardised team in the resident's building and individual accommodation in a small building (t_2-t_3).

Consistent with the reports of respondents, as can be seen in table 2, the move to a new individual apartment in a small unit, especially created for residents R1 and R2, particularly offered R2 more opportunity to recover from his daily activities. This explains the decrease in the number of his behavioural incidents. The fact that the individual staff was present from 8 a.m. till 10 p.m. in the building where they lived was experienced as positive by both

residents. However the team composition changed often and the conduction of the care program was not standardised. As a result R1 played out staff members against each other also leading to aggressive behaviours and even running away. Lack of standardised staff behaviour for R2 led to suspicion and aggressive behaviours.

Thirdly, a comparison was made between the third and fourth periods. Be reminded that in the third period t_2-t_3 residents moved to an individual apartment in a small unit, with individualised staff presence, but that the team composition changed often and the conduction of the care program was not standardised. Comparing the third period t_2-t_3 with the fourth period t_3-t_4 the organisational-spatial changes in the fourth period partly differ for R1 and R2. The changes were based on the creation of more clarity and overview for the residents and this was done on an individual basis.

In the fourth period R1 obtained a new time schedule for his personal care program. It was decided to create a rhythm of three months instead of one month, because it became clear that R1 needs one month to get used to a new care program. R2 was likely to enter the nursing station and express suspicion about the activities of the staff, also leading to aggressive behaviours. Consequently, the access to the nursing station was physically closed with reported positive effects on suspicion and behaviours. In addition, the organisation of the delivery of care was standardised. This resulted in standard staff behaviours, irrespective of team member, and in more clarity for R1 and R2 about the individual staff presence for several days per week. There were no further spatial changes in the apartments. The observations in number of incidents during the above two periods are presented in table 3 and showed no substantial reduction of incidents at R1, and a substantial reduction at R2. But were the incidents reported for R1 in the fourth period t_3-t_4 related to organisational or spatial properties?

Resident	R1		R2	
Period **Observation**	t_2-t_3	t_3-t_4	t_2-t_3	t_3-t_4
Number of incidents	0.9	0.8	0.8	0.2

Table 3 Comparison of mean number of incidents per month, per resident, between a period with team changes, individual not standardised team in the resident's building and individual accommodation in a small building (t_2-t_3) and a period with and stable team, individual standardised team in the resident's building, a more tailor made-care program for R1 and a closed nursing station for R2 and no further changes in the apartments (t_3-t_4).

The answer is no. After the changes at t_3 in a research experiment of a Dutch University the anti-psychotic medication for R1 was lowered and in the same period his beloved grandmother died. He reacted with aggression and self-mutilation. Restored medication and the before mentioned organisational interventions helped him back on track. The last three months of the fourth period t_3-t_4 no incidents were reported for both residents.

Be reminded that the improvement in the mental well-being of the residents did not only appear from the decrease in the number of incidents. The respondents reported that during the last months they experienced that the residents were more in balance. The effectiveness of the organisational interventions, such as standardization and team stability, was endorsed by all respondents. Moreover, the entire nursing staff considered these organisational interventions

more important than the above reported spatial interventions, such as the difference between individual and group accommodations. The institutional doctor and the remedial educationalist mentioned that space is an important prerequisite for the well-being of these residents.

5   CONCLUSION

In this explorative study in the context of discovery a facility management perspective on organisation and space was applied to explore its relation with reported incidents of intellectually disabled residents in an institute. It was shown that reduction of stimuli can improve the quality of life of residents. Stimuli can occur both in organisation and in space. Such stimuli, for instance, may be team changes and group accommodation. The study showed that in periods where there were an individual and stable team, a standardised approach and individual accommodations less incidents were reported than in periods with a group team, team changes, no standardised approach and accommodation of residents in group accommodations. Moreover, better adjustment of the individual care program to the characteristics of the residents supported the residents' control over spatial stimuli. Finally, it was very surprising to see that in a room for lunch and coffee & tea breaks a large number of stimuli were observed even though it is a well-known fact that these residents have serious problems coping with stimuli. These preliminary results suggest that a fit between the needs of residents with organisational and spatial designs can improve the interaction between residents and staff, and by doing so, positively influence the well-being of residents.

6   DISCUSSION

This study was performed in the context of discovery. Future research with more residents should reveal if the here established preliminary findings have general validity. With such an approach it can be determined whether the current findings will also proof to be valid for other care institutes where intellectually disabled residents with severe behavioural problems live and work.

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Relocating a Nursing Home

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ABSTRACT

One of the areas that is included in facility management is relocation and move management. This exploratory research focuses on the relocation of nursing home residents and the influence on their wellbeing. As other organizations, nursing homes do change over time. Such changes may include reorganizations, mergers, and closures.

At the same time such changes will foster a changing demand for space. As a direct consequence there may be a need to relocate residents leading to transitional and irreversible spatial interventions in the life of these nursing home residents. This may affect their physiological and psychological wellbeing: be reminded that a relocation process may cause serious stress and related health problems at these residents.

The aim of this paper is to provide a literature review of studies on relocation outcomes. Because no recent literature was found on the particular Dutch situation, other studies have been reviewed in order to expose the diversity of studies and varying results.

It is confirmed that relocation influences the wellbeing of nursing home residents. Positive or negative influences are determined by the organization of the relocation. Positive influences can be expected, for instance, if residents are mentally well-prepared prior to the move, if extra staff is deployed to stay in close contact with residents during the move, and if facility managers develop after-care programs until residents are completely accustomed to the new situation.

1   INTRODUCTION

In 2011, The Netherlands counted 16.7 million citizens of which 2,594,946 (15.6%) citizens are 65 years or older. 667,547 (4%) of these citizens are older than 80 years. In 2011, approximately 160,000 elderly are living in a Dutch care or nursing home (Health Care Inspectorate, 2012): a total of 6.2% of those older than 65 and 1% of the total Dutch population.

The proportion of the population in the age of 65 years and older is rising significantly: from 6% in 1900 to 15.6% in 2011 and towards a predicted 25.9% in 2040 (Statistics Netherlands, 2012). These changing demographics are very likely to increase demand for care and put, together with government savings, the Dutch health care system under pressure.

2   HEALTH CARE IN THE NETHERLANDS

The Netherlands have a dual-level healthcare system which means that all primary and curative care is financed from private obligatory insurance. This covers for example the cost of a physician, a hospital, and pharmacy. The companies that offer the private insurances must offer a core universal insurance package at fixed prices. This package covers the primary curative care. Besides these core packages, insurance companies can offer additional services at extra cost.

Long term care for the elderly and, for instance, for long term mentally ill people is covered by social insurance funded from taxation. The 'General Law on Exceptional Medical Expenses', in The Netherlands known as the AWBZ, is a Dutch health care law which provides general insurance for special health care needs. This AWBZ is intended for 'care' rather than 'cure'. In the Netherlands, more than 600,000 people are supported by this law. On the basis of a care needs assessment the authority decides to what degree a person gets compensation from the AWBZ. Through this legislation, the AWBZ will (partially) pay for nursing home costs. This nursing can either be extramural care (at home) or residential care (in a residential). The lowest care needs package required to get residential care paid by the AWBZ is the so-called package nº4.

Of the ten care needs packages, nº4 is the package that contains sheltered housing with intensive support and extended care. Lower packages also contain *sheltered* housing, but with less needs for support and care, whereas higher packages contain *protected* housing and intensive or very intensive care. These higher care needs packages are assigned to people who suffer from severe dementia (nº5), a chronically physical disease (nº6), psychiatric problems in combination with physical problems or brain damage (nº7) and people with a severe physical disease and therefore with a very special need of care (nº8). The highest packages are assigned to people who need temporary care after major surgery (due to physical disease, nº9) or to people who are terminally ill (nº10).

2.1   Changes in Dutch Legislation

On 29 October 2012 the winning parties of the Dutch elections concluded a coalition agreement. In this agreement, the governance announces that patients with less demanding needs will receive care at home rather than residential care. In this way, they aim to separate accommodation and care. It means that the elderly will no longer be entitled to care needs package nº4 or care needs packages of a similar level. The measure will apply to new clients and re-assessments as from 2016.

In addition, from 2017 home care will be transferred from the Exceptional Medical Expenses Act (AWBZ) to the Healthcare Insurance Act (ZVW), placing it in the same system of population-based funding as general practitioners care, and will be subject to a care needs assessment (Government of the Netherlands, 2012).

This change in funding – as well as the separation of living and care – will affect the way nursing homes are organized and are therefore motives to change.

2.2 Nursing Homes Changes

The developments aforementioned make it necessary to change the organization of nursing homes. These changes include for example reorganizations, mergers, and closures (Castle, 2001) and may be organizational, architectural, or both. Most likely it will affect the organization as such and the spatial environment in which it operates through what a changing demand for space will emerge. This can result in a need to relocate.

3 FACILITATING THE RELOCATION

One of the areas that is included in facility management is relocation and move management (Barrett & Baldry, 2003; Cotts et al., 2010). A facilities manager should carefully plan and co-ordinate all elements of the relocation. He should also keep clients informed at all stages of the process (Wiggins, 2010).

Relocation is defined as 'moving from one environment to another for various reasons' (Burnette, 1986). Relocation is a change in physical and social environment (Young, 1990). However, relocation involves not only the actual physical relocation but also the adjustment to new surroundings afterwards (Johnson & Hlava, 1994).

3.1 Organization, Space and Health

Mobach (2009) states that the spatial environment influences health, mind and behaviour of people. Research also shows that the physical healthcare environment affects the wellbeing of patients (Dijkstra et al., 2006). Joseph confirms this as she concludes that the design of the physical environment impacts resident outcomes in long-term care settings and contributes to a better quality of life for those who live in these facilities (2006). Relocation leads to transitional and irreversible change of the spatial, organizational and social environment of nursing home residents.

3.2 Relocation Outcomes

Relocation events may be detrimental to the wellbeing of the nursing home residents: potential negative outcomes are mortality, physiological decline and psychological decline (Castle, 2001; Castle, 2005; Jolley et al., 2011). In addition, relocation can change cognitive performance and social engagement and it can also lead to depression (Castle, 2005).

Reviews of relocation literature show varying results. In some studies, mortality is higher after relocation but in other studies there were no significant findings or mortality was even lower after relocation (Castle, 2005; Davis et al., 1990; Thorson & Davis, 2000). The same holds for changes in health (physiologic or psychological): some studies found increase or decrease of health after relocation, while others had non-significant findings when examining the association between changes in health and relocation (Castle, 2001; Castle, 2005).

Castle (2001) performed a systematic review of 78 empirical studies addressing relocation of the elderly.[27] The review has confirmed the large variety of relocation outcomes. The outcomes of the reviewed relocation studies included mortality rates, morbidity, and psychological and social status. The results of these studies on patient outcomes: mortality, morbidity, and psychological and social status are presented in tables 1, 2, and 3 respectively. For each study, patient outcomes of the relocated groups were compared with expected patient outcomes based on the pre-relocation comparison groups. In the tables are the numbers of studies in which the outcomes of relocated residents were equivalent, higher or lower than expected. If both outcomes were the same it was equivalent to the expected outcome. In other situations, for instance, the outcome could be higher or lower in situations when the relocated groups had respective higher rates of mortality and lower rates of mortality compared to the expected outcomes based on the pre-relocation comparison groups.

Table 1 A comparison of studies on mortality rates at relocated and pre-relocation groups

Comparison Outcome	Number of studies in which mortality of relocated residents was *equivalent* to pre-relocation	Number of studies in which mortality of relocated residents was *higher* than at pre-relocation	Number of studies in which mortality of relocated residents was *lower* than at pre-relocation
Mortality Rate	49%	30%	21%

In almost half of the studies (49%) the mortality rate of the relocated residents was equivalent to the mortality rate at the pre-relocation comparison groups (table 1). Of the other half of the studies mortality was higher after the relocation than before. More specifically, the maximum mortality rate of the post-relocation groups was 7.5% higher than the maximum rate of the pre-relocation groups.

Table 2 A comparison of studies on morbidity at relocated and pre-relocation groups

Comparison Outcome	Number of studies in which morbidity of relocated residents was *equivalent* to pre-relocation	Number of studies in which morbidity of relocated residents was *higher* than at pre-relocation	Number of studies in which morbidity of relocated residents was *lower* than at pre-relocation
Morbidity	55%	39%	7%

More than half (55%) of the studies that researched morbidity show equivalent outcomes for the relocated and pre-relocation group (table 2). The other studies mainly showed higher morbidity outcomes for the relocated groups than at pre-relocation. This means that general health of the residents was poorer after the move than before.

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[27] In his study, Castle (2001) compared 78 studies addressing the relocation of elderly. He analysed these studies on mortality, morbidity and psychological or social statuses and included in this review the research design, control variables, type (voluntary/involuntary) relocation, sample size, and facility setting.

Table 3 A comparison of studies on psychological and social statuses at relocated and pre-relocation groups

Comparison Outcome	Number of studies in which psychological and social statuses of relocated residents was *equivalent* to pre-relocation	Number of studies in which psychological and social statuses of relocated residents was *higher* than at pre-relocation	Number of studies in which psychological and social statuses of relocated residents was *lower* than at pre-relocation
Psychological and social statuses			
Positive indicators	51%	27%	22%
Negative indicators	65%	22%	13%

In case of psychological and social statuses (table 3), a distinction has to be made between positive and negative indicators in order to give the right meaning to the patient outcomes. For the positive indicators it means that the higher the outcome, the better it is for the wellbeing of the residents (for example hygiene and life satisfaction). For the negative indicators it means that the higher the outcome, the worse is it for the wellbeing (for example violent behaviour and alienation). In both, more than half of the studies show unaltered psychological and social statuses of the relocated groups compared to the pre-relocation groups. Of the other half of the studies that researched on the positive indicators a slight majority shows an improved psychological and social status, whereas the studies on negative indicators show a decrease of wellbeing.

Relocation outcomes vary. While there are a few studies confirming positive patient outcomes, most studies show patient outcomes of relocated residents that were equivalent to the pre-relocation comparison groups. However, mortality and morbidity rates as well as the indicators of psychological and social statuses where the second highest. These are negative impacts on the wellbeing of the residents.

3.3   Reducing Negative Impact

Relocation effects may be positive when nursing home residents are prepared for the move: the choices the residents have directly impacted on their quality of life (Cohen, 1981; Holzapfel et al., 1992). There are practices that will reduce the stress and its possible consequences during pre-relocation, relocation and post-relocation phases (Jolley et al., 2011).

In the pre-relocation phase it is important to inform residents, make careful plans and facilitate discussions. In addition, it is also essential to undertake individual medical and psycho-social needs assessments and to arrange familiarization visits to the new facility (Castle, 2001; Jolley et al., 2011). Planned interventions may reduce negative impact. Pre-relocation involvement of the nursing home residents in visiting the new facility and in selecting their bedrooms and roommates reduced their anxiety to an acceptable, even positive level because this involvement makes the new environment more predictable (Holzapfel et al., 1992; Kowalski, 1981; Locker & Rublin, 1974). According to Keister (2006), predictability to the new environment was inversely related to anxiety. When people are prepared for the relocation, they give higher appraisal, higher morale, functional independence, and lower harm-loss scores (Gass et al., 1992; Petrou & Obenchain, 1987).

In facilitating the relocation itself, appropriate health checks (at departure and arrival) should be done, a familiar and responsible person should travel with the resident (Rosswurm, 1983) and each resident should get a warm welcome at the new facility in order to feel safe, comfortable and wanted. The care providers better approach the relocation as a positive step or challenge and appeal to the residents' strengths and skills to avoid negative labels (Holzapfel et al., 1992; King et al., 1987). For relocating successfully, mastery (the belief that life is under one's control), social support, and cognitive appraisal (assigning meaning to the relocation event) of the older adults are important (Keister, 2006; Rantz & Egan, 1987).

Once the relocation is over, it is good to organize a review of progress and current health and psycho-social care needs in the post-relocation phase. It is also important to provide orientation within the new facility and to maximize stability and continuation of good practices from the previous home (Jolley et al., 2011).

Interventions that involve, inform, and prepare older people before relocation to enhance their sense of control and the predictability of the move might minimize adverse relocation effects (Falk et al., 2011; Johnson & Hlava, 1994). All nursing home residents are individuals which are not equally vulnerable to these adverse effects (Jolley et al., 2011; Keister, 2006; Holzapfel et al., 1992; Gass et al., 1992).

Table 4 shows three other studies from Amenta et al. (1984), Potter & Berger (1974) and Castle (1997) emphasizing key elements of facilitating relocation in order to reduce negative impact.

Table 4 How to Relocate a Nursing Home?

Amenta et al., 1984	Potter & Berger, 1974	Castle, 1997
1. To all residents, show a film describing the new facility	1. Let the staff describe the new facility to the residents	1. Ask residents what their preferences or choices for a new home are
2. Take residents several times to the new facility	2. Discuss rooms and roommates	2. Ask residents' family members for their facility preferences
3. Prior to the move, take inventories of personal possessions	3. Let residents handle their own property as much as possible	3. Let a committee review the preferences and choices of each resident (and their family)
4. Individual counselling of needs regarding the move	4. Give residents a tour around the new facility	
5. Let residents themselves choose roommates		

5   CONCLUSION

A facilities manager should carefully plan and co-ordinate all elements of the relocation (Wiggins, 2010). In moving a nursing home, the difficulty may lie in the fact that it has to be moved without closing it in the process (Denoyer, 2011). This literature review highlights the elements of the relocation which are important to plan and co-ordinate in order to reduce negative impact on the residents.

It can carefully be concluded that within a relocation process three phases can be distinguished. In the first *pre-relocation* phase, the facility manager has to ensure that the residents are prepared for the move. For this purpose, he has to consider which people are most suitable to take care of this preparation and how the preparation program should look. The second phase contains the *relocation process* itself. During this phase, the facility manager is mainly focused on the physical move and should therefore deploy staff that can stay close to the residents. For example, nurses who are known to the residents. When the relocation is over, the third *post-relocation* phase is about to begin. When this phase ends, varies by each relocated nursing home. The facility manager has to develop a kind of after-care program in which he includes monitoring the health of the relocated residents as well as remedying deficiencies in the new facility.

So, the responsibility of a facility manager should not only be to oversee the physical facilities and activities, but also to have a responsibility for taking care of the nursing home residents' wellbeing during the relocation process. Only in this way, the facility manager can potentially optimize a relocation process and reduce or eliminate potential negative impact on the wellbeing of the nursing home residents. This emphasizes the multidisciplinary nature of the field of facility management.

Further Research

Despite these findings, there is still a need for further research on the impact of relocations on old and cognitively impaired people, the research methods that should be used, and the effects of preparatory interventions (Falk et al., 2011).

A longitudinal comparative case study can be done to assess relocation appraisal and effects on the wellbeing of nursing home residents prior to the event of relocation and several times during one year following relocation in order to investigate changes in relocation appraisal and wellbeing over time (Gass et al., 1992). It may also be interesting to assess what kinds of preparation are most successful (Thorson & Davis, 2000) and how characteristics of the relocatees and the new facility influence the relocation outcomes (Castle, 2001). A challenge in this field of research is to increase validity and reliability by using control groups that are representative and that using such control groups is ethically responsible since it is about people's health.

Furthermore, no recent studies have been found that researched the relationship between relocation and wellbeing of nursing home residents in the Netherlands. For further research, one could consider examining this relationship in the Dutch context.

None of the studies explicitly examined the impact of the facility manager on the process and outcomes of the process. In the field of facility management, a study about this impact might be a valuable contribution to the literature and the profession of facility management.

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Facility Management in Austria 2012 – Value Add?

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ABSTRACT

20% of expenditure is linked to infrastructure (buildings etc.) and related services, so the question is what value can Facility Management (FM) add for companies? Since 2005 the Vienna University of Technology (TU Wien) has performed surveys in the area of Facility Management on a yearly basis. The main goal was to define and identify parameters that guarantee an economic effective implementation of FM which results in cost savings and increase of productivity. Companies for the survey are selected randomly from the Austrian journal "Trend", which publishes a list of Austria's Top 500 companies every year (ranking is sales driven). This research paper presents some first results of the current survey as well as the next research steps to show the parameters that have positive impact on the efficiency and effectiveness of FM. The research is based on the Mixed Method Approach.

Keywords

Facility Management, Value Added, Mixed Method Approach

1   INTRODUCTION

From an academic/scientific point-of-view as well as in daily practice there is a need to improve the understanding of how Facility Management (FM) can become more effective and add value to the company's core business and the different stakeholders (Jensen et. al., 2012). Many books and publications refer to the benefits and savings from the use of FM. Two articles by Lynch focus on maximizing FM's contribution to shareholder value and therefore on economical value (Jensen et. al. 2010, Lynch 2002a and 2002b). More than 80% of the total costs for buildings are operation costs like costs for maintenance or energy supply, whereas only 10 to 20% costs are spent for planning and construction (Limke, 2003, Nävy, 2006). As these running costs are still rising, a lot of companies have recognized FM as a management strategy capable to reduce costs for facilities (Redmann, 2000). According to different publications, it is possible to save between 10 and 30% of the costs of buildings through the efficient use of FM (Nävy, 2006). Therefore, there is a need to determine the economic effects/value added of the use of FM with the help of scientific models and methods.

Since 2005 the Vienna University of Technology (TU Wien) has performed surveys in the area of FM on a yearly basis. The first attempt to prove the profitability and efficiency of FM was performed by Susanne Hauk. In her study she showed that companies using FM achieve an increase of efficiency and productivity[28] as well as cost savings but also create more cost

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[28] In the questionnaire/survey productivity was defined as: Increase in productivity = More output with the same input e.g. staff; respectively increase of output per unit of input.

drivers[29] (Hauk, 2007). This research paper shows further results of the actual survey as well as a discussion of the next research steps to show and define the parameters that have positive impact on the efficiency and productivity of FM.

2   METHODOLOGY

According to Jensen et. al. FM value research needs both qualitative and quantitative research methods. Quantitative surveys should be combined with qualitative data collection methods e.g. personal interviews, expert groups, focus groups with professionals and content analysis (Jensen et. al., 2012). Therefore the Mixed Method Approach/Research was used to combine these research methods (qualitative research paradigm is used for one phase of the study, quantitative research paradigm is used for another phase of the study). The goal of Mixed Method Research is to draw from the strengths and minimize the weaknesses of both research methods (quantitative and qualitative) in single research studies and across studies. Its logic of inquiry includes the use of induction (discovery of patterns), deduction (testing of theories and hypotheses) and abduction (uncovering and relying on the best of a set of explanations for understanding one's results). Taking a mixed position allows researchers to mix and match design components that offer the best chance of answering their specific (research) questions (Johnson and Onwuegbuzie, 2004). The current study consists of four steps. The qualitative steps had the purpose to prepare the next quantitative steps. Based on the results of the qualitative steps, the questionnaire for the following quantitative steps has to be developed. The quantitative studies had the goal to validate the results of the qualitative steps done before (Redlein and Sustr, 2008). The qualitative steps were used to survey the (potential) profitability and efficiency of FM. Based on the quantitative studies/steps, the results of the qualitative steps were analyzed and validated (Hauk, 2007).

The whole survey process from creating the questionnaire to evaluating results is under yearly review (quantitative step). Results of expert interviews are included in the existing questionnaire. Questions are rephrased if necessary, added or deleted (Hizgilov and Redlein, 2011). The standardized questionnaire for the survey with closed and open questions was subdivided into the parts: Companies in general and FM organization (e.g. questions about the industry of the company, number of employees), savings through the use of FM, increase of productivity through the use of FM, cost drivers through the use of FM, Outsourcing and IT Support (e.g. questions about the use of an ERP and CAFM system). Depending on the answers there are up to about forty questions.

Companies for the survey are selected randomly from the Austrian's Top 500 (ranking is sales driven) published by the Austrian journal "Trend" (Leeb, 2012). Tools for the survey were phone and/or E-Mail. Interviewees of the survey were the Facility Managers themselves or if this position does not exist, the persons responsible for the FM tasks. The data (answers) was entered in a MS Access database and afterwards exported into statistical programmes and analyzed and evaluated (qualitative step).

3   FIRST RESULTS

This paper shows some first results of the quantitative part of the actual survey.

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[29] Cost drivers open up the possibility of differentiated cost planning and cost control. They are measures of cost causation and resource use and output (Leidig, 2004).

3.1 General Facts (Organization of FM)

In the year 2012, 87% of the surveyed companies (N=82) had their own FM department. In the years 2011 and 2010 the portion of companies with own FM departments were about 90% respectively 87%. This slight decrease of companies with an own FM department can be explained by the random sample. In 2012 more small companies participated in the survey. However, the share of companies with an own FM department is still on a high level. The importance of FM departments is underlined by its organizational integration within the company's hierarchy. In the year 2012 about 35% of FM departments are organizational integrated as staff unit, while another 54% are integrated as line function. Most of the FM departments are staffed with 3 to 5 employees (2012: 30%). The share of companies with over 50 employees is only about 3% in 2012. The trend is therefore towards smaller and sleeker departments. The (economic) crisis could be a possible explanation for this significant change since 2007, where 14% of the companies were staffed with more than 50 employees (Hizgilov and Redlein, 2011). The increased awareness for FM is also evident in the rise of companies having a description of tasks for the FM area. In the year 2012 about 89% of the surveyed companies had a task description. Companies having a description of tasks for the FM department frequently have assigned the tasks to specific persons (88%). While only 12% of the companies having a description do not assign to specific persons.

3.2 Value Added

Value Added[30] of FM includes cost savings and increase in productivity on the one side and on the other side cost drivers (Mierl, 2012). The biggest cost driver in 2012 was energy, which was mentioned by 27% of the answering Facility Managers. This cost driver was followed by more "labor-intensive" areas such as safety (13%), maintenance/repair (12%) and cleaning (12%). The most relevant areas of cost savings in 2012 (number of mentions/frequencies to total respondents in %) were energy (51%), cleaning (44%) and personnel (21%). Savings reasons are (sorted by number of mentions): new type of contract, rates, technical upgrade, reorganization and utilization of synergies. In the evaluation of 2012 the area administration (18%) was the most named area in which an increase in productivity could be observed (answers in % to total respondents). This area was followed by maintenance/repair (17%) and personnel (16%). Reasons for an increase in productivity are (sorted by number of mentions): process optimization, utilization of synergies and personnel/employee workload.

4 CONCLUSION AND NEXT STEPS

The first results of the actual survey show that the share of companies with an own FM department is still on a very high level. Also that FM is a very important tool to achieve an increase in savings and productivity. As mentioned before, a lot of publications indicate that the introduction of FM has positive effects on savings. This can be confirmed by the recent study. An own FM department had positive effects on cost savings, especially in the areas cleaning and energy. FM also leads to an increase in productivity. Most named areas were administration and maintenance/repair. The authors already started to define statistical models to prove if there is an (significant) correlation between different variables/parameters

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[30] In the past, added value was seen as a combination of price and quality. Nowadays added value is considered as a complex concept that can be studied from different perspectives. There appears to be broad consensus about added value being the ratio between benefits and sacrifices for the costumer. Risk is also mentioned as a separate aspect. The assessment of and decision about added value involves a trade-off and a choice between different criteria – benefits, costs and risks – which in themselves are difficult to compare (Kok et al., 2011).

(e.g. Cramer's V). In addition parameters were defined that have influence on the efficiency of FM. According to Jensen et. al. still much work has to be done to learn about adding value of FM e.g. identifying value drivers, examining the nature of value and its dimensions (Jensen et. al., 2012). The actual and next research steps will be to define even more statistical models how parameters influence the value added e.g. prove if there is an (significant) correlation between different variables/parameters (e.g. Cramer's V, Spearman rank correlation). Also an equivalent test could be used for comparing the average performance of two groups (Wilcoxon Test) to verify if there is a difference between two populations on the basis of the random samples from these populations (Dodge, 2008). Regression analysis could be used to make quantitative estimates of economic relationships between different variables/parameters to specify that a dependent variable is a function of one or more independent variables (Studenmund, 2006). Also more detailed analyses of different industries and/or countries are possible to gather more information and an expansion of the data about this research field and help to find out how general these results are.

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Section Eight
POSTGRADUATE RESEARCH

Introduction

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Evaluation methods for hospital facilities

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The potential for energy savings in a school with outsourced FM

Rachel Freeman and Chris Preist
University of Bristol, UK

The nature of innovation processes in FM

Giulia Nardelli
Roskilde University, Denmark

Added value of FM know-how in the building whole life process

Simon Ashworth
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Introduction
POSTGRADUATE RESEARCH

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A key objective of the EuroFM Research Network is to provide effective support for the community of European postgraduate researchers in Facilities Management. The RNG network recognises the importance of connecting students to share their interests, discuss their emerging research and to enable mutual support and peer group learning.

The network can provide important additional support through access to the FM research agenda, knowledge base and network of experience and expertise in FM research. In addition it can provide the connection to FM practitioners and service providers to sponsor and support postgraduate research projects.

On a number of previous occasions, EuroFM has tried to form a postgraduate network, to connect students from around European and to encourage their full involvement in the collaborative research activities in the network. Separate attempts have had mixed success and, on the whole, have failed to establish the foundations for a continuous network.

EuroFM research projects and the EuroFM Research Symposium provide the opportunity to publish papers about their emerging research ideas, designs and findings. The criteria for selection of papers for publication are exactly the same as all other submissions to calls for papers for example for the Research Symposium. The double-blind refereeing process ensures that each paper submitted is treated with anonymity and that the standards are applied to ensure quality. Many of the papers will be submitted as part of a PhD by publication and as such are essential to successful completion.

This year for the first time, paper sessions for the postgraduate community have been organised as part of the first EuroFM research workshops as part of the overall programme for EFMC 2013. In addition and open meeting for the postgraduate community has been scheduled to encourage discussion and exchange of experience.

In addition to the support provided through the supervisory arrangements and resources available in in individual Universities, the RNG is also able to respond to demands from the postgraduate network for courses and meetings to explore philosophical, conceptual, theoretical and methodological issues arising out of postgraduate research.

EuroFM has always believed that the postgraduate research network should be self-organising and that the agenda should be decided by the group themselves. The network will respond sympathetically to the identified needs of the group and will endeavour to support them through effective collaboration. EuroFM is also prepared to offer the postgraduate network representation in the decision making about the programme of the RNG.

Evaluation methods for hospital facilities

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ABSTRACT

Initial position & background: There are various methods and tools for evaluating facilities. The focus is usually on the technical building performance, function/usability or form/beauty. Examples are: Post-Occupancy Evaluation (POE) and Usability Appraisal. Nevertheless, evaluations of buildings in use are seldom. They are considered a long and expensive part of the final phase of a building project. Therefore the experiences of finished building projects are not collected and mistakes are repeated.

Problem & task description: This paper lists different types of evaluation methods ordered according to focus areas and proposes which evaluation methods to use in different building phases of healthcare facilities. Hospital evaluations with experts and users are also considered; their subjective view on space, function, technology, usability and aesthetics.

Results & solutions: This paper presents the different methods for evaluating buildings in use in a new model, the Evaluation Focus Flower, and proposes which evaluation methods are suitable for various aims and building phases, i.e. which is giving best input for the initial briefing process of new hospital facilities with ambition of creating buildings with enhanced usability. Additionally various evaluation methods used in hospital cases in Denmark and Norway are presented. Involvement of users is proposed, not just in defining requirements but also in co-creation/design and evaluation of solutions. The theories and preliminary research results have relevance to researchers and practitioners planning new complex facilities, of any kind, not only hospitals.

Keywords

Evaluation methods, Hospitals, Briefing process, POE, Usability Appraisal

1 INTRODUCTION

There are various methods and tools for evaluating facilities. The focus is usually on one of the three: the technical building performance, function/usability or form/beauty. Nevertheless, evaluations of buildings in use are seldom. They are considered a long and expensive part of the final phase of a building project. Therefore the experiences of finished building projects are not collected and mistakes are repeated.

My focus is on planning usable complex facilities, like hospitals with multiple challenges of healthcare sector. In Denmark there are currently 28 (16 new) hospital building projects that will shape the future for a long time ahead. They can probably be planned more optimally, resulting in better usability, if the building process, especially the briefing stage is enhanced with evaluations to support decisions.

This paper proposes a way to organise evaluation methods according to focus area and how to choose the right evaluation method for different buildings phases of new healthcare facilities. A new model, the Evaluation Focus Flower, for sorting methods according to focus area is presented. An additional model proposes evaluation methods that can be used at different phases of a hospital building project, specially focusing on early stages and briefing process.

The article is structured as follows. Section 2 presents a literature review on POE, a detailed overview of various methods and the new models structuring various evaluation methods. Section 3 describes three hospital cases in Denmark and Norway. Section 4 covers analysis of how the methods could be used in hospital projects at different phases. Finally section 5 presents the conclusion.

2 EXPLORATION OF EVALUATION METHODS

2.1 Reasons for evaluation

Several reasons exist for making evaluations. Cold (2012) divides them under 3 groups:

- Recognition - To understand the place and yourself, experience, understanding, development of theories

- Control - To see others' experience and use of place, control and get abilities/ knowledge

- Professional information - To know expert evaluations, discuss and inform

The British Council for Offices (BCO) suggests two main purposes for a Post Occupancy Evaluation (POE). The main aim is to gain feedback on how successful the workplace is in supporting the occupying organisation and individual end-users. The other purpose is to use POE to assess if a project brief – the programme of requirements, was met.

Researchers recently presented additional aims of making a POE - to gain knowledge from own and other sites and *feed forward* for new briefing processes (Jensen, 2010, Preiser, 2010, Lindahl, Hansen, Alexander, 2012). This use of POE methods for new building projects is called Pre Design Evaluation (PDE) (Ornstein and Andrade, 2012, Preiser and Vischer, 2005).

I recommend combining POE / PDE with user involvement and co-learning, making a common understanding in the participant group (Fronczek-Munter, 2012).

A model combining those aspects is presented in Figure 1 and shows various reasons for evaluations of buildings. The model has two axes.

The horizontal axis is inspired by innovation thinking and shows the amount of action and innovation level in the building.

The vertical axis adds the context:

- Existing building, (either testing current existing conditions, or knowledge applied for improvements or radical innovation in same facility)

- New building, (testing if requirements are met, learning from other existing facilities and feed forward for briefing and innovation in a new building, part of user involvement and co-learning process)

- Develop generic knowledge (documentation of best practice case in specific type of building or geographical area, inspiration to innovation – many cases)
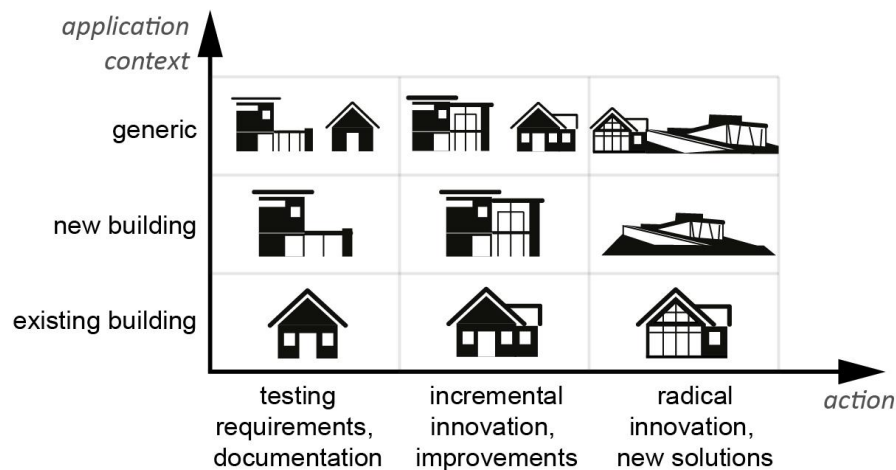
Figure 1 Model of the various reasons for evaluations of buildings

Comparable to the methods of user involvement, which I recommend to chose carefully to fit the expected focus and type of result (Fronczek-Munter, 2011), I also recommend to be aware of an organisation's motivation for doing evaluations and in advance choose the focus areas and methods to support the aims.

2.2 Methods of evaluation

Once the goals of the evaluation are clear, a suitable method can be chosen. In order to assist that process I have organised the different methods from literature review in Table 1. Additionally, I have developed a new Evaluation Focus Flower model, see Figure 2, for an easy overview of methods and their main focus. The POE method is described in two understandings: the traditional common practice and a broader "umbrella" understanding, in which all the further methods can be used.

2.2.1 POE

The most known evaluation method for buildings is Post Occupancy Evaluation (POE) (Preiser, 1988, 1995, 2003, 2005). 'Post occupancy' refers to the fact that the building is already taken to use at the point of evaluation. The origins of the method are in the USA and it has been used since the 1960s. According to the definition of Preiser et al. (1988, 2005), POE is "the process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time".

There are 3 levels of detail in POE, (Preiser, 1995, 1988, 2003, Blackstad, 2008):

- *indicative* - quick, walk-through evaluations, involving structured interviews with key personnel, group meetings with end-users, inspections. Result is a quick overview of positive and negative aspects of building performance, gained with limited use of resources
- *investigative* - in-depth evaluations, interviews and survey questionnaires, photographic/video recordings, physical measurements, benchmarking with literature and state of the art facilities. Result is in depth evaluation of the facility
- *diagnostic* - longitudinal and cross-sectional evaluation studies of performance aspects, comprehensive, many variables, research approach. The result is knowledge from state of the art descriptions from cases.

The POE approaches have evolved from case studies of stand-alone building projects, to structured studies of varied building forms with valid, cross functional results for benchmarking (National Research Council, 1987). The critique of traditional POE was that it usually focuses on technical building performance. Nowadays the term for such technical

focused assessments is commissioning. Jensen (2010) proposes, that evaluation of usability complements commissioning activities in a combined validation of both the technical and the user oriented performance of buildings, and that the processes could run continuously, like the continuous briefing (Jensen et al., 2009), but with different peak times. Riley et al. (2003) present the historical development of POE, also previous resistance to POE by construction professionals. Preiser (2010) recently states that POE /PDE is a proactive process which feeds into the next building cycle through strategic planning/ needs analysis and programming/briefing. The broad understanding of POE, is that it evaluates the performance of the building based on user experiences, but also considers a more holistic, process-oriented evaluation (Preiser and Vischer, 2005). The clients are interested in POE to improve their facilities and occupants' performance (Bordass and Leaman, 2005).

POE practitioners are usually architects, but according to Preiser (2010) they will be trained in several other disciplines in the future, also in social sciences/management. Nevertheless other kinds of participants can run POE or PDE: managers and design team with user groups, personnel and end-users.

2.2.2 Overview of evaluation methods

There are over 150 POE techniques available worldwide (McDougall et al., 2002, Leaman, 2003, Bruhns, Bordass, Leaman, 2005, Blakstad, Hansen, Knudsen, 2008, Riley et al. 2009, Haron, Hamid, 2011). Some are well established: Mental Map (Lynch, 1960), Save (1990) others are more recent: USEtool (Hansen, Blakstad, Knudsen, 2009). Some of the different methods of evaluation are presented in Table 1 and Figure 2 with typical focus areas.

Figure 2 provides an overview of the methods, grouped and placed on the Evaluation Focus Flower model in order to easily find the right evaluation method fitting the focus area to study. The many focus areas are represented by flower petals with overlaps. The model background are three main areas, that are based on three qualities of architecture, that were defined in Ancient Rome by Vitruvius (80-15 BC) in his book *De architectura,* also known as *The Ten Books on Architecture.* The qualities are*: firmitas, utilitas* and *venustas*. Today most architecture students hear about the three elements in their first architecture history classes. Nevertheless the understanding of the words is not universal, but constantly changing throughout time and place. Venustas will be translated in this paper as Beauty / Form, Firmitas as Durability / Technology, and Utilitas as Utility / Usability.
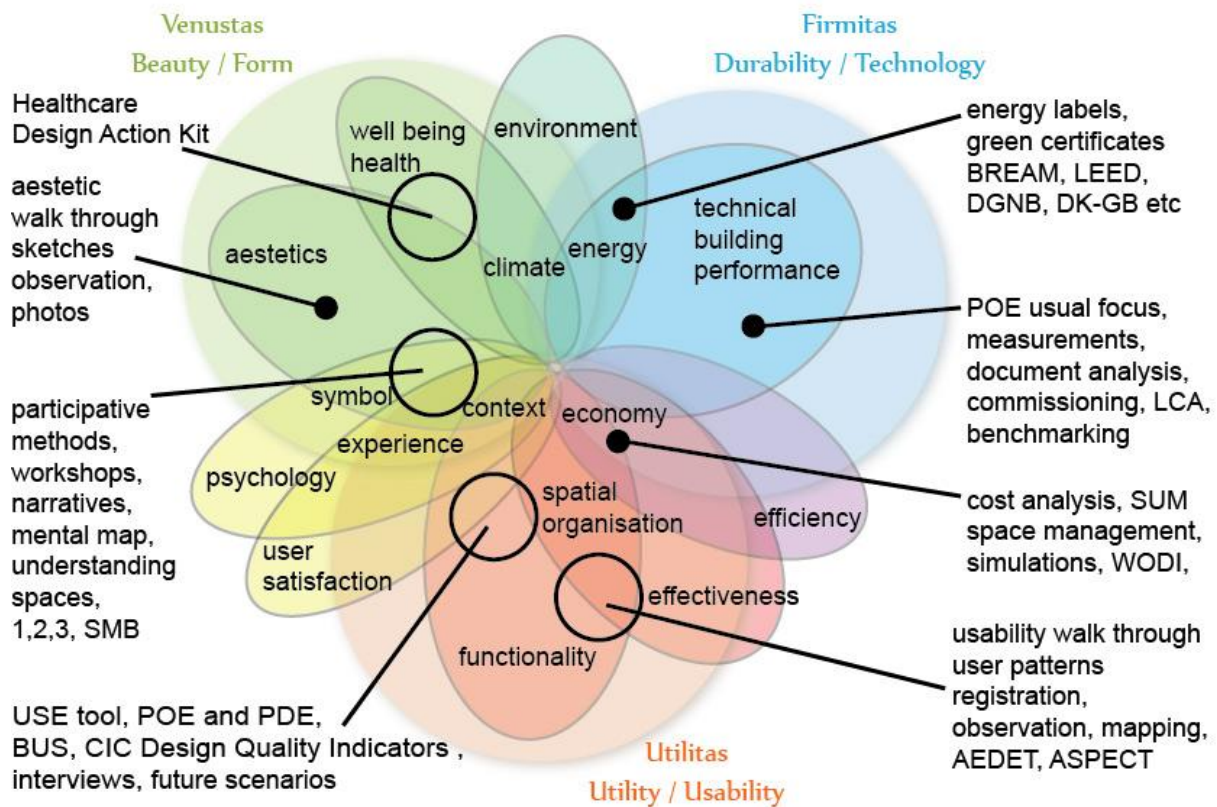
Figure 2 Evaluation Focus Flower model with a few evaluation methods placed accordingly to their main focus

In Table 1 the methods are grouped and explained, and generic methods that can be used in various focus areas are added.

Table 1 Different methods of building evaluation and their main focus. Numbers refer to references

Method	Tools used	Focus
Generic methods		
Benchmarking (23,26)	comparing standard data from own evaluation to others	Generic method, often energy, space utilisation
BRE Design Quality Method (DQM) (22)	Studies of architecture, interior, comfort, life cycle cost, user satisfaction - questionnaire	Architecture, interior, comfort, life cycle cost, user satisfaction
Document analysis (2,17)	Study of documents, drawings etc.	Generic method for various use
Interviews (2,17)	Individual or group interviews	Generic: current use of space, explore experiences of users, satisfaction, efficiency, existing work practice, context
Learning from experience (4,5,36)	- Facilitated group discussions or interviews	Team learning from its experience

Observation, documentation, photographs (2,17)	Observation of facilities, their use and focus topics, documentation, photographs, experience, test, learn	Generic method: beauty, usability, technology
Overall Liking Score (22,36)	Questionnaire (Hardcopy/web based) 7 point scale	Occupant survey. Diagnostic tool
Participatory methods (2,17)	workshops, narratives (story telling), pictures, personas, future scenarios, simulations	Generic method, get various inputs from stakeholders, co-learning
POE broad understanding, PDE (pre-design evaluation) (4,5,18,26,36)	Questionnaire, space measurement, walk-through, survey, focus groups, forum, facilitated group discussions, interviews, workshops	Generic method: Functionality, building quality/impact, user satisfaction, productivity, added value of FM, sustainability, workplace management, aims: testing, monitoring, co-learning, input to decisions, beauty, usability, technology
Survey/ questionnaire (2,4,5,17)	Questionnaire	Generic method: usability, work style and pattern, culture, efficiency, satisfaction
Walk-through, excursion (2,17) A walk around the block (9,25) Observing physical traces- Behaviour vs. Design	Walk-through – structured route and focus areas, positive and negative aspects, walk with everyday users and visitors excursion – free route	Generic method: usability, aesthetics, technology, functional design, behaviour and appearance
Beauty		
Mental map (9,25)	Drawing important places on a map, comparison, discussion	Remembered and used physical spaces of the city, our different relations to them
Place understanding (9,28, 29)	Understand : the causal - intentions, the formal /configurative – the form, the semantic - symbolic	aesthetical expression of a place or architecture, intentions, form and symbolic value
Townscape, Serial vision (9,12)	Systematic sketches and notes	Experience the city space through movement, systematic visual, perception, position, form, changing experiences in continuous movement
Place identity and role (7, 9)	Interviews, workshops: assessment of interaction of physical environment, activities and people's	Identity of a place as interaction of physical environment, activities and people's perceptions, dynamic

	perceptions, culture, cognitive ecology	and will change when factors change
Semantic differential scheme (9,19,21)	Scheme with 8 parameters, i.e.: complexity, originality, pleasantness, people's immediate experience and evaluation of places, comparisons	Comparing people's immediate experiences, beauty, psychology
SAVE (1990) Survey for Architectural Values in the Environment (9,27)	Mapping architectural values of cities, municipality atlas. topographic, historic, architectonic analysis	City's dominating features, structures, character of topographic, historic, architectonic value
1,2,3 method (9)	1- *immediate impressions* - sketches and notes. 2- *analysis, 3- consolidated place assessment*	Place and architecture evaluation, preliminary impressions and feelings about space confronted with scientific analysis
Usability		
AEDET, ASPECT, QIND, CIC DQI (18,22)	Study by designers, not users	Help in design process, functionality
BUS Occupant survey (Building USE Studies), OBU Healthcare POE Method (4,5,22,23,26,36)	- Building walk-throughs - Questionnaire backed up by focus groups	Occupant satisfaction productivity, comfort
CIC Design Quality Indicators (4,5)	Questionnaire	Functionality, building quality/impact
De Montfort method	forum, walk-through	Broadly covers the process review and functional performance
Healthcare Design Action Kit (22)	Checklist for managers, architects and a patient inquiry about building in use	Hospital supporting patients and relatives
Healthcare Design Quality Assessment Method (22)	Many qualitative tools i.e. questionnaire with open questions	Design , architectural solutions, effect on users
Interaction model for the emotional process (Küller, 1986, 1991)	Observations of the physical environment and users/ patients behaviour, mood, social behaviour, activities, resources, eating patterns, etc.	Users relations to physical environment, functionality, psychology. Studies show i.e: homey interior affects wellbeing
Mapping, analysis of space and relations (2)	Analysis of space and relations between them, observations, interviews, organisation, mapping	Space utilisation, functionality, organisation
Overall Liking	User survey on comfort and	Comfort , well-being of users,

Score (4,5)	well-being	how important are various conditions
PROBE, (4,5,22,23,26,31,36)	Questionnaire/- Focus groups/- Visual surveys, energy assessment, evaluation Performance of systems	User satisfaction / occupant survey Systems performance, building engineering benchmarks developed
Quality of city space and 3 types of activities (15)	Systematic assessment of quality through observation of necessary, optional and supplementary (also social) activities in city spaces	City spaces of good quality will have many of optional and supplementary activities
ST&M, ASTM standards (22,26)	measuring if requirements are met	functional requirements test
USE tool (1,2,16,17)	Usability walk-through, user survey, process guideline - the organisation can make it without experts, 5 phases: defining, mapping, walk-through, workshop, action plan.	Usability of the facility, functionality, user satisfaction, productivity
User patterns, time/activity/space studies example: SUM space utilization monitor (CfPB) (2)	self reported and registered study of time/activity/space	Space utilisation
Technology		
BRE Design Quality Method (DQM)	Questionnaire	Architecture, indoor climate, Life Cycle Cost (LCC), user satisfaction
Commissioning (20)	Testing technical installations, measurements, calculations	Validation of performance, interplay of technical installations, life cycle
Energy Assessment and Reporting Methodology (4,5,23,36)	Energy use survey, data collection e.g. from energy bills	Energy use and potential savings
LEED, BREAM, DGNB, DK-GB (26)	Energy measurements, levels	Energy labels, green certificates, high goals, proving excellence
POE traditionally, BPE (Building Performance Evaluation) (4,5,22,23,26,31-35,36)	Questionnaire, Energy assessment, environmental monitoring, space measurement, cost analysis, data collection e.g. from energy bills, interviews etc.	Testing if aims are achieved, systems performance, benchmarks, energy use
WODI, WODI	Web based questionnaire	KPIs database, employee

Light (CfPB)		satisfaction, productivity

3   HOSPITAL CASE STUDIES

To show a sample of the varied use of evaluation methods used currently in hospital projects I present three recent cases.

3.1   Healthcare Innovation Lab (HIL), Herlev Hospital, Denmark.

The case study was conducted at the Gynaecologic Department at Herlev Hospital in 2010-2011 as part of Healthcare Innovation Lab, which was a public-private collaboration project testing the use of simulations and user-driven innovation between users and companies at Hospitals in the Danish Capital Region.

I participated as one of the researchers in a number of design and simulation workshops with a user group from the outpatient clinic. One evaluation method was a scenario-based table-top simulation, a series of evaluations of possible new spatial arrangements and working organisation The simulations have proven to be both time efficient, easy to understand and use for all participants and very innovative in both process and results. The user group succeeded in developing an innovative concept of the future outpatient clinic in terms of spatial layout, work organization, knowledge sharing and technology.

This case has proven that evaluations can be one of the activities for involvement of users at workshops for developing new clinic facilities, but also that evaluation can lead to innovation.

The workshops took place while the architectural competition for new design of the hospital was running. I would suggest using the simulation method either in the *briefing stage* to evaluate alternatives for the future or in the *design stage* to evaluate the preliminary sketch design solutions.

3.2   St Olavs Hospital, Norway.

I have conducted a test of parts of Use tool at Laboratoriesenteret at St. Olavs Hospital, Trondheim, Norway as part of a PhD course "Evaluation of architecture" in November 2012. I guided a few co-students from the course for a walk-through at Laboratory Centre. The route had 4 stops where we observed the focus points Aesthetics and Usability, made notes and discussed our analysis. To finalise I made a pilot test of USE tool survey at 2 locations. The results of USE tool were: broad overview of the facility, structured observations and group summary, but also surprising additional information about usability from user questionnaire. It can be concluded, that for a full overview the observations must be followed up by questionnaire filled at site by employees. The evaluation was not part of the hospital project. It must be noted that the process was not a full USE tool test, but only parts of it, but it gave valuable inputs, that could be used for *briefing* of other hospitals.

3.3   Bispebjerg Hospital, Denmark

This case study took place in Bispebjerg Hospital, Capital Region in Denmark in 2010-2013, where I observed the processes of briefing and user involvement for a major redevelopment of the whole hospital at its site. One of the evaluation methods used was Study trips/excursions – a less structured walk-through process, where the managers and client project group visited other sites for inspiration. The focus was often one specific area ie. logistics, and the location was chosen as the best case within exactly that theme. Interesting cases were not only hospitals, but also other buildings: hotels, airports, to observe the best systems running smoothly. Another evaluation method was User patterns and space utilization, time/activity/space studies. These were run as preliminary studies of used and empty rooms, done by an external party and served as basis for area calculations. Both methods were used in *briefing stage* of the project.

4 HOSPITAL BUILDING PHASES AND SUGGESTED EVALUATION METHODS:

As building performance and usability assessments are complex, they require multi–method strategies using a triangulation of methods and evaluations with multiple perspectives (Lindahl, Hansen, Alexander, 2012). Case studies have shown that hospital projects use various evaluation methods for different reasons. I present a generic example model of evaluation methods with different aims, suggested to use at different phases of hospital projects, in Figure 3.
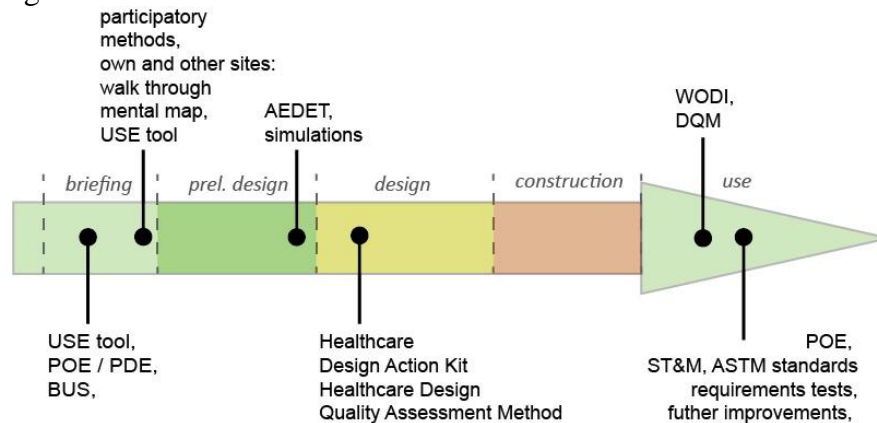
Figure 3 Example model of evaluation methods used at different phases of hospital projects

In the *briefing phase* for new healthcare facilities I propose running usability evaluations of buildings, like POE or PDE (Pre-Design Evaluation) also evaluating alternative scenarios (Ornstein, Andrade, 2012), USE tool, mental map and participatory methods. I suggest that "users can and perhaps should be involved in much earlier stages of project development and in a much broader extent than traditionally in the building sector. One of the possible ways is to make *Usability evaluations* at early design stages, in cooperation of the design team and users of buildings, which are similar to the planned one. In that way co-learning can occur and there can be achieved a deeper understanding of users needs and potential possibilities. The claim is that would result in a better usability of the built environment" (Fronczek-Munter, 2011). Some of the evaluation methods can be run on own existing facilities for future comparison, and for learning which areas need improvement and which are ideal and need to be kept. There should also be walk-through evaluations of best cases, both for inspiration in terms of beauty, usability and technology, but also to provide a common base for the project participants.

In the *preliminary design stage*, I suggest evaluation methods that help the architects in the early process, methods such as User patterns and Learning from experience. The team can get valuable and structured information about space utilisation and uncover the previous experiences, in order to rethink and innovate from the current situation and together with the client choose the right scenarios for the future.

The following *design phase* is where main decisions have already been taken, but there are still lots of complex design solutions that need to be chosen. In order to optimise that process some evaluation methods can be used to learn from other locations and experiences, methods like Adet and especially for hospital projects the Healthcare Design Action Kit to help the functionality issues. Another possibility is running simulations of the preliminary design solutions, which can possibly find improvements in how the architecture and layout can support the future organisation.

The *construction phase* has legally specified procedures for evaluations.

In the *use phase* I suggest running evaluations for testing if requirements are met and possibly make improvements, but also to teach the users how to operate the building and

check the satisfaction of different users and productivity levels in the organisation. Examples are WODI, POE, ST&M.

5   CONCLUSION

Various evaluation methods for buildings are available. I present a new model, the Evaluation Focus Flower, in which the different methods for evaluating buildings are grouped and ordered on the background of the three Vitruvian qualities of Architecture, in order to easily find the right evaluation method fitting the focus area to study. In this paper I give an example of methods that can be applied at different phases of a hospital building project, and propose which evaluation methods can give best input for the initial briefing process of new hospital facilities with ambition of creating buildings with enhanced usability. Additional information about current use of various evaluation methods is provided from three hospital cases in Denmark and Norway.

The models from this paper can structure thinking about types of evaluations, the reasons for doing evaluation, expected process, focus and results and use of the right tools at the various stages of hospital projects. In that way you can secure both meaningful process and results, but also user involvement, providing a common understanding, inspirations, co-creation and innovation for the future hospital facility.

This paper is part of an ongoing PhD study on Hospital Usability Briefing, therefore the interest and further research will continue in optimising methods that can be used in briefing stages for healthcare facilities. The findings have relevance to researchers and practitioners planning new complex facilities of any kind, not only hospitals.

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The Potential for Energy Savings in a School with Outsourced FM

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ABSTRACT

Purpose / Theory: Modern school buildings are complex and interactions between users, equipment, and the building change over time, with energy use often creeping up as equipment is added. Within a contractual structure in which the different roles needed to run a school are outsourced to several agencies, responsibility and accountability for energy use are sometimes mismatched. There is one energy bill but many legal entities and many different groups of people causing it. This paper draws lessons from a case study in a relatively new school in the UK. It examines the effects of the contractual structure, and equipment and building use, on the efforts of the parties involved to bring down high electricity use.

Design/methodology/approach: The case study was run over several months and involved several meetings with representatives from the FM, contractual management, and Information Technology (IT) companies, along with the school manager. Meter data was analysed and group and individual interviews were conducted. Systems thinking was used to better understand the dynamics at play between the building, agencies, and energy consumption.

Findings: The paper illustrates the need for flexibility in FM contracting, the perception of fairness in paying for energy bills (matching accountability with responsibility), and explores the potential for more effective energy saving campaigns in a modern school building.

Originality/value: This paper takes a fresh look at energy management within a school where FM and other services are outsourced. It finds that even when people want to do the right thing their actions and decision making are restricted by contractual arrangements, the availability of information, and operational needs.

Keywords

Facilities Management, Outsourcing, Energy Management, Systems Thinking.

1   INTRODUCTION

There is a need to reduce energy consumption in non-residential buildings to both tackle climate change and make organisations more cost-efficient. The £55bln UK government programme Building Schools for the Future rebuilt over 180 secondary schools between 2005 and 2011[31], and it might be expected that so many new and more efficient buildings would have improved that sector's energy performance, yet a review by (Godoy-shimizu et al. 2011) of Display Energy Certificates[32] revealed that average carbon emissions in secondary schools rose by 8% between 1995 and 2007. There are many possible reasons for this: modern schools host a wide diversity of uses, contain more electronic equipment, more mechanical

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[31] FM World Magazine, 6/7/2010

[32] Display Energy Certificates provide an A-G rating for non-residential buildings based on actual energy use. DECs are required for buildings occupied by the public sector over 1000m^2.

ventilation and more cooling, and they are being used more during out of school hours for community purposes (Carbon Trust 2010). As (Prodromou et al. 2009) found, classrooms are environmentally complex, with high transient heat loads as students come and go, lighting requirements that change with the teaching methods used, and generally full or near-full occupancy levels. Part of the problem lies in everyday energy and building management practices: Building Management Systems (BMSs) may be programmed incorrectly, equipment and lights may be left on when not needed, and unplanned-for amounts of plug-load equipment may be brought into the building.

Post-occupancy evaluations have shown that actual energy consumption in buildings can be much higher than planned for at design stage. For example, CarbonBuzz, an online database of performance data for buildings in the UK, shows average actual performance for UK schools of 56.9 kg CO_{2e}/m^2/yr[33] versus an average of 29.4 kg CO_{2e}/m^2/yr for design performance[34]. Similarly, (Prodromou et al. 2009) state that post-occupancy building performance for new schools can be up to 45% higher than predicted at design stage. (Demanuele et al. 2010) found that the most successful management of new school buildings occurs when occupants are well-informed and/or there are experienced facilities managers available to deal with operational issues, plus data management to track energy targets.

The management of a school building by Facilities Management (FM) inevitably includes responsibility for the management of energy consumption. This role has been traditionally assigned to FM staff because of their role in maintaining the building services that consume energy - in other words, Energy Management (EM) has been seen as a part of providing building services along with making them reliable and safe. However, due to the amount and variety of energy-using equipment in modern schools it's no longer true that a staff focused on providing those services can control the majority of carbon emissions from a building. This paper relates this story of ever-increasing technologisation in schools and the resulting difficulty in doing EM, through a case study done at a school in the UK. It uses concepts from the field of systems thinking to better understand the case study and identify ways of achieving higher levels of energy savings.

2   BACKGROUND
2.1   FM and Energy Management in Buildings
In general, there is a research gap concerning energy management in non-residential sectors. (Payne 2006) found that *'the energy policy field has not done a thorough job of describing energy consumption in the commercial sector';* there is a lack of empirical evidence, with discussion of consumption in the commercial sector *'driven primarily by theory, with very little field data collected on the way commercial sector decision-makers describe their own options, choices, and reasons for taking action.'*(ibid.) A review of research on energy efficiency barriers in non-residential sectors by the UK government's Department for Energy and Climate Change found that *'research was particularly clustered in the industrial and commercial office sectors, leaving most of the other sectors under-researched by comparison. In particular, there was very little specific research on the following sectors: retail, schools, government estate, sports, public offices, heritage and entertainment, healthcare, transport and communications. This distribution of research is unrelated to the relative carbon emissions of each sector.'* (DECC et al. 2012)

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[33] The terms "GHG emissions", "carbon", "CO2" and "CO2e" are commonly used interchangeably in industry to mean carbon dioxide gas or equivalent amounts of other greenhouse gases emitted either directly from the fuel combustion process or indirectly via electricity from the grid.

[34] Carbon Buzz (www.carbonbuzz.org) is an online database of building energy consumption data, created to highlight the performance gap between design figures and actual readings.

However, several authors have written specifically about FM's role in energy management.

- A review of building evaluation practice by (Leaman et al. 2010) identifies the institutional barriers to good energy management, such as the fact that it is difficult to *'set aside capital budgets to include aftercare, tune-up and feedback'* of equipment and buildings once the building is occupied. When new buildings are built through a Private Finance Initiative (PFI) contracting package – which combines the finance, design, build, and operation of buildings for clients in one contract – it could be expected that link-up of installation with maintenance and performance would be easier, but instead *'inside the package responsibilities can be even more tightly divided up than ever, e.g. with the project being sold on after it has been built; and if feedback is obtained, it tends not to be shared.'* (ibid.)
- (Duffy 2000) discusses the practice of the outsourcing of FM functions in the UK's public sector, which has had the effect of reducing the contact between facilities managers, senior management, and end users, despite one of the original goals of FM being that of becoming *'a strategic discipline with a strong voice in the boardroom'*. FM's *'customary technical and service role'* means they are *'almost entirely reactive: in effect, a part of the supply chain, but embedded, more or less by accident, in client organisations'* (ibid.) Duffy finds that this reactive role disempowers facilities managers, despite them having to manage what are often quite complex building services such as BMSs, commercial kitchens, fire and security systems, and air conditioning and ventilation systems.
- A study by (Aune et al. 2009) in Norway revealed the hidden roles performed by FM staff that go beyond the FM handbook. The authors identified *'four important, yet often neglected daily activities of building operators (which we call teaching, housekeeping, managing and juggling)'*. The paper found that facilities managers need to have broad knowledge and sufficient technical training to support these different roles, and that because FM staff carry out these roles they have *'an underestimated potential of contributing to energy efficient buildings'*; because facilities managers *'are able to "see" both users and energy, they were in a unique position to improve the interplay between technology and use and to contribute to more energy efficiency.'* (ibid.) Whether this potential is helped or hindered by outsourcing is not examined in the paper, but making use of this potential would require acknowledgment by all building users that the FM role goes beyond maintaining building services systems.

To summarise, there is a lack of understanding of reasons for high discrepancies between design and actual building performance, FM staff are crucial in implementation in any efforts to save energy, and changing the role of FM to be outsourced building managers, rather than embedded within the organisation, has made this more difficult.

ENERGY MANAGEMENT

The need for end-use services (e.g. computing, lighting, heating) to meet organisational needs leads to purchase and use of energy-using equipment (e.g. computers, light fixtures, heating systems), which lead to energy being consumed (electricity or gas). The annual energy consumption of a piece of equipment in kWh can be calculated as the number of hours it is turned on per year multiplied by its kW rating, times the percentage of time equipment is actually running while turned on (100% for lighting but only around 50% for servers) and the actual efficiency with which it runs. If there are n pieces of equipment in a building then total energy use is the sum of energy use per piece of equipment from 1 to n, with the four variables having unique values, as shown in Equation [1].

$$Total\ Annual\ kWh\ in\ Building = \sum_1^n(annual\ operating\ hours\ (h) * power\ rating(kW) *$$
$$\%\ of\ time\ running * \frac{1}{efficiency\ (\%)}) \hspace{3cm} [1]$$

Energy savings can be achieved by affecting the values of these five variables through several types of interventions, shown in Table 1.

Table 1: Variables Influencing Energy Use and Ways to Reduce Them

Variable	Interventions
N	Reduce total amount of equipment through consolidation of devices and/or reduction in service levels (e.g. fewer lights per room)
operating hours	End-user behavioural change programmes to get users to switch off equipment when not in use, automated controls, improved programming of building management services software that controls central building services
power rating	Reduce power rating by purchasing higher efficiency equipment or down-rating equipment
efficiency and % time running	Improve efficiency by maintaining equipment regularly, use of specialist control software, and ensuring correct operating environment

SYSTEMS THINKING

The term "systems thinking" broadly refers to an approach to working with the world that recognizes the complexity and interconnectedness of things within both engineering and people systems. The International Council on Systems Engineering describes systems thinking as '*a way of thinking used to address complex and uncertain real world problems. It recognizes that the world is a set of highly interconnected technical and social entities which are hierarchically organized producing emergent behaviour.*' (INCOSEUK 2010) The field of systems thinking covers a wide range of analytical and simulation methodologies, including problem structuring methods that provide ways to systemically approach a complex system, and System Dynamics (SD) which uses computer simulation to model real-world systems so that they can be diagnosed and solutions to problems can be found.

The SD methodology involves several stages: conceptualization (problem definition and system conceptualisation); formulation (positing a detailed structure and selecting the parameter values); testing (model behaviour and model evaluation); and implementation (policy analysis and use) (adapted from (Luna-Reyes & Andersen 2003)). One tool commonly used for problem definition is Causal Loop Diagramming. Causal Loop Diagrams (CLD)s are '*visual representations of the dynamic influences and inter-relationships that exist among a collection of variables*' (Spector et al. 2001). CLDs can help by: (i) quickly capturing hypotheses about the causes of system dynamics; (ii) eliciting and capturing the mental models of individuals or teams about the system; (iii) communicating important feedbacks believed to be responsible for a problem (adapted from (J. D. Sterman 2001)). CLDs cannot be parameterised or simulated, and they don't communicate levels of change in stocks and flows of equipment, information and people; however, they are a good way to represent key system elements, the causation between them, and important feedback loops; they can form the basis of a full SD model.

One of the key concepts in SD is the understanding of structure and its relation to system behaviour. In fact (J. Sterman 2000) says that the behaviour of a system *arises* from its structure. So if behaviour arises from structure, how much agency do individuals have to change things? (Richardson 2011) explores this question by asking: '*Who are the actors in the dynamics of a complex system and how do their perceptions, pressures and policies interact? Are we parts of the problem, or parts of the solution, or merely bystanders watching*

difficult dynamics play out over time?' According to (Lane 2000) it is not either-or; the SD approach involves *'a feedback model of the relationship between agency and structure'.* Thus, a SD model will always include both structure and agent decision-making and the dynamical behaviour between them.

In this paper we use causal loop diagrams to represent our dynamic hypothesis about the causation of levels of energy consumption at the case study school – the conceptualisation stage of SD modelling. We use the concepts of structure, behaviour and feedback to interpret evidence from the case study, and to identify potential types of actions that could be implemented to reduce energy use. Future work is expected to build initial CLDs into a full SD model, which would enable model simulation and scenario testing of possible interventions.

3   CASE STUDY

The case study was done at a secondary school built in 2007 in the UK under a Private Finance Initiative (PFI) contract. There are five agencies involved in its running: the PFI company owns the building and leases it to the school; the FM company maintain central building services and ensure health and safety and security; and there are subcontractors for the provision of Information and Communications Technology (ICT) and catering. The school pays a lease fee to the PFI which covers FM. Gas use is low against national benchmarks, but electricity use is high. Contractually, energy management is the responsibility of FM. Each year a consumption target is set for the coming year's energy consumption based on an expected reduction in the previous year's consumption, usually around 5%. If at the end of the year energy use is different to the target by up to plus or minus 10% then FM get or pay the difference. If savings are greater than 10% then they share the savings with the school. Thus, if savings are made each year the target will gradually fall. This arrangement often has the somewhat perverse result of discouraging facilities managers from achieving all the savings they can in one year, as that result will make savings much harder the following year.

Figure i shows the basic types of equipment within the school building, who is responsible for procurement and maintenance, and who uses them.
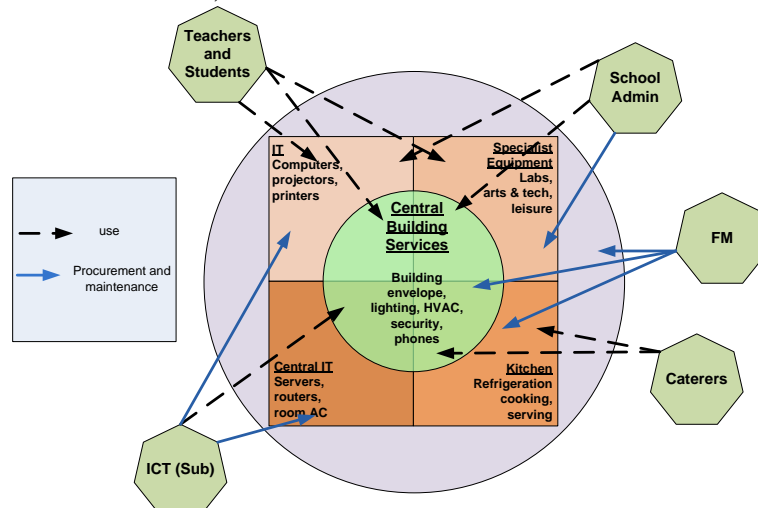

Figure i: Types of Equipment in Use at Case Study School, Which Agencies Procure and Maintain them, and Which Agencies Use Them

For the first three years of occupancy, an error made in the original governing agreement for the contract meant that the school did not pay for its electricity. Once this error was rectified,

there was suddenly an awareness of how much they were using and efforts were put into place to reduce consumption. Actions included the following shown in Table 2.

Table 2: Initial Actions Taken by School

Action	Effects on Values in Equation [1]
a switch-off campaign aimed at end users (school staff and students)	reduced operating hours
a policy that gave FM staff permission to turn off any equipment left on at the end of the day such as printers, projectors, etc.	reduced operating hours
a programme of consolidation and upgrading of central ICT service equipment such as switches and routers	reduced total amount of equipment (n) and improved efficiency and power rating
changes to scheduling of central building services equipment such as heating, cooling, lighting and air handling (reducing operating hours).	reduced operating hours

After some initial success in reducing consumption, savings reached a plateau and all concerned had run out of ideas for further actions. At this point, the researcher was invited to come into the school to help find further opportunities for savings, and a trial was run from March to September 2012. The trial involved several group meetings, analysis of meter and submeter data, walkthroughs of the building, an equipment audit, and semi-structured interviews. At the end of the trial, a suite of recommended actions was presented to the group by the researcher; however most of these were not taken up.

Figure ii shows the past two years of consumption history. The high data points are school days and the low data points are weekends or school holidays. Significant savings were achieved during the 2012 summer holidays, due to the site manager's actions in turning off a range of equipment not previously turned off during holidays, resulting in a rather dark and stuffy school building for the small number of staff working there over the holidays.
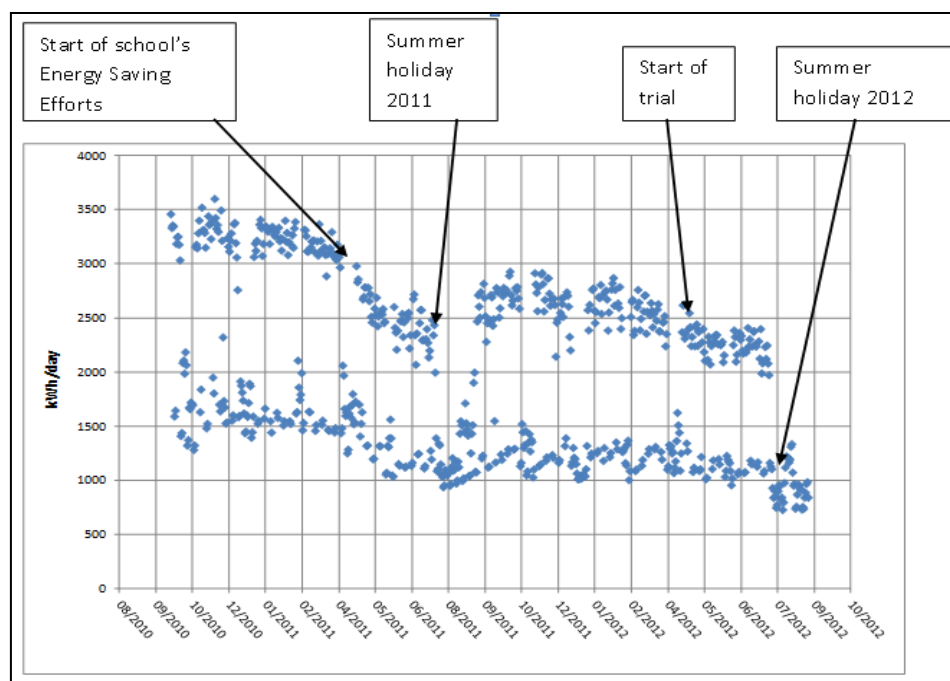

Figure ii: History of Energy Use at Case Study School in kWh/day

4 UNDERSTANDING CAUSATION

The causal loop diagrams presented in this section were created to communicate our hypothesis about the factors influencing energy use in the school and the causation between them including feedback loops. This is an interpretation (a mental model) of the real world created by the authors, intended to be useful solely for the purpose of understanding energy use. Figure iii shows the hypothesis about the primary positive feedback loop influencing consumption before the school started receiving energy bills.
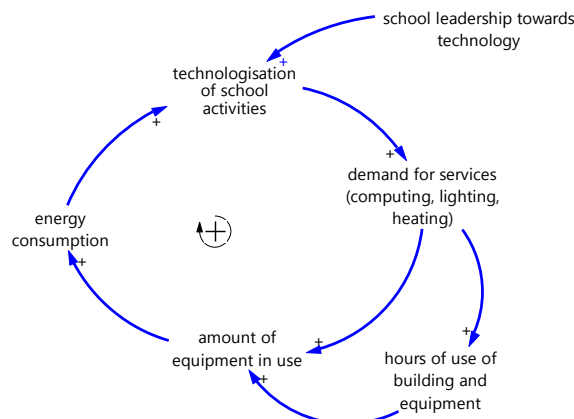

Figure iii: Positive Feedback Leading to Increasing Energy Consumption

Once the school started to receive bills they realized that consumption was much higher than other comparable schools and the financial penalties for this, so started to take action to reduce it. The CLD in Figure iv shows the addition of a balancing loop that decreases energy use over time, which is driven by awareness of energy use through receiving energy bills, which leads to actions to reduce energy use. A secondary feedback loop feeds into the main balancing loop, when willingness to act increases the likelihood of actions to reduce energy use, which leads to savings for the agencies involved, which leads to more willingness to act.
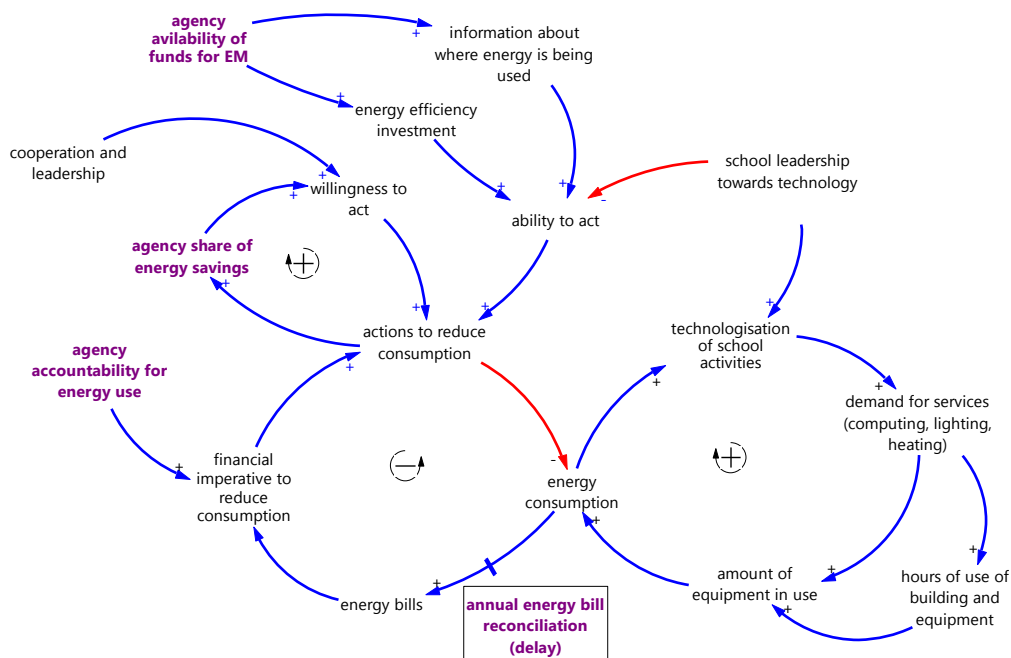

Figure iv: Positive Feedback Leading to Increasing Energy Consumption

What enables action to reduce energy use is information about how much and where energy is being used and the ability to act (behavioural changes or upgrading equipment). The school has a strong technology focus and prioritises access to ICT and other technologies such as photography and graphics for students, and this impedes the balancing loop somewhat, as the total amount of equipment continues to slowly grow.

Four influences on the balancing loop arise from the PFI contracting (shown in purple):

1. **Agency share of energy savings**: FM takes the hit on differences less than 10% above or below target, and the school gets a share of savings over 10%. If energy use is within the target range, FM does not have a large incentive to make further savings; however, this is where the school would see the benefits. If the school make effort to reduce consumption but savings are less than 10% then they get nothing back.

2. **Availability of funds for energy management:** FM will invest if they can see that it will bring additional income or avoid a fine for over consumption, but investments must meet their internal payback rules. The school have no budget for energy efficiency, presumably because this is supposed to be covered under their PFI lease payment.

3. **Agency accountability for energy management:** Accountability is not directly related to responsibility (i.e. cause) of energy use; the school are responsible for a large part of energy use (estimates of up to 50%) through end-use equipment and yet FM take the majority of the accountability.

4. **Annual energy bill reconciliation:** There is a delay in the energy-reducing balancing loop which weakens it, because energy bill reconciliation is only done once per year, and the negotiations are complicated and not fully understood by all of the parties. Additionally, the school does not currently see the effects of utility tariff increases.

5   UNDERSTANDING POTENTIAL

To help understand where the potential for energy savings is, we can use the concepts of structure (things that accumulate over time and change very slowly) and behaviour (e.g. habits of end users and everyday decision making) from SD. Changing behavioural factors is quicker, but because behaviour happens partly a result of structure, deeper and more lasting changes cannot be made without addressing structural influences – which are more difficult to change. Table 3 analyses the nature of the main driving variables in the CLD in Figure iv.

Table 3: Structural and Behavioural Factors Influencing Energy Use, and Potential for Change

Factor	Category	Observed Effects	Potential for Change
agency accountability for energy use	structural	Although accountability was partially shared between school and FM, its assignment was felt to be unfair by many. When the trial started, FM felt they had done all they could to reduce central building services energy use, but were still being pressured to reduce more – even though they suspected that high use was because of school management decisions and	Change the contracting to make all the subcontractors and the school management accountable for the portion of the energy bill they are directly responsible for. So, caterers would pay for the energy they use for catering, and similarly for ICT and the school. This would need detailed submetering available in real time, which would enable the agencies to manage energy use and be billed correctly.

		staff behaviours.	
agency availability of funds for EM	Structural	There were no funds for EM from any of the agencies, except FM had installed some lighting controls that were expected to pay back quickly. This factor ties in with accountability.	A change in contracting would probably lead to agencies making more funds available. However, a formal agreement that requires all agencies to put aside a small amount purely for EM could prove cost-effective in the long term.
agency share of energy savings	Structural	This is the carrot factor, and it motivated the school who were seeking to get funds to supplement a very tight school budget. However, this did not motivate FM as much because higher levels of savings don't benefit them.	This would be solved by the change in contracting described above. The only problem would be where there is fuzziness about use and responsibility for equipment and what is reasonable to request from the FM.
information about where energy is being used	Structural and behavioural	This problem was stalling progress at the start of the trial. There was a lack of knowledge of what equipment is in the building (i.e. the "n" from equation [1] is not known) and how much each type of equipment was consuming. Information about the submeters had been lost and there was no central equipment inventory, but separate ones in each agency.	Putting automatic meter reading on submeters is essential to allow more active management of energy by department and by agency. In addition, putting meters on individual pieces of equipment would reveal more useful information. Finding information on the "hidden" equipment that's always running in the background would explain the "mysterious" baseline use that confounded everyone.
cooperation and leadership	Behavioural	The school business manager's leadership helped to kick-start the energy saving campaign and there was genuine desire to meet goals. However, cooperation was often lacking in the correct use of equipment by staff. It's not uncommon for teachers to put on the AC full blast and open the windows!	Better communication between agencies on choice and use of equipment would enable more savings. There are many urban myths about how equipment should be used that are incorrect. Setting up two-way communication channels between all the agencies would enable this.
amount of equipment in use	Structural (fixed equip) and behavioural (new equip)	The building is sophisticated and there is a minimum amount of equipment running all the time to serve security and H&S needs. Complicated controls are needed to deal with the wide variety of equipment. New equipment is continually being added to support school activities, although some is also taken away when it reaches end of life.	An overarching equipment management policy that monitors and sets targets for the amount of equipment in use could prevent an ever increasing inventory. Whole-life costing of new equipment that takes into account running costs would encourage more efficient products being procured. The value of services should be evaluated against the cost of energy needed to run them.
school leadership towards technology and technologisation of school activities	structural	This affects the amount of equipment used in everyday school activities. Most classrooms have projectors, and there is approximately one computer per student (1200) as well as 7 photocopiers, 53 printers, 18 fridges, 15 laminators, and a wide range of other specialist equipment such as graphics and	This is dependent on the ideas of what constitutes good teaching practice. Because the school is focused on teaching technology this is probably not going to be changeable. There are some schools that have taken on the sustainability agenda and have achieved a low-carbon and successful school, but these all had leadership from the school

		photography.	principal.
hours of use of building and equipment	Behavioural	This was the first place to start and actions have helped to reduce energy waste that was occurring because of people leaving equipment on when not needed and not managing the building well to keep in heat or coolth.	More can always be done to reduce energy wastage, such as smarter controls and programming of the BMS. However, the amount of savings is limited because equipment will always have to be switched on during those hours when it is needed.
demand for services (computing, lighting, heating	Behavioural and structural (school culture)	Subcontractors are contractually obliged to meet the needs of school staff and students; they cannot refuse a request for, e.g., more AC. There is rarely push back from the support services or the school admin when teachers request equipment and longer opening hours, while budget allows.	The demand for services depends on curriculum needs, perceptions of comfort and convenience, and the range of subjects offered to students. Some of these demands are changeable in terms of staff accepting lower levels of service, and some are not. It may be possible to get teachers to question their need for services.

6   CONCLUSIONS

The technical complexity of modern school buildings, and the amount and diversity of equipment in use, pose challenges for energy management in schools. Complex contractual arrangements on responsibility for maintaining equipment and on accountability for energy use in a PFI structure can further contribute to energy management being a problem. Splitting the benefits of energy savings between parties can weaken the incentive to act, and not knowing which agency within a multi-agency structure is causing which parts of the total bill can create resentment between parties when they are continually being asked to reduce consumption.

This paper has taken a look at this problem through examination of a case study school with the use of concepts from systems thinking and System Dynamics. The authors first identified a positive feedback loop that was leading to ever increasing amounts of energy use, partly due to the use of technology in teaching, and then a rather weaker balancing loop to reduce consumption was identified, influenced by incentives such as high energy bills and income from energy savings. The structure of contractual arrangements led to part of the difficulties, with little money available for energy efficiency investments and agencies only being held accountable once per year at reconciliation time. The main sticking point was lack of information about what equipment was running in the building and causing the energy use, partly due to the lack of real-time submetering and partly due to there not being a central register of equipment.

The main factors influencing energy consumption were analysed for their interactive effects, and identified as structural or behavioural, leading to proposals for actions to change the current dynamics, principally: rewriting contracts so that accountability and responsibility are better matched; making budgets available for energy efficiency; maintaining knowledge about what equipment is in use and how much energy it's using; and, proactive energy management by all those with the power to make decisions that ultimately lead to energy use. These actions would allow the school to be run with lower carbon emissions while supporting the prime objective of the system – to provide an education specialised in technology to secondary school students.

ACKNOWLEDGMENTS

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The nature of innovation processes in FM

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ABSTRACT

Purpose: This work investigates the dynamics of interaction between stakeholders of Facilities Management (FM) innovation and improvement processes. The aim is to understand how the complex value chain of FM services influences innovation processes within this field.

Theory: This study combines theories on innovation in services with research focused on the empirical field of FM. More specifically, the analytical framework for this study applies the differentiation between reactive and proactive innovation processes by Toivonen and Tuominen (2009) to the value chain identified by Coenen, Alexander, and Kok (2012) and, by doing so, it emphasizes the dynamics of interaction between stakeholders.

Design/methodology/approach: This work applies a qualitative methodology based on abduction. The data collection was carried out in the Danish FM field through an explorative study, which included 14 semi-structured interviews and archival data, along with three in-depth interviews. The data analysis was carried out during and after the data collection, and was aided by the qualitative data analysis software Atlas.ti.

Findings: The findings suggest that the complex value chain that characterizes FM has a threefold impact on the nature of innovation processes within this field. Firstly, end-users of FM services are usually not involved in innovation processes, although they might sometimes play a role as initial drivers. Secondly, FM services are intangible but more easily reproducible than other services, which impacts on the diffusion of innovation. Finally, the evaluation of the added value derived from innovation depends on and changes according to a heterogeneous set of internal and external stakeholders, of a higher complexity as compared to that of other services.

Originality/value: This work aims at contributing to the literature on innovation in FM, by combining two frameworks from the different research areas, i.e. innovation in services and FM. The originality of the findings stands in depicting the distinguishing characteristics of FM, and their impact on how innovation is characterized within FM as compared to other service contexts.

1 INTRODUCTION

Services are an important part of economic activities and employment in the developed countries, and involve a significant share of innovative effort (OECD, 2005). Among services, Facilities (or Facility) Management (FM) is increasingly being recognized as a growing business ground and scientific field. Throughout the last decades, FM scholars have intensified their research efforts around the need for innovation that this field is recently experiencing. Both researchers and practitioners have moved away from the paradigm that saw FM as supporting function for the core business of organizations; and have begun to highlight the added value potential of FM (Cardellino & Finch, 2006; Goyal & Pitt, 2007; Jensen, 2008, 2010).

Although the debate around it is still vivid, existing research has confirmed the value adding role played by innovation, among other factors, within FM (Jensen, 2010; Scupola, 2012). The literature on innovation in services is widely developed, but a specific focus on the field of FM services is still lacking and yet is needed to support the development of this research area (Jensen & Andersen, 2010). More specifically, scholars have depicted a high level of complexity in the value chain that characterizes FM (Coenen et al., 2012), which might therefore involve distinguishing features as compared to other services. The role of stakeholders in innovation within the context of FM has been addressed from different perspectives (e.g. Jensen & Andersen, 2010; Noor & Pitt, 2009), but it has not yet been investigated whether and how there is a causal relationship between the role of stakeholders and the nature of innovation.

This study combines theories on innovation in services with research focused on the empirical field of FM to better understand innovation within this particular context; and investigates the dynamics of interaction between stakeholders of FM innovation and improvement processes. The aim is to understand whether and how the complex value chain of FM services influences innovation processes within this field. The research design includes an explorative study among FM practitioners in Denmark, a thorough literature review, archival data and three in-depth interviews.

The research question, on which this work focuses on, is:

How does the structure of the value chain impact on innovation processes within the context of FM?

The paper is structured as follows. The introduction depicts background, motivation and aim of the study, as well as the research question. In the theoretical background the problem area and scope of the study is defined; relevant existing literature is presented and the analytical framework is introduced. The third section is dedicated to the methodology, while the fourth depicts analysis of findings and discussion of results. Finally, the conclusion outlines the value, the implications and the limitations of this study, along with suggestions for future research.

2 THEORETICAL BACKGROUND

Due to the inner characteristics of services, innovation in this industry has often been found to be non-technological and involving small and incremental changes in processes and procedures (Jong, Bruins, Dolfsma, & Meijaard, 2003). Aiming at clarifying the concept of service innovation, Toivonen and Tuominen (2009) outline that it is crucial to distinguish the outcome from the process of innovation in services. They start by presenting three criteria, derived from Schumpeter, which can be used to separate innovation outcomes and the process that leads to them from other kinds of renewal in organizations. First, innovation is an idea, which is developed and carried into practice. Secondly, innovation provides a benefit to its developer, which usually derives from the added value perceived by the customer

(Sundbo, 1997). Finally, innovation needs to be reproducible, which means that it has to be applied more than once. The first two criteria are relevant for both goods and services, but the third one is particularly important when defining service innovation, as many new services are actually ad hoc projects, and can therefore not be considered as innovations (Toivonen & Tuominen, 2009).

2.1 Innovation in FM

FM is a relatively new and growing business field and scientific discipline that can be categorized as a set of services (Jensen, 2008). Following the definition of FM as set of support services, FM involves a heterogeneous range of stakeholders from both the supply and the demand side of the service providing (Coenen et al., 2012).

According to the framework by Coenen et al. (2012), when one or more FM services are outsourced, two main parties are involved in the supply of services: the internal function responsible for the procurement of FM services and the outsourced service provider(s). Three key stakeholders are involved in the demand side of FM services: clients, customers and end-users. The client is the organization as a whole, which specifies and orders the provision of FM services by means of FM agreements with the internal FM function. The customer is the internal FM function, which manages the relationship with the outsourced service provider(s) through service agreements. Finally, the end-users are the employees of the organization, who receive the FM services (Coenen et al., 2012). Coenen et al. (2012) have not explicitly included the role of the customers of the client organizations in their framework. Nevertheless, they present the map of the key stakeholders of value in FM as a hybrid that involves elements of the Business-to-Business and the Business-to-Customers environment. Depending on the case, the end-users are not only the employees, but also the customers of the client organizations. On the one hand, the variety of stakeholders on the demand side implies that they perceive the value created by facility service in different ways. On the other hand, value co-creation takes place within the provision of FM services, thanks to the interaction of the various stakeholders on both demand and supply side (Coenen et al., 2012). If FM services are not outsourced, but rather provided internally by the FM function, the variety of stakeholders diminishes, but value co-creation still happens among the internal stakeholders. Figure 1 presents a visualization of the stakeholder dynamics in the FM value chain.
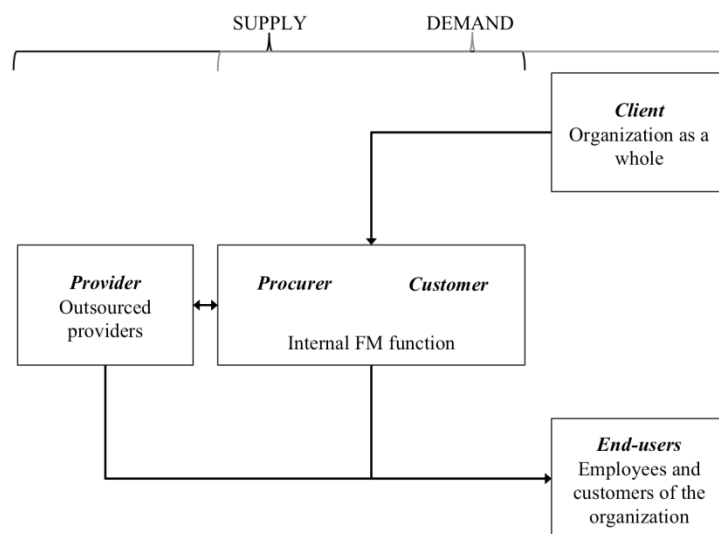

Figure 1: A visual representation of stakeholder dynamics in the FM value chain

2.2 The analytical framework: Innovation processes in services and the FM value chain

The purpose of this study is to shed light on the nature of innovation processes in services within the context of FM by investigating the dynamics of interaction between stakeholders within the service innovation process. The focus is therefore on the innovation process within FM. This work adopts Sundbo's (1997) definition of service innovation process as the process through which an idea for a new service, or for the renewal of an existing service, is developed and carried into practice to offer added value to the customer and provide benefit to the provider. To be an innovation, the renewal must impact not only on the developer but involve elements that allow reproduction in different contexts (Sundbo, 1997). Toivonen and Tuominen (2009) exclude new-to-the-firm services from their study, due to the need for reproducibility, which characterizes Schumpeterian innovation. In this work, new-to-the-firm services are however included among innovations, when they assume specific character in each firm, and are later on diffused and reproduced across the organization. This decision was taken during the explorative study, and is justified by the characteristics of FM services as depicted in the analysis section.

The innovation process in services is typically characterized by a low amount of systematic practices and dedicated resources, although it is possible to recognize innovation flows (Toivonen & Tuominen, 2009). Toivonen and Tuominen (2009) present two ways of characterizing these innovation flows. On the one hand, they distinguish between (a) R&D, (b) rapid application and (c) practice-driven models of innovation processes in services. On the other hand, they emphasize the role of key drivers for innovation, and separate reactive from proactive innovation processes. This latter typology has been chosen as the ground for the analytical framework used in this work, for two main, related reasons: (1) it eases the investigation of the dynamics of interaction among stakeholders within the FM context; (2) this distinction emerged from the field during the explorative study, before the literature on innovation processes in services was approached, and thus appeared as an appropriate analytical lens.

The main differentiating element between reactive and proactive innovation processes is the driver, which originates innovation processes. Reactive innovation processes are typically initiated because the organization has a more or less urgent need to renew its operations, and are thus driven by either (a) internal goal or objectives; or (b) demanding customers. On the other hand, proactive processes start with the identification of new opportunities and ideas that the service provider wants to test. Here the most important drivers are usually ambitious actors, whose strive is facilitated by an innovative organizational culture.

While Toivonen and Tuominen (2009) set the innovation processes in the dyadic relation between provider and client, in FM the relationship between supply and demand is more complex (Coenen et al., 2012). The analytical framework for this study therefore applies the differentiation between reactive and proactive innovation processes to the value chain identified by Coenen et al. (2012) and, by doing so, it emphasizes the dynamics of interaction between stakeholders. The unit of analysis is the network of internal and external stakeholders presented in the value chain framework.

3 RESEARCH METHODOLOGY

The methodology applied for this study is based on abduction as described by Dubois and Gadde (2002). The research process was characterized by the continuous evolution of the empirical and theoretical framework, along with the case analysis (Dubois & Gadde, 2002). The investigation started with an explorative study, generally aimed at understanding innovation and improvement processes within FM services. The explorative study was

necessary given the high degree of novelty that characterizes the study of innovation within the empirical field of FM services. While collecting the data, existing research was researched aiming at a proper matching between the empirical world and existing research. First the literature on innovation in FM and innovation in services was reviewed; and then compared with the evidence in the empirical data (Miles & Huberman, 1994). The need for theory evolved throughout the research process, and was characterized by several episodes of re-direction (Dubois & Gadde, 2002), which supported the identification of the best analytical framework to address the research question. The research focus was narrowed while the investigation progressed (Dubois & Gadde, 2002), and the frameworks of reference (Coenen et al., 2012; Toivonen & Tuominen, 2009) were chosen.

Throughout the explorative phase, the data were collected through 14 explorative, semi-structured interviews among FM services practitioners (clients; providers; consultants) from the Danish FM field. The interviewees were selected with a combination of convenience (at the beginning of the study) and snowball (later on) sampling criteria (Eisenhardt, 1989). To complement the explorative study and ensure triangulation (Eisenhardt, 1989; Yin, 2009), archival data – i.e. reports, power point presentations, emails, newsletters, corporate brochures – were collected both from the interviewees and from secondary sources, such as corporate websites and during conferences. Furthermore, the interviewees from two of the client companies agreed on carrying out three in-depth interviews, which aimed at gathering more details and examples of the innovation processes that were spotted during the explorative round.

The constant comparison of theory and data was crucial for the identification of patterns of relationships among the concepts arising throughout the interviews. This supported both the sharpening and comparison of the theoretical constructs with the actual data (Eisenhardt, 1989). The qualitative data analysis software Atlas.ti (v.6) aided the analysis of the data, which, following Dubois and Gadde (2002), was carried out both during and after the data collection.

4 ANALYSIS OF FINDINGS AND DISCUSSION OF RESULTS

4.1   Innovation in FM

To depict the features of innovation in FM, the empirical findings and the existing literature on FM were confronted with the theories on innovation in services, which ground the framework by Toivonen and Tuominen (2009). Table 1 collects and summarizes the empirical findings on the characterization of FM as compared to services in general. In the table, the first two columns are dedicated to the comparison between the characteristics of services in general and how they apply to FM, while the third column outlines how the specific FM features impact on innovation processes within this context.

Table 1: The characteristics of FM as compared to services in general

Literature on services	Empirical evidence in the FM context	Impact on innovation processes in FM
Services call for a differentiation between inputs and resources: in services inputs are the customers themselves, while the resources are the facilitating goods, human and financial resources,	In FM, the demand side of the service process is fragmented across the client organization, the customer/internal FM function and the actual end-users. Applying Fitzsimmons and Fitzsimmons's (2006)	The data depicts that, in practice, the management of resources takes place through (a) contract management, as underlined by Coenen et al. (2012); and (b) management of the personal interactions between the internal and the

whose combination allows to respond to customers' expectations (Fitzsimmons & Fitzsimmons, 2006). In fact, although service providers can organize the resources in advance, the service process does not take place until the customers themselves are present to receive it.	differentiation in FM shows that the service process actually takes place when the employees and customers of the organization receive the service procured by the internal FM function and provided by the external provider. Therefore, the end-users – employees and customers of the organization – can be categorized as the inputs of the service process. On the other hand, the internal FM function, as customer of FM, takes care of managing the resources by procuring FM services from the external providers. The interaction between end-users, customers/internal providers and external providers ensures that the facilitating goods, human and financial resources are combined the right way to ensure the best response to the expectations and needs of the organization as a whole.	outsourced facility managers, who are responsible for the specific project. This has an influence not only on the daily service provision, but also on the innovation processes, which are grounded in the management of the interactions among stakeholders. The internal FM function allocates the resources by mediating between the needs and expectations of the end-users and those of the organization as a whole.
A service can be depicted as such only when it is delivered, as opposed to goods that are produced (Jong et al., 2003). This characteristic differentiates services from tangible products. Whereas the simultaneous production and consumption process of the former often makes them heterogeneous and hard to be reproduced, the latter tend to be homogeneous and easily replicable.	In FM, production and consumption is not always simultaneous. This does not mean that FM services are not perishable. Nonetheless, as opposed to other services, FM services are produced in the 'back office'. In many cases, such as for cleaning, space allocation or building maintenance, the consumption of the services follows their provision, and there is not direct contact between the providers and the end users. Even in those cases, where the production and consumption is simultaneous, such as catering and reception, the	On the one hand, FM services are intangible as other services, as their purpose is to ensure that the core business of the organization is produced. On the other hand, they can be reproduced in different settings and contexts. This feature, however, does not make FM services homogeneous as tangible goods, but rather allows innovation to be more easily reproduced.

	supportive nature of FM services makes the needs they aim at satisfying more homogeneous, and thus allows easier reproduction.	
Customers experience services individually, and their impression of it is at the basis of the perception of the service itself (Fitzsimmons & Fitzsimmons, 2006).	In FM, it is the end users that experience the service individually, the customers that evaluate the quality of it, and the organization as a whole that finally benefits from (or is hindered by) it. To do so, the FM functions try to consider employees expectation through dedicated surveys and email when designing new services.	The customers/internal FM functions need then to find a balance between the expectations of the individual end users, and the welfare of the client/organization as a whole, in the daily activities and when dealing with innovation processes. As a result, the end users/employees are usually excluded from the improvement and innovation processes, as each of them has a personal perception and opinion on how the FM services should be provided.

4.2   The innovation process in FM

The data collected among FM practitioners confirm the distinction between reactive and proactive innovation processes. In table 2 and table 3 the findings relative to respectively reactive and proactive innovation processes are presented. The findings are organized according to the four stakeholders identified in Coenen et al. (2012) and are particularly focused on highlighting the dynamics of interactions among stakeholders.

Table 2: Reactive innovation processes in FM

Actors	Reactive innovation processes	Examples
Client-organization	The organization as a whole originates reactive innovation processes mostly by intervening at the strategic level. For instance, when there is a shift in the strategy of the company, the strategic goal and objectives of the internal FM function need to be adapted accordingly. This usually starts a reactive innovation process. The internal FM function and the external providers(s) then work together at the tactical and operational level to ensure the implementation of the process.	The environmental strategies are set at the corporate management level. When the environmental strategies change, reactive innovation processes are launched to cohere with the new goals and objectives by the internal FM function and developed together with the external suppliers.

	Similarly, reactive processes that intervene on aspects concerning the organization as a whole always need to be approved at the corporate level before actually being initiated.	In the case of space management and space allocation, in some cases reactive innovation processes have an influence on the Real Estate Strategy, which is directly related to the needs and expectations of the organization as a whole.
Customer and internal provider-internal FM function	The internal FM function originates reactive innovation processes mainly at the tactical level and at the operational level, when wastes and inefficiencies arise in the middle- and short-term FM operations.	When noticing inefficiencies in the space management operation, the internal FM function reacts by originating an innovation process to improve the space management services, e.g. by adopting an IT support system or by hiring a space manager, in accordance with the external providers. In some cases, external actors such as academics or representatives of other industries are called in to support the development of the innovation.
End-users-employees and customers of the organization	The employees can be the originating driver of reactive innovation processes at the very operational level. Similarly, especially when the client organization operates in the Business-to-Customers environment, the customers of the organization might act as drivers. In some cases, the end-users can, in fact, be the ones that notice failures in the services as they are currently provided. If the failure is then signaled to and recognized by the internal FM function, a new or innovated service is procured from the external supplier(s).	The IT systems that support FM and the related service provision are usually built precisely to support the initiation of a reactive innovation process when necessary. Very often, in fact, FM IT support systems are built with modules, which contain information about the different aspects of each service to be provided to the end user. When an employee signals an issue, it is possible to visualize the "big picture" around it, and decide whether a reactive innovation process is needed. The customers of the client organization can, on the other hand, can signal issues and require modification in the provided services by using the Customer Relationship Management (CRM) system of the service provider, when available.
External provider(s)-outsourced providers	The workers of the outsourced providers are those who operate on the field and actually take care of the daily provision of services. Therefore they might originate	In one of the client companies included in study, the external provider has suggested to start a reactive innovation process after notifying the inefficiency in the

	reactive innovation processes when signaling wastes and inefficiencies to the internal FM functions.	provision of security and reception services. ! The decision on whether to start the reactive process is a responsibility of the internal FM function.

Table 3: Proactive innovation processes in FM

Actors	Proactive innovation processes	Examples
! Client-organization	Neither the explorative study, nor the in-depth interviews revealed proactive innovation processes initiated by the client-organization. Nevertheless, this does not mean that examples of such proactive processes cannot be found in the field. Further investigations are required to complement this study, and shed light on the potential proactive role of the client-organization within FM services innovation processes.	
Customer and internal provider -internal FM function	The internal FM function might provide new ideas to the external suppliers, thus acting as a driver for innovation, which is then develop and implemented thanks to the interaction with the external supplier. These proactive processes can have a strategic, tactical or operational impact. When having strategic implications for the organization as a whole, however, they require the involvement of the corporate management.	The inspiration sources, from which internal FM managers build upon to originate proactive innovation processes are various, from knowledge sharing with fellow clients and academia, to services experienced in other organizations, to specialized newspapers and magazines.
End-users-employees and customers of the organization	Employees have the opportunity to originate proactive innovation processes by submitting ideas for improvements and innovations to the internal FM function, which is in charge of assessing the proposals and eventually start the innovation process together with the external provider.	In most cases, employees have the opportunity to submit proposals to the internal FM function per email. In some cases, a dedicated system is set up to systemically collect ideas from the end-users.
	! The interviewees did not present any example, where the customers of the client organization acted as drivers of a proactive innovation process. This is most likely due to the fact that most of the client organizations involved in this study operate in the Business-to-Business environment. The customers of the organization have therefore only rare and time limited opportunities to experience the FM services. However, it can be assumed that, if the customers of the client organization were to act as drivers of reactive innovation processes, they would refer to the external provider, who would then propose the innovative idea to the internal FM function. This is due to the fact that it is the employees of	

	the external provider who are more likely to encounter the customers of the client organization during the provision of the services. Similarly, it is more likely for the external providers to have a CRM system focused on FM services that is open to the public.	
! Internal provider-internal FM function	When assessing the proposals and ideas submitted by end-users, the internal FM function does not operate as a customer, but rather as an internal provider. When the proposals are too specific, they are developed internally. This cases corresponds to what Gallouj and Weinstein (1997) call ad hoc innovations, which are not considered here accordingly to Toivonen and Tuominen's (2009) approach.	
External provider(s)-outsourced providers	External providers are often expected to be driver of proactive improvement and innovation processes as part of the service provision agreement.	The role of external providers as drivers of proactive innovation processes is typically enforced through contract management.
	! In many cases, the proactive processes originated by external providers as accomplishment of contract obligations are ad hoc innovations.	

4.3   Discussion of results

The drivers of the reactive innovation process within FM reflected the findings by Toivonen and Tuominen (2009). On the other hand, the results of this study highlighted a main difference in the FM proactive processes as compared to Toivonen and Tuominen's (2009) framework. In fact, the role of key persons is taken over by the overall internal FM function, which acts both as filter and as promoter of innovation projects. When the innovation processes are being rolled out, the internal FM function is responsible for the coordination between the different layers of the demand. The crucial issue that internal FM functions need to address throughout innovation processes is the matching between strategic, tactical and operational goals and objectives of the organization and with the needs and expectations of the end users, along with those of the external providers.

The sectorial model of innovation within FM by Jensen and Andersen (2010) depicts the exchanges between (a) research and education and (b) the FM sector as the grounds of innovation within this field. Megatrends in the strategic environment exercise an external influence on these exchanges, and thus impact on the innovative outcomes. The results of this study are grounded in the sectorial model of innovation, which represents the environment in which FM innovation processes take place. At the same time, however, these findings create the need for an extension of the sectorial model, which seems to mainly describe the proactive type of innovation exchanges within FM. The empirical data collected for this work, in fact, shows how, in some case, exchanges between academics and the field are originated by a 'call for help' linked to a reactive innovation process.

5 CONCLUSION

This study addresses the research question: "*How does the structure of the value chain impact on innovation processes within the context of FM?*" The findings suggest that the complexity of the value chain has a threefold impact on the nature of innovation within FM. Firstly, the distinction between inputs and resources that is typical of services has a different impact on FM as compared to other services. In fact, end-users/inputs are usually not involved in the innovation process, although they might sometimes play a role as initial drivers. Secondly, FM services are intangible but more easily reproduced than other services, which especially

impacts on the diffusion of innovation. These two features together shorten the distance between FM services and tangible products. Finally, the evaluation of the added value derived from innovation depends on and changes according to a heterogeneous set of internal and external stakeholders, of a higher complexity as compared to that of other services.

This work aims at contributing to the literature on innovation in FM. The analysis depicts the involvement of diverse stakeholders not only in the value chain, but also directly in the innovation processes of FM. This might enrich the value chain framework by Coenen et al. (2012) by introducing the role played by the personal interactions, along with contract management, in stakeholder management. Moreover, the differentiation between reactive and proactive processes increases our understanding on the relations among actors throughout innovation processes.

Practical implications regard both supply and demand side of the value chain. As the intermediary that operates in between the two sides, the internal FM managers should aim at balancing needs and expectations of internal and external stakeholders with an eye on the strategic, tactical and operational agendas of the organization as a whole. For example, they could organize workshops with representatives of internal and external stakeholders to discuss and match the diverse needs and expectation. This could and should be arranged both *ad hoc*, e.g. when the strategy of the client organization changes, and periodically, to ensure a fit over time. External providers, on the other hand, should invest equal effort into respecting their contract obligations and into creating and maintaining good personal interactions with the organizations they serve. This might ease the role as drivers of proactive innovation processes, which directly address explicit and tacit needs of the demand. Such aim could be achieved through the workshops mentioned before, and through periodical team building activities organized with the customers.

Nevertheless, this study is not free of limitations. First and foremost the data collection took place within a rather small set of practitioners in Denmark. For instance, the lack of examples for the potential role played by the client organization or by the customers thereof in proactive innovation processes might have been caused by the emphasis on FM clients, who operate in the Business-to-Business environment. The research question thus requires further investigation through a more extended data collection, in Denmark and abroad, to strengthen the validity of results. Finally, the picture depicted in this work is cross-sectional, whereas a longitudinal approach, specifically looking at innovation processes over time, might contribute to a deeper understanding of innovation and innovation processes in FM.

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Added Value of FM Know-how: In the Building Whole Life Process

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ABSTRACT

Purpose: This research aims to establish how Facility Management (FM) know-how adds value to optimize a buildings performance and quality over its whole-life. It also focuses on how transition from construction to operation can be improved.

Theories: A framework of theory and best practice in the following key areas was used; perception of value, added value, the design and construction process, life cycle costing, the triple bottom line, transition management and knowledge capture and transfer.

Design/methodology/approach: Mixed methods were used including the creation of two conceptual models (4P life-cycle value measurement). Semi-structured interviews and an online questionnaire were used to explore stakeholder's perceptions of FM and how it can add value in the whole life process. Thematic coding was then used with the interview data to establish key themes and sub-themes of interest and SPSS was used to analyse the online questionnaire data. The findings were then triangulated to consider and compare the results.

Originality/value: The findings help contribute to established theory on added value in FM. The concept of the delta angle of FM know-how is introduced as a way to visualize how value can be incrementally added during each phase of the whole-life process. It is of direct and immediate relevance to stakeholders in property, FM and construction. It is also significant when considering the combined value and size of the construction and FM markets and the potential value that can be delivered to users, society and countries' economies.

Keywords
Facilities management, added value, FM know-how, whole life process

1 INTRODUCTION

The research topic of FM know-how and the added value to a building over its whole-life process originated from the author's own experience of the design and construction process and the transition process to operation. The traditional process often presented a frustrating experience when trying to deliver value to the end users. The field of research associated with added value and FM is increasing. FM can help designers with key decisions, which will have lasting usability, cost efficiency and sustainability impacts over the whole of a buildings life. As such it is worthwhile exploring the role of FM with the whole life and construction process and how FM can add value in the process.

There is now an increasing acceptance of the added value FM know-how brings to ensuring users and building owners achieve the best value and performance from a building over its whole-life. Global economic, social and environmental drivers are all forcing the property, FM and construction sectors to increasingly consider long-term value, rather than simply focusing on short-term returns and the initial capital cost of construction. The importance of FM know-how and its potential to delivery real value to the economy and society has never been greater and FM is now being included in government Corporate Real Estate (CRE)

strategies (All Party Parlimentary Group for Excellence in the Built Environment, 2012). Experience in the construction industry has shown that acceptance of the lowest price bid does not provide value for money in both the final cost of construction or the through life and operational costs (Bourn, 2001).

The building industry is the second largest in the world (after agriculture) and buildings contain our lives and all civilization. Office buildings are now the largest capital asset of developed nations and employ over half of their workforce (Brand, 1995). As such achieving a building with a good performance offers the potential for countries to realise real value in economic, environmental and sustainable value terms. It is the relationship between long-term costs and the benefit achieved by clients that represents real value for money" (OGC, 2007). When considering how optimisation of value can be realised, understanding the total cost of ownership and the relative costs of each life phase become critical. For a business case the long-term value over the life of the asset is a much more reliable indicator. Thus a change in paradigm is required from stakeholders involved in the process in order to achieve the best value for users, investors and owners, community and ultimately wider society.

Research by Keller (1995) in Germany considered the ratio of cost between the construction and operation phases of various building types. The exact value of the ratios changes significantly depending on building type but the work showed that in all cases the cost of the maintenance and operation are several times that of the construction. This reflects the now generally accepted principle that the amount spent on buildings, in initial capital and in use, is small compared to the value added by their occupants (Saxon, 2005, p. 1). Further work undertaken by the Royal Academy of Engineering (OGC, 2007) in the UK using an example of a typical office building considered the relative cost ratios for the key phases of; Construction, Maintenance and Operation over a 30 year life cycle and found these to be 1:5:200 leading the UK government to conclude that in order to deliver best value to society and the economy a long-term view needs to be taken.

Many researchers including Hubbuch (2012) have researched the timeline relationship between a buildings operational costs and potential influence on the cost during a buildings whole life. The planning and design phase offers the greatest potential to influence the post-construction life-cycle cost. Up to 80% of the operation cost can be influenced in the first 20% of the design process (ISO, 2008, p. 12). This illustrates why the early involvement of FM Know-how is critical at the early stages. It is at this time when key decisions are being made which will largely define the long-term usability and the life cycle costs (LCC) that FM can have maximum impact. Such decisions will have a direct and lasting impact on future FM functionality and the resulting operational costs and the degree to which they can be optimised in the future (Hubbuch, 2012, p. 3).

The author's own experience in leading a team of FM experts together with the representatives from the customer, architect, builder and specialists through the initial phases of the design and construction process and the transition to operation led to consideration of the how the potential added value of FM know-how could be measured. In addition the author was interested in how the transition process to operation could be improved to address common FM operational issues and problems such as design decisions with a future impact on FM. Also key is the loss of accumulated knowledge as the design and construction project team disbands at building handover.

2   LITERATURE REVIEW

A theoretical framework of established theories and best practice were reviewed in the development of the two conceptual models. These were used to explore how the value of FM Know-how can be represented and measured in relation to the whole-life process. The following key areas were considered:

Perception of value: The UK Office of Government Commerce Procurement Guide for Whole Life Costing and Cost Management (OGC, 2007) and the Constructing Excellence Be Valuable Report (Saxon, 2005) were used as a reference for understanding perceptions of value using the value equation and the principle of achieving best value.

The added value of FM: The FM Value Map (Jensen, 2009) shows FM primarily as a value adding rather than cost saving discipline, which supports and links the stakeholders' needs with resources, processes, outputs and outcomes. This was used as a frame of reference for thinking about the practical application of FM know-how in terms of value to meet the needs of users and wider society. Work by Jensen, P. A. (2009) and others academics from the book *Facilities Management and Added Value: An EuroFM Research Initiative.* Denmark, Denmark: EuroFM was also used as background reference as to FM added value

Design and construction process: The Swiss SIA 112 Service model (SIA, 2001) and the British Plan of Work for Multi-disciplinary Services (RIBA, 2008) were used as a reference for understanding the different phases of the whole-life of a building and to establish if similar phases are used in different countries. From these models generic phases were used as a frame of reference for the conceptual models.

LCC and FM know-how impact on design decisions: The International Standard ISO 15686-5 on Life-cycle costing (ISO, 2008), the Swiss IFMA LLC best practice guide and model (IMFA, 2011) and the guide; Bringing Facilities Expertise into the Design Process (Jackson, 2001) were used to identify and define the scope of what falls into life-cycle costs. They were also used to consider the impact of early design decisions on future FM operational costs and achieving value for money through sustainable procurement.

Sustainability: The Triple Bottom Line sustainability concept (Savitz & Weber, 2006) was incorporated into the conceptual models to reflect the need to achieve the best value performance balance between the needs of users, society and the environment whilst producing a cost efficient building from a design and operation perspective.

Transition process and knowledge capture: Best practice was reviewed in the area of transition and capture of knowledge from the construction to operation phases. There are many excellent examples of best practice in this area (Baaninger, 2008), (Stierli, 2012), (Austin, 2005) etc. There are established specific procedures such as the FM SIA 113 process used in the Switzerland (SIA, 2010) and the now established UK Soft landings and Pit Stopping processes developed by BSRIA (Way & Bordass, 2009) and (Bunn, 2011) as well as the VALiD process (Austin, 2005). These were used when reviewing transition and knowledge capture in the design and construction process.

Combining these concepts and ideas the author developed the conceptual models to represent the value of FM Know-how in the design and construction process and to consider ways it could be measured.

3   METHODOLOGY

The research used a mixed method approach. This combined a qualitative literature review, in-depth semi-structured interviews with subject matter experts involved in the whole-life process, discussions with practitioners and other academics and a qualitative on-line survey to address the hypothesis; Can FM know-how add value and help optimize the performance and quality of a building over the whole life process?

3.1   Conceptual models

Two conceptual models; The 4P Life-Cycle model – The Added Value of FM (Figure 1) and the 4P Life-Cycle Measurement of FM Added Value (Figure 2) were created to explore how FM know-how can help buildings achieve optimum value through a balance of economic, environmental and social factors. These were then used in the interviews to explore the perception of how FM know-how adds value during the whole life process.
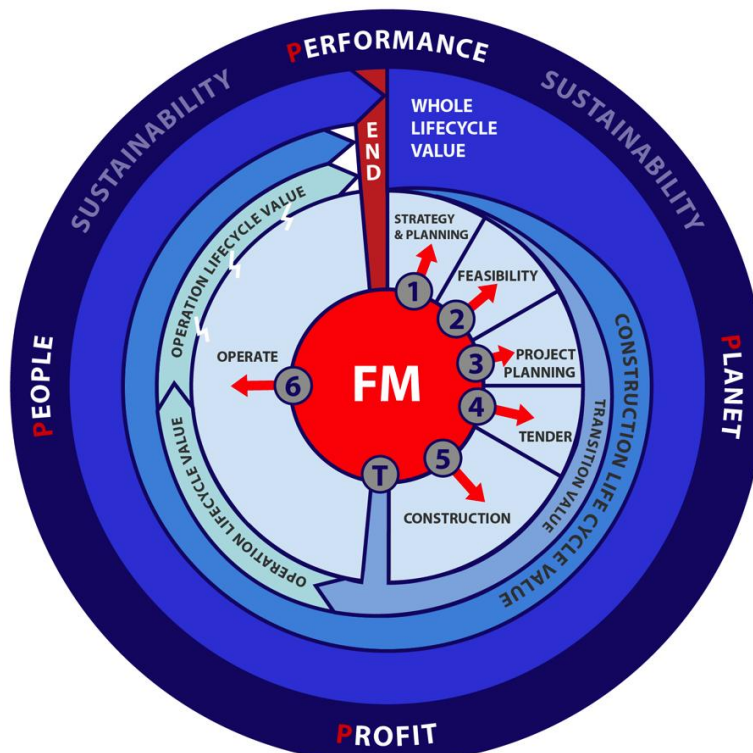
The first model:

Figure 1: 4P Life-Cycle Model: The Added Value of FM

This model shows FM at the centre of the model with the red arrows outwards representing the application of FM know-how in each whole life phase of a buildings life cycle over time. The whole life phases (represented by light blue segments and grey numbered circles) are as per the established Swiss design and construction process SIA112 process but are generic in nature. It is difficult to accurately represent the relative timescales of each phase. As such the broken lines and larger segment for the operation phase reflect the fact that this is a significantly longer period (usually 30 plus years).

The outer blue dark ring representing the 4**P** idea of achieving a building design with an ideal and sustainable **P**erformance, achieved by balancing value and benefits that meets the user's needs (**P**eople), are as environmentally friendly as possible (**P**lanet) and which result in a design that is has efficient construction and operation costs (**P**rofit/savings) for the organisation.

Best value is achieved by using a transition process that links and combines the value elements of construction and the operational value. This is achieved by using FM know-how about users needs and functional requirements and combining these with established LCC methods. The ideal transition process should ideally start of the beginning of the project and allows a continuous improvement feedback mechanism with loops during each of the whole-life phases. The process should run into the operational phase with an aftercare programme built into the transition process to ensure the building functions as it was intended to in the design process. This also allows any changes to be made once the users are actively using the facilities after the handover from construction to operation.
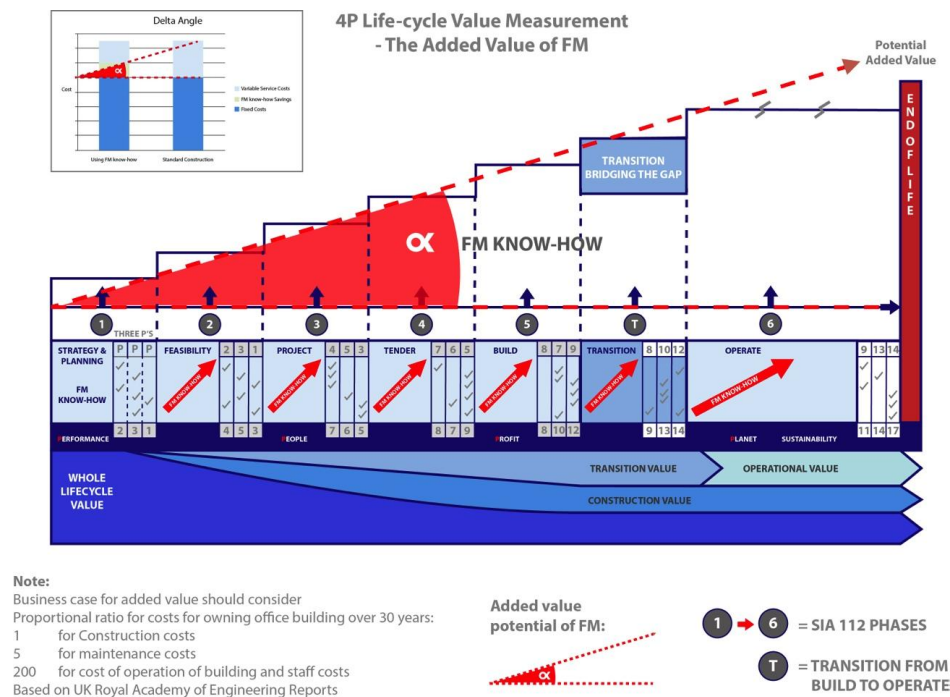
The second model:

Figure 2: 4P Life-Cycle Measurement of FM Added Value

This model incorporates the ideas of the first model in a linear format. The model also incorporates the idea of measuring the added value of FM know-how as a series of incremental steps in the whole life process. At each phase value is added to the process by asking a series of questions using FM know-how to regularly test that the best value and design is being achieved.

A series of questions based around the key sustainable areas of **P**eople, **P**lanet and **P**rofit (represented by the **Three P's** columns) are developed for each project (Note: these are not defined in this thesis). These are then used at the appropriate phase with the design and construction team to test key FM issues and principles of usability, functionality, sustainability, energy efficiency etc. The review of these key issues and the answers represent FM added value to the project by having tested the design (represented as ticks in the Three P columns). The ticks are added up for each column to create a total nominal value for each phase. In each phase the accumulated knowledge is shown as a series of red "Know-how arrows" transferring the value from one phase to the next, cascading and resulting in an incremental increase in the accumulated know-how as the column totals increase.

The total potential added value of the FM know-how is represented in terms of the **Delta Angle (α) of FM know-how** between the two dotted red lines. A flat line would represent a building project where no added value is added using FM Know-how.

3.1 Interviews

Ten in-depth interviews were undertaken with representatives from the different stakeholders involved in the whole life process. To help avoid bias interviewees were selected through professional associations representing stakeholder groups key to the building whole-life process; property investors, FM and construction.

The interviews followed a semi-structured interview guideline. The conceptual models were explained and then interviewees asked a series of questions exploring their perception of the value of FM in each of the three main phases of; planning and construction, transition and

operation. Each interview was 60-90 minutes in duration and was recorded for thematic coding at a later point.

3.1 On-line questionnaire

Feedback from the interviews was used to develop an on-line questionnaire as the collection instrument for the primary quantitative data. The format was as follows; initially the participants were asked what language they would like to use (German and English were offered). Then a general introduction was given describing the purpose of the questionnaire and an initial series of questions were asked which captured information about their background, experience, their stakeholder position in line with EN 15521 (CEN, 2011) etc. The next section of the questionnaire used a seven-point scale (1 = "strongly agree"; 7 = "strongly agree") to explore the perception of stakeholders as to the added value of FM know-how in each of the whole-life phases of planning, construction and operation of a building in alignment with SIA112 as follows:

- Phase 1 - Strategy and planning
- Phase 2 - Feasibility study
- Phase 3 - Project planning
- Phase 4 - Tendering
- Phase 5 - Construction
- Transition from Construction to Operation
- Phase 6 - Operation

The questionnaire was tested with five test cases to ensure the questions were appropriate, understandable. Distribution was via various stakeholder group organisations, on-line forums and from personal contacts in Switzerland, the UK and Denmark. A total of 62 fully completed questionnaires were captured. It should be noted that the researcher would like to have had a higher return on the questionnaire to help improve the reliability and validity of the data.

4   ANALYSIS AND RESULTS

4.1 Qualitative main themes and subthemes

21 subthemes were identified during the interview process. Reviewing reoccurring themes and issues raised by the interviewees during the interview process identified the sub-themes. These were then grouped under the four key theme areas as per Table 1.

Table 4: Themes and sub-themes

Theme A) The Perception of FM Added Value and the Development of FM
A1) FM adds value
A2) Conceptual models
A3) Added value is difficult to measure, quantify and record
A4) FM in the local context
A5) Professional development of FM
Theme B) FM Added Value in Planning, Design and Construction
B1) Early involvement of FM in the design process
B2) Strategic recognition of FM
B3) FM Know-how and sustainability
B4) FM Know-how is key to ensuring users needs are met in the whole-life cycle of a building
B5) FM specialists should review design specifications, plans and workplace proposals
B6) Role of FM in project planning

Theme C) Improving the Transition Process by Using FM Know-how
C1) Recognition of transition phase
C2) Key issues and factors for customer in transition
C3) Organisation and management of transition for handover planning
C4) Optimisation of the transition process
C5) Knowledge capture/transfer in the transition process

Theme D) Use of FM Know-how in Operation
D1) Common understanding and recognition of EN 15221 FM standards, norms and sustainability certification systems
D2) The key FM value drivers
D3) Use of EN 15221 FM process or other process standards
D4) Relationships, teamwork and good communication
D5) Use of SLA, KPIs and performance monitoring

4.1 Quantitative analysis and results

The following background statistics were gathered on participants:

Survey Participation; In sum 123 people looked at the on-line questionnaire. 62 people completed the questionnaire with 60 people opting not to fully complete the questionnaire. 33 people answered in German and 29 in English. There were 13 female and 49 male participants.

Demographic Split: There was a wide demographic spilt with the majority (56.45%) based in Switzerland, 17.74% in the UK, 12.90% in Denmark, 3.23% in Germany and 9.68% from other countries including two from India, and one each from Australia, Austria, New Zealand and Spain.

Commercial Decision-Making Responsibility and FM Experience: 47 participants had direct influence whilst 15 had none. Table 4 shows there was also a broad range of stakeholder's experience in the FM sector; 56.5% had more than 10 years experience, 11.3% had between 6-9 years experience, 22.6% had between 3-5 years experience and 9.7% had less than two years experience.

EN 15221 roles: The participant's perception of their own role in line with EN15221 showed a split of: 37 FM Suppliers, 15 Clients (Building Owners/Investors), four End User of FM Services and four Customers.

Stakeholder groups; The split of stakeholders was; investors (10), facility managers (20), FM contractors/providers (10), Consultants (14) and design and construction (5).

Organisation size: Figure 37 shows the organisation size in terms of the number of employees. The majority (45.2%) had more than 500 employees, 9.7% had 201-500 employees, 11.3% had 51-200 employees, 21% had 11-50 employees and 12.9% has less than 10 employees.

From the questionnaire:

The **highest five** ranked factors (in terms of mean scores) were:

Score	Higher scoring factors
6.06	Users needs are fully captured in the design and planning process (Supporting the core corporate strategy, vision and mission)
6.00	The risk of poor quality or higher building maintenance costs are minimized
5.98	The optimum FM organization is in place to support the core business
5.97	User satisfaction with FM and a buildings facilities is achieved and contributes to the organizations productivity and employee welfare (well being)
5.94	Space usage planning is optimized to best meet the clients needs

The **lowest five** ranked factors (in terms of mean scores) were:

Score	Lower scoring factors
5.52	Project changes are reviewed before implementation to ensure they meet users needs and do unduly not increase operational costs
5.52	The proposed FM service design can be easily adjusted to meet changing customer requirements as efficiently as possible
5.52	Information is saved in the correct format for use in Clients CAFM or other Building Management Systems (BMS)
5.48	Ensuring buildings are designed in line with the Triple Bottom Line concept to best support their staff and environment whilst taking into account cost
5.34	Project teams can implement a sustainability certification system to ensure buildings are more sustainable

Note: The scores from the questionnaire data were rather close. Thus the author concludes that the statistical significance of the data maybe limited. A larger sample would have been preferable to establish clearer results.

5   CONCLUSION

5. 1   Key factors in how FM can optimise value creation in the whole-life process

The following five key conclusions were drawn when comparing the quotes from the interviews in the themes and subthemes with the quantitative questionnaire data and existing theory and best practice:

Early involvement of FM increases the potential to deliver value: The different stakeholders felt FM could add benefit and value in the whole-life process of a building. The research shows that the optimisation of value, knowledge capture and transfer is achieved by involving FM in the early strategic and planning phases ensuring users needs are met and the benefits of cost management, sustainability can be maximized.

Best value is delivered through a balance of economic, social and environmental factors: The best value is also clearly shown as being achieved by considering a balance of users needs with those of the environment and society whilst remembering that economic value drivers are key to acceptance by management.

FM know-how value is maximized over the long-term: Early involvement of FM know-how is necessary to ensure the design process meets users needs and that that initial FM concepts are fit for purpose. The optimal benefit of FM know-how is realized over the long-term with the introduction of strategies for; energy management, management of maintenance, operation and assets. For this reason FM know-how is best utilized not on projects where the investor is only interested in short term gains but where they have a long-term view and are looking at benefits over the long-term.

Transition Delivers Maximum Value when Viewed as a Process: In order to achieve the optimum value and transfer of knowledge from the planning and construction phases to operation Transition needs to be considered as a process starting early in the whole life process and not a single point in time after completion of the construction. This ensures optimal transfer of information and knowledge to the FM team allowing them to optimise the long-term building performance.

The Delta Angle (α) of FM Know-how Helps Visualize the Value of FM: The added value of FM can be clearly seen in the conceptual models. The concept of the delta angle (α) of FM Know-how shows how FM Know-how can help to deliver potential cost savings and ensure the optimum capture and transfer of knowledge.

The hypothesis has been tested by the author and found to be valid. FM Know-how can add value and help optimize the performance and quality of a building over the whole life process.

5. 2   Theoretical implications

This study provides the idea of the delta angle of FM know-how and how it can be used to visualize how added value can be delivered to the building whole life process. There is a need now in future research to focus on ways that delta angle (α) of FM know-how can be measured and quantified in terms of the value FM can deliver in benefits to users, the environment and cost savings. The author believes that when this can be done all parties involved will take FM know-how very seriously.

5. 3   Managerial implications

The research has implications for the three main stakeholder groups of property investors, FM and Construction. FM know-how can be used to increase the value of assets over the long term by reducing maintenance costs and increasing profits from rents of assets whilst at the same time improving the facilities and usability of assets. The research provides an incentive to all parties to ensure there is more involvement from facility managers who are ideally placed to understand the client's needs and thus act as the link to interpret the clients/users needs into design output requirements, meeting the objective of achieving buildings, which are seen as successful and meet their customers' needs. In turn this should lead to an improved reputation and repeat business.

5.4   Future research

Further research is needed to identify ways to quantify the measurement of the delta angle of FM know-how. This should focus on the key areas of; people, planet and profit. It is worth investigating in more depth the key FM knowledge that can be used in each phase to deliver practical tangible and intangible benefits. Consideration should be given as to the practical application in business to ensure the early involvement of FM in the design process. The overall transition process should be reviewed to look at critical FM factors in each phase of the whole-life process of buildings.

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