

European Facility Management Conference

EFMC 2018
SOFIA

**RESEARCH PAPERS FOR
THE 17TH EUROFM RESEARCH SYMPOSIUM
EFMC 2018
5-8 JUNE 2018 IN SOFIA, BULGARIA**

MATTHEW TUCKER (EDITOR)

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PREFACE

EuroFM exists to create a platform for opportunities for the facilities management (FM) community. The flagship event for EuroFM is the European Facilities Management Conference (EFMC) and the Research Symposium.

This year, the EFMC conference organisation has taken a fresh approach by consolidating the EFMC with the EuroFM Research Symposium, creating one holistic platform for all FM researchers, practitioners and educators to share their work. This will mark the 26th Edition of the EFMC and the 17th Edition of the Research Symposium, all engaging together in one collective space, in the wonderful city of Sofia, Bulgaria.

The theme for this year's conference is "*Once upon a time in facilities management land*". The theme symbolises the impact that FM has on our daily lives, in which FM researchers, practitioners and educators will share their experiences on the impact of new technologies and other innovations in FM.

The research journey for this year's conference started in October 2017, where the call for abstracts was first announced. All together 26 abstracts were received and a Scientific Committee was assembled to ensure that all abstracts undertook a double-blind review process. A total of 15 papers were finally submitted and approved for publication in this year's proceedings.

Each paper is produced in a standardised format. You will see a structured abstract at the beginning outlining the purpose, methodology, findings and impact of the work. You will also see the type of paper that is presented, to which there are 13 research papers, one literature review, and one viewpoint paper. I would like to commend all the authors that have worked hard to get their papers to an excellent standard for this final submission.

I would also like to express my sincere thanks to the Scientific Committee who have given up their valuable time to undertake a very rigorous exercise. It is the work of this committee, and all the other 16 committees that have previously stood, that ensures that the research proceedings for our EFMC's are consistently kept to a high quality standard.

EuroFM's mission is to create a network of professionals for advancing knowledge in FM and ensuring its effective application in practice, research and education. EFMC 2018 is testament to this mission, and I hope you all enjoy the experience.

Dr Matthew Tucker

Research Network Group Chair

THE SCIENTIFIC COMMITTEE

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The role of facility maintenance in data centres: a case study

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ABSTRACT

Purpose: This study aims to demonstrate the relation between capital expenditure (Capex) and operational expenditure (Opex) associated with the entire Data Centre (DC) building life cycle. The main aim is to reveal the importance of focusing on maintenance and maintainability as the key influencing factor of Life Cycle Cost (LCC) of DC and to show how it is directly linked to the cost of quality in Data Centres. Additionally, the application of the “80/20 Cost Ratio Rule” suggests that 80% of total costs correspond to the operational costs while only 20% of total costs correspond to the construction of Data Centres. Our paper demonstrates that making the assumption that every DC conforms to the 80/20 Cost Ratio is an oversimplification and incomplete assumption.

Methodology: As part of a qualitative study, a sample of five clients who build and operate DC portfolios internationally were selected based on the availability of data required for the analysis such as construction costs, energy costs etc. The case study was conducted at Apleona HSG in Germany. The results are obtained from the analyses of interviews along with a thorough literature study conducted by the authors.

Findings: Maintenance costs represent only a very small portion of LCC in Data Centres. Energy costs stand as the key cost driver, however maintenance has more economic value than energy when quality costs are taken into account. Quality in terms of Facility Management (FM) in Data Centres means extending the useful life span, as well as reducing failure rates of systems and components, which results in high availability with almost zero outages of technical systems in the DC. Costs associated with poor quality include the direct cost of systems unavailability such as loss of capacity, cost of defects and delay costs. On the other hand, the indirect costs incurred as a result of loss of image, missing opportunities to increase profits, legal considerations, etc. These costs could have massive negative impacts on the business. In this context, ensuring quality in the DC with an effective maintenance approach has higher priority than other costs. Furthermore, the evaluation of the relation between Capex and Opex costs in a DC over four decades shows that the 80/20 Cost Ratio is achieved at different time spans for different Data Centres compared to the published results which neglect this aspect. Considering the useful life of the equipment introduces more accuracy in the decision making process.

Impact: The study shows that facility maintenance plays a subordinate role in terms of costs (less than 10%), however it is essential for uninterrupted building operation. The focus should be on maintaining quality criteria in the area of maintenance in order to maximize the lifetime of the facilities as well as ensuring "zero" DC outages.

Paper type: Research Paper

Keywords: Data Centre, Capex, Opex, Facility Management, Life Cycle Cost.

1 INTRODUCTION

The IT industry is changing at an exponential pace. IT operations nowadays are essential to most business organizations. According to Cisco (2017), hyperscale as an example of the growth of Data Centres "growth of IT operations" will reach a number of 628 DC in 2021, rising up to 86 percent from 2016. In addition to that, Gartner estimates that the Internet of Things (IoT) will include 25 billion connected units by 2020 (Gartner, 2015). This enormous amount of digital information drives the growth of the Data Centre market. According to BroadGroup (2015), Germany offers the largest DC market in Europe with 25% of total European Data Centres capacity. The UK offers 22% followed by France with 15%. These three countries alone are accounted for more than 60% of total DC capacity in Europe.

Data Centres can be divided into three categories: (i) In-house; (Data Centre including IT hardware and building infrastructure is privately owned and operated as a capital asset), (ii) Co-Locator; (Provider/Owner offers modular service packages to the clients, e.g. server racks, with or without IT applications and/or dedicated areas of facility space as a service) (iii) Cloud; (Providers offer an extensive range of services over the Internet and the users do not own any of the IT infrastructure associated to these services) (Bieser & Menzel, 2017). According to a study conducted by DCD Intelligence (2016), there is an annual growth of 11 % in the Co-location DC business area, while the In-house DC market shows more stability. The market of cloud service providers focuses on the so-called hyper-scales. Growth in this segment is extremely large.

For the purpose of this paper, the scope of the technical infrastructure in a DC includes the critical facilities like power supply, cooling, and monitoring systems. The key role of FM in Data Centres is mainly related to the operation and maintenance of such critical systems. Maintenance Management is a substantial part of Facility Management with an increasing importance for a secure and efficient operation of facilities. The significance of maintenance lies behind the fact that it represents one of the main pillars of LCC as well as being directly related to the quality level in DC. However, there is a scarce literature about the role of maintenance in the field of Data Centres from the author's point of view.

This paper proposes that a DC which has been designed according to maintainability requirements, where a best-class maintenance programme has been implemented will achieve high quality in terms of higher availability and longer life span thus reduced costs. The paper also contends more accurate and precise results considering the 80/20 Cost Ratio since it is an oversimplification to assume that every DC conforms to this ratio. The paper is structured as follows: Firstly, the subsequent section evaluates LCC. Next, the relation between quality and costs in DC is thoroughly illustrated. Then, the role of maintenance in DC and how it is directly linked to quality is discussed. In the fifth section, the results of the case study are presented and compared to the results published by Siemens in order to accurately enunciate the 80/20 ratio for the field of Data Centres. The final section contains the conclusion and discussion.

2 LIFE CYCLE COST

Life Cycle Cost (LCC) can be defined as the method of valuing of all recurring and one-time costs over the entire life span or specific period of a certain system. The Facility LCC structure

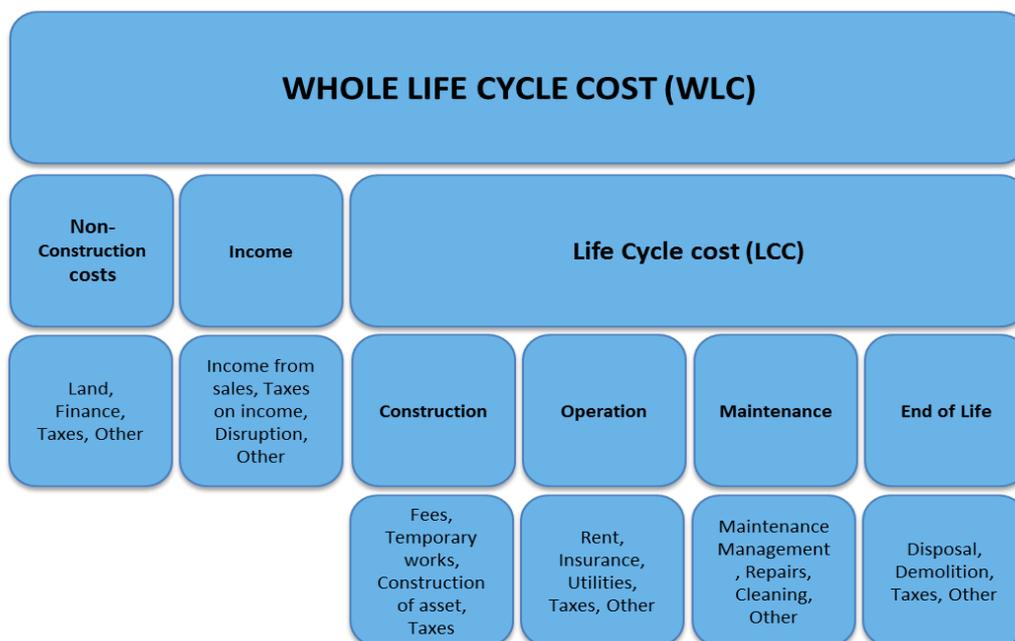
has four main components as shown in Figure 1. These are: construction, operation, maintenance and end of life (ISO 15686-5, 2008).

Based on (Boussabaine & Kirkham, 2008; Gantenbein, 2003), the design and execution costs represents about 15-20% of the total LCC (LCC for short). Thus, it is worth noting that in general, during the lifetime of a building, the operation and maintenance costs will far exceed the initial construction costs, reaching up to 80-85% of the total costs. Therefore, the main focus of the Life Cycle Costs is on the utilization phase which has the longest period of time and causes the highest costs.

Facility Management (FM) aims to reduce the required structural and service-related costs over the entire life cycle (GEFMA, 2004). Maintenance costs as one of the main pillars of LCC are influenced by many factors such as asset condition (age, type, etc.), the experience of the operator, the policy of the company, the skill set of maintenance labour, standards and regulations, system specifications as well as the operational environment (Levitt, 1997). These factors have massive impacts on life cycle considerations.

Carrying out the LCC study for various systems provides insights that are very valuable for the following applications: (i) Supporting the decisions regarding the selection of systems and their components, (ii) Assisting the decisions of repairing or replacing certain items, (iii) Evaluating the efficiency of plant or systems at the end of its useful life, which in the future can help in planning maintenance activities, eradicating unplanned outages and enhancing reliability by avoiding excessive maintenance expenditure (CIBSE, 2008).

Figure 1 Facility LCC Structure ISO 15686-5 (2008)



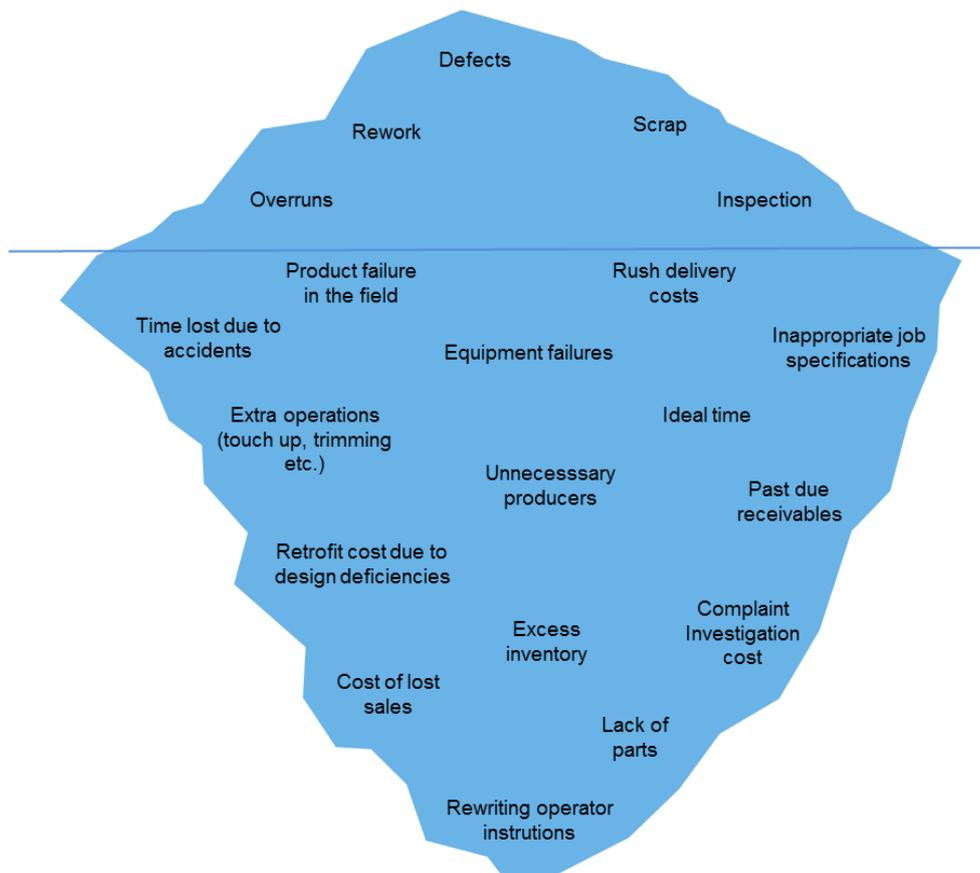
3 QUALITY VS. COST

The increasing use of technology has led to more complex systems as well as a wide range of physical assets where quality becomes a crucial issue. Improving quality implies more investment in terms of money, however, investing on various quality plans without estimating the likely outcomes can lead to investments that have no impact on the bottom line

(Schiffauerova & Thomson, 2006). The main challenge for many industries is to find an accurate balance between the cost of quality and the value of quality (Juran, 1951).

Quality costs could be defined as the difference between the actual operating costs, and the operating costs where no outages or failures occur (Lenane, 1986). Quality related cost according to the British Standard BSI (BSI, 1990) is the cost associated with process of assuring quality as well as the loss incurred if quality is not achieved. Juran, et al. (1999) define the costs of poor quality as the costs incurred due to ineffective processes, nonconformities costs or even the costs of missing opportunities for future revenue. They state that the costs of poor quality and the costs of quality are the same. Quality costs are represented by two main categories according to Crosby (1979), the conformance and non-conformance costs. The price associated with the process of preventing poor quality represents the cost of conformance. On the other hand, the cost of the non-conformance is the cost incurred as a result of failures and mistakes which in turn refer to the cost of poor quality. As stated by Krishnan (2006), the visible and invisible costs of poor quality can be seen in the Iceberg model (see Figure 2).

Figure 2 Cost of Poor Quality represented by the Iceberg Model (Krishnan, 2006)



A limited portion of costs can be noticed, while the rest are hidden under the water. In most cases, only visible costs are taken into account when poor quality is evaluated. However, invisible costs can be as high as three to ten times in comparison to the visible costs. These hidden costs include downgrading, loss of goodwill, missing opportunities to increase profits, loss of capacity spent on producing defective products as well as the resultant delay of such situations, poor quality planning costs, extra inventory, costs of redesigning products as well

as changing processes, costs of downtime of systems, increased engineering and management time.

The term “Quality” in Data Centers is directly linked to the availability of its critical facilities with almost zero outages. Quality requirements in a DC encompass a good understanding of various legal requirements, effective asset and change management, efficient risk management, accurate execution of different activities as well as a consistent review process that ensures a high quality level. Comprehensive and effective maintenance strategy guarantees all previous aspects and assures that systems are operating at the highest standards with controlled procedures and processes through execution. As a result of that, the negative implications of poor quality, including costs incurred, are prevented.

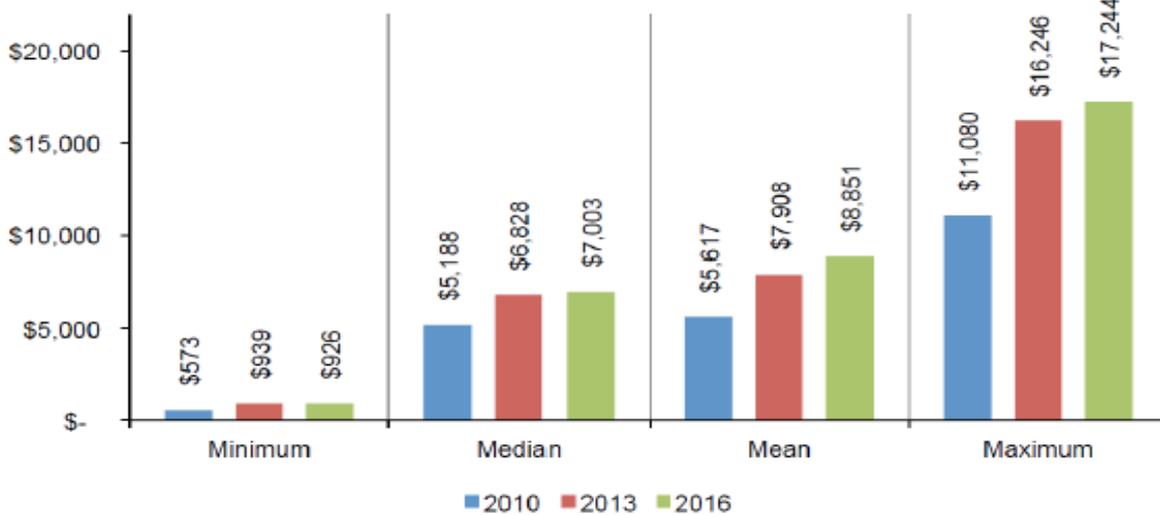
4 THE ROLE OF MAINTENANCE IN THE DATA CENTRE LIFE CYCLE

Maintenance represents a combination of all technical, administrative and as well as managerial activities that take place throughout the life cycle of the equipment (Au-Yong, et al., 2014). A comprehensive maintenance management strategy covers aspects such as, (i) the “technical product” (documentation and understanding of its functionality), (ii) the operational processes (what, when, and how to maintain) and (iii) the so called “Human Factor” (i.e. the socio-technical aspects) (Bieser & Menzel, 2017). In addition to that, DIN EN 13306 (2015) defines maintenance management as all activities that determine the maintenance objectives, strategies, responsibilities, and implementation of them by such means as maintenance planning, maintenance control, and the improvement of maintenance activities and economics.

The main aim of maintenance is to guarantee a high quality in the DC through ensuring safe and uninterrupted operations of different systems (Bieser & Menzel, 2018). However, poor maintenance strategy can have massive negative impacts on the organization in terms of output, safety, environmental integrity, system quality, customer satisfaction, and emergency repair costs after the occurrence of failures. Frequent machine breakdowns, low plant availability and increased overtime are threats to any organisation as they increase its operating costs (Eti, et al., 2006).

The cost per minute of IT equipment downtime has been estimated as \$7,900 on average with an average incident length of 86 minutes, resulting in costs per incident of approximately \$690,200 (depending on the company’s sector) (Ponemon, 2013). A research report conducted by Ponemon Institute (Ponemon, 2016) remove the dramatic increase of per minute outage costs between 2010, 2013 and 2016, respectively (see Figure 3). The report reveals also that the cost of an unplanned outage in a DC could far exceed \$17,000 per minute. The average cost of an unplanned outage in Data Centres is nearly \$9,000 per minute.

Figure 3 Total Cost per Minute of an Unplanned Outage in Data Centres (Ponemon, 2016)



An important aspect that must be taken into account is the indirect costs of maintenance (see Table 1). Any cost saving strategy in the area of direct costs can have negative effects on the indirect costs as a consequence. These negative impacts might start with the need to reinvest in the renewal of technical systems due to lack of maintenance up to the loss of image in the event of critical infrastructure failures.

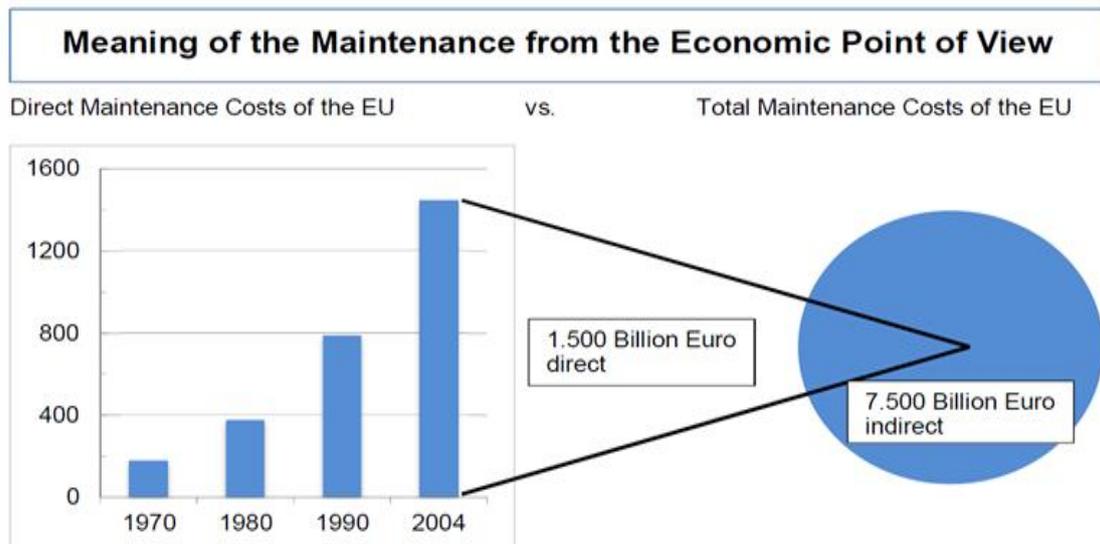
Table 1 Direct Maintenance Costs vs. Indirect Maintenance Costs

Direct Maintenance Costs	Indirect Maintenance Costs
Staff costs	Machine failure times
Consumables, spare parts	Quality degradation
Maintenance system (Sensors, IPS-Systems, connections ...)	Legal consequences
	Loss of image
	Storage costs, spare parts
	Replacement investments

Figure 4 shows that the ratio between direct and indirect maintenance costs is 1:5. Qualitative deficits and cost savings in the area of direct maintenance costs lead to massive consequential expenses in the indirect area (BAMF, 2006).

According to Usher, et al (1998), maintenance can contribute to a reduction in costs by minimizing systems downtime (production loss) which in turns increase the productivity and improve the overall quality.

Figure 4 Direct Maintenance Costs vs. Indirect Maintenance Costs in the EU (BAMF, 2006)



5 CASE STUDY

Interviews were conducted with representatives of five clients of Apleona that operate DC portfolios internationally, in order to determine the availability classes (tier level), the size of IT areas, the electric power supply in megawatt, the investment costs for construction (Capex), the costs of operation and maintenance (Total FM) and the energy costs for a typical DC. Using this information, TOTEX costs were analysed over four decades (see Table 2).

Table 2 Case Study Results

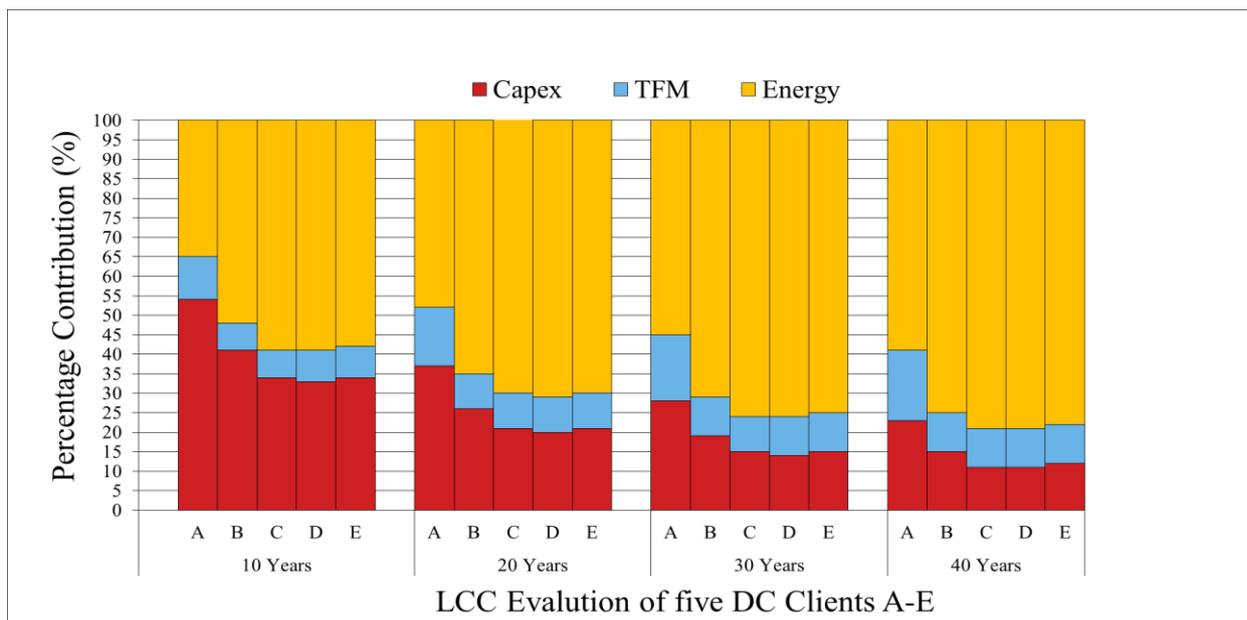
Client	Tier-Class	IT-Space [m ²]	Electric Power Supply [MW]	Capex	Opex		TOTEX [T€]			
				Construction Costs [T€]	TFM Costs Ann. [T€]	Energy Costs Ann. [T€]	10 Years	20 Years	30 Years	40 Years
A	4	4k	4.5	60,000	1,200	3,900	111,000	162,000	213,000	264,000
B	3	2.5k	7.5	50,000	900	6,400	123,000	196,000	269,000	342,000
C	3	2k	7.0	35,000	750	6,000	102,500	170,000	237,000	305,000
D	3	1k	4.0	19,000	440	3,400	57,400	95,800	134,200	172,600
E	3	2k	4.0	20,000	450	3,400	58,500	97,000	135,500	174,000

First of all, it is important to define the term Total FM “TFM”. According to DIN 31051 (2012), maintenance includes the activities related to servicing, inspection and repair. The DIN 32541 (1997) defines operation as maintenance activities along with the operation of the facilities where operation means switching, controlling, start-up, shut down, monitoring and troubleshooting. However, the DIN 32541 was withdrawn in 2008. From the author's point of view, there is no standard that clearly distinguishes maintenance from operational management.

For this reason, the costs determined in the case study are related to the Total FM, which means maintenance and operation management. 70% of the Total FM presented in Table 2 is related to the technical FM only.

The term TOTEX presented in the table corresponds to the total costs of Capex and Opex together. Capex costs directly refer to the investment expenditures for long-term assets, machines, buildings, as well as for facility related original equipment, spare parts, computer systems, etc. Opex costs refer to the running expenses required for a functioning and operating business. Presented Opex costs include the costs for raw materials, operating materials, personnel, leasing, energy etc. Opex costs presented in the table are divided into two main parts: (i)TFM and (ii)Energy, in order to evaluate the distribution of each cost category over the four decades. The distribution of LCC for the five Data Centres (A-E) over four decades is illustrated in Figure 5. No discount factors was considered in the calculation of LCC since it does not influence the determination of the maintenance proportion.

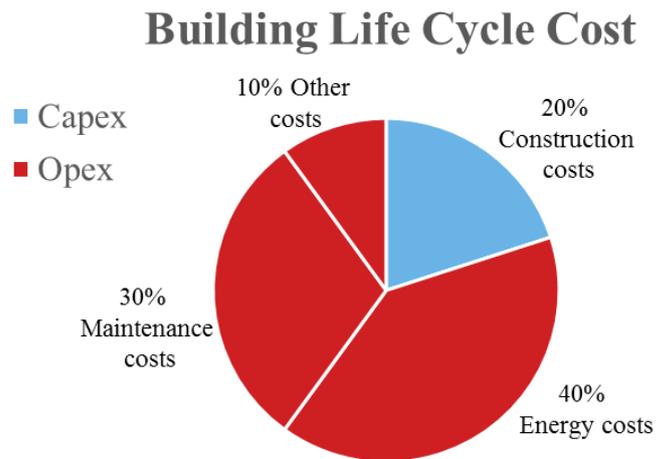
Figure 5 LCC Distribution over four Decades



It can be clearly noticed that energy costs represent the main share of the building operation costs for Data Centres with a minimum share of 35% of total LCC in the first 10 years (this is the case of client A which has the minimum share of energy costs compared to other clients). A minimum share of energy costs with 59% of total LCC is reached after 40 years (also client A has the minimum share of energy costs after 40 years compared to other clients). TFM (including maintenance costs) has only a small share of LCC.

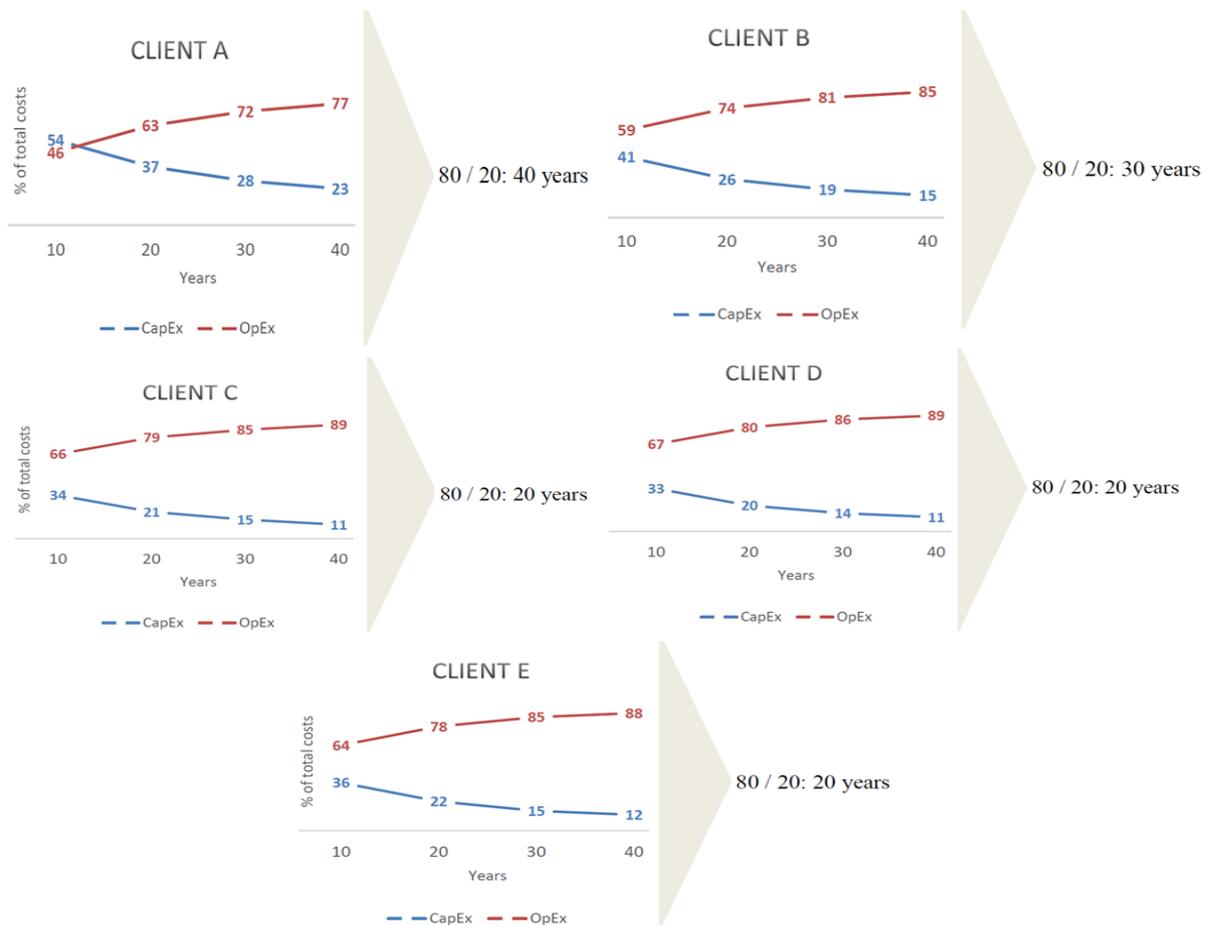
It is also very important to notice that the 80/20 ratio is achieved over different time spans for the different clients and Data Centres considered in this study. Figure 6 shows an illustration of Building Life Cycle Cost of a Data Centre presented by Siemens (2016). The results presented by Siemens confirm the Cost 80/20 ratio for the field of Data Centres where Capex costs account for nearly 20% of the total costs, while the costs of facilities Operation presented by Opex account for 80% of the total costs.

Figure 6 Building Life cycle Cost of Data Centres (Siemens, 2016)



Our results confirm the Cost 80/20 ratio for Data Centres as well. However, the report of Siemens discards the time span at which this ratio is achieved. This introduces a huge inaccuracy when considering LCC as a method for evaluating investment alternatives. Figure 7 shows how different clients achieve the 80/20 ratio at various time spans.

Figure 7 Clients A-E achieve the 80/20 Ratio at Various Time Spans



6 CONCLUSION AND DISCUSSION

This paper illustrates the role of facility maintenance in the field of Data Centres. The results of analysing the relation between Capex and Opex in a DC show that the 80/20 Cost Ratio is also applicable in the field of Data Centres where in general, Opex represents 80% of the total costs, while only 20% are represented by the Capex. However, the time span to reach the 80/20 Cost Ratio will vary for different Data Centres, depending on the cost ratio between Capex and Opex. Any decisions based on a simplistic acceptance of the 80/20 Cost Ratio will result in higher costs and shorter life spans.

Energy costs represent the main cost driver in DC. Maintenance costs have only a small share of LCC. Nevertheless, it is easy to notice that the total cost of ownership (TCO) is directly linked to the size of DC as well as the availability level (tier level) of the technical infrastructure. The higher the level of availability and the larger the DC, the higher the number of redundant units required to ensure uninterrupted operation of the servers, all of which results in higher construction costs as well as higher energy and maintenance costs. However, the first priority in the DC is the quality which is directly linked to the availability of technical systems. The role of FM in terms of ensuring quality is to extend the useful life span and reduce failure rates for systems and components through effective maintenance and operation procedures. As a result of that, the small share of maintenance in the LCC of DC has a significant role as being directly related to uninterrupted and safe building operations with an almost 100% availability where any failures quickly lead to very high costs and maybe loss of the business as a result of reputation loss. DC owners and operators must focus on maintenance and maintainability as the key influencing factor of the LCC of DC. Data Centres that implementing effective maintenance strategy/programme will have less downtime occurrences and will achieve a longer life span.

As digitisation drives the exponential growth of the number of Data Centres worldwide, FM providers have big potential in the field of developing effective maintenance Programmes with the aim of achieving challenging quality requirements in terms of ensuring high availability and reducing costs. Recent research initiatives encourage FM providers to invest more in identifying innovative and best practice maintenance approaches. An example of this is the recent research project by Acatech (2015) about Maintenance 4.0 where an innovative maintenance control centre that forecasts outage times and proposes anticipatory maintenance measures is being developed.

7 ACKNOWLEDGMENTS

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The effect of the contract on trust in PPP projects

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ABSTRACT

Purpose: The purpose of the paper is an in-depth research to evaluate the effect of the content of a contract on trust development. Public Private Partnership (PPP) is a popular international governance. Managing these partnerships across sectors is difficult, but essential for a successful outcome. To achieve superior inter-organisational relations, it is essential to create trust.

Methodology: Based on an extensive literature review, seven propositions were phrased regarding the role of trust in PPP projects. These propositions were discussed in eight in-depth interviews with experts from six Dutch PPP projects that varied in duration and level of detail of the contract.

Findings: This study showed that the content of the contract can be divided into technical aspects (the product, e.g. building, services) and relational aspects (the way partners communicate and interact). Both aspects have an effect on trust development, relational aspects more than technical aspects. Trust development is supported by three main aspects within the contract:

- Specify only the essentials of the technical aspects, leave room for interpretation.
- Include relational elements, which enable partners to communicate and invest in each other.
- Manage and reward the performance pro-actively, supported by a performance management system. This makes monitoring transparent and facilitates parties to steer on process.

In the end, trust is summative of all prior experience though with unequal weight per experience.

Impact: PPP projects are often extensive projects, up to 30 years. It is essential that the partners within the contract trust each other, as it is not possible to foresee every detail of the total project. This paper delivers valuable information on the development of trust, and will be useful for all PPP projects. The topic is relevant for facility management (FM) because the operation and maintenance phase in a PPP project are by far the longest phase, and require FM knowledge and skills.

Paper type: Research Paper

Keywords: Trust, PPP, Contract, Technical aspects, Relational aspects, Facility manager

1 INTRODUCTION

“One may KNOW how to conquer without being able to DO it” - (Sun Tzu, Art of war).

With this tactical disposition, Sun Tzu implied that partnerships may be used to achieve results one cannot achieve on one's own. In discussing manoeuvring, Sun Tzu stated that we cannot enter into alliances until we are acquainted with the designs of our neighbours (Griffith, 1971). This implies that we need to know and trust the motives of our partners. 2500 years later, inter-organisational relations, partnerships, alliances and networks still appear to be important strategies of organisations. Combining knowledge and resources is required to innovate in today's complex world (Edelenbos & Klijn, 2007). Theoretical study showed that outsourcing of non-core competences results in increased added value, higher commercial return and lower costs (Ancarani & Capaldo, 2005). This trend also applies on the public sector. To achieve policy outcomes, governments are relocating their focus to core government activities and are using more horizontal, instead of vertical, governance of managing and working together with other public and private actors (Edelenbos & Klijn, 2007). A form of collaboration that focusses on sharing added values between public and private organisations is Public Private Partnerships (PPP) (Sanders, 2015).

PPP facilitates the interaction between public and private parties by organising services or products for the consumer in an integrated way. PPP is defined as a concession which integrally outsourced the main components of the value chain, so-called Design Build Finance Maintain and Operate projects (DBFMO-contracts). Added value of this governance lies in lower coordination costs, because all components are integrated into one contract (Sanders, 2015).

Sun Tzu reported the relevance of trust in relations. Trust is defined as “the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or contract that other party” (Mayer et al., 1995). In present days, we appear to have replaced trust with contracts. Because of the long-term nature (often 30 years) of PPP, this context provides a good opportunity to create, develop and sustain trust between client and contractors (Kumaraswamy & Anvuur, 2008). To achieve superior inter-organisational relations, it is essential to create trust. Trust is seen as a basis for a cooperation that secures many benefits. Trust is beneficial in governance networks because it reduces risks. Trust is seen as important for the interaction and the outcome of projects. However, trust is very vulnerable and easily broken. So it should be built consciously (Klijn & Eshuis, 2013).

Improving PPP-performance calls for a change in behaviour, attitude and procedures. Members of both public and private organisations should acknowledge the differences in each other's institution and this requires mechanisms in the contract that facilitate trust development. Because there is a scanty of research on the effect of the contract on trust development in the context of PPP, this research answers the following main question: How does the content of a contract affect trust development in Public Private Partnerships?

2 THEORETICAL BACKGROUND

Managing alliances and partnerships across sectors is difficult, but essential for a successful outcome. Noteworthy, the majority of PPP-failures are related to the inter-personal and inter-organisational relations (Edelenbos & Klijn, 2007; Bult & Van Engen, 2015). Based on theoretical study, the knowledge gap arose on studies investigating cooperation-issues between public and private actors in PPP. However, many researchers (e.g. Ring & Van de Ven, 1994;

Maurer, 2010; Klijn & Eshuis, 2013) investigated cooperation-issues in other type of inter-organisational partnerships, which often last shorter than PPP. In these studies, trust is mentioned as one of the success factors. Research presented the difficulty of trust development and showed the importance of investing in each other (Ring & Van de Ven, 1994; Klijn & Eshuis, 2013). “Trust can help to strengthen and improve the relationship between project-partners which in turn, entails a variety of benefits for the project at whole” (Maurer, 2010). Trust stimulates innovation, facilitates learning and decreases transaction costs (Klijn & Eshuis, 2013). Liu et al. (2014) mention trust as one of the critical success factors in public-private infrastructure projects, Osei-Kyei and Chan (2013) in their review of academic papers on PPP also mention trust as a critical factor. These papers, however, cover many factors that influence PPP, and do not go deep into the role of trust specifically. Neither were these papers written for the benefit of facility managers, despite the fact that during the lifetime of PPP projects the phases Maintain and Operate, managed by facility managers, are by far the most extensive phases in a PPP project. Therefore, this paper aims to investigate the role of trust in PPP projects, for the benefit of FM.

A PPP process consists of six phases, which are shown in figure 1 (APMG International, 2017). The scope of this paper includes phase three to six, because in these phases mechanisms for trust development can be set and executed.

Figure 1 PPP Process Cycle



3 METHODS

This research is based on an extensive literature review that resulted in seven propositions. These propositions were validated in eight in-depth interviews with experts on PPP. During the interviews, respondents reflected on each proposition; they were asked whether their experience with PPP supported the propositions, and were stimulated to elaborate on any aspect of PPP related to trust that they considered relevant. The last interview did not provide any new information on these aspects. The sampling method is purposive sampling, with maximum variation, including respondents from both public (client) and private (contractor) side, with various roles, and operating in different phases of a PPP. An overview of the sample is presented in Table 1.

Table 1 Overview Sampling

Respondent	Organisation	Role	Phase	Current year of the PPP
1	Public	Contract manager	Design and Build	1
2	Private	Customer manager	Design	1
3	Private	FM manager	Maintain and Operate	2
4	Public	FM Manager	Maintain and Operate	2
5	Public	Project manager	Design and Build	2
6	Public	FM manager	Maintain and Operate	6
7	Public	Quality manager	Maintain and Operate	15
8	Public	Legal expert	Maintain and operate	15

Interviews were recorded, transcribed and analysed with thematic coding in an iterative process. The essence of thematic analysis is constantly comparing pieces of data to determine if it belongs to a particular theme, in order to recognize common feature of themes (Tuckett, 2005).

4 RESULTS AND DISCUSSION

4.1 Proposition 1: Incomplete contracts contribute to trust development

Classical contract theory defines contractual agreement as “writing between two or more parties; which are perceived, or intended, as legally binding” (Eversdijk & Korsten, 2015). This theory assumes complete contracts can be drafted including all necessary safeguards to mitigate opportunistic behaviour, to reduce transaction ambiguity by including detailed specifications and describing what is allowed in the relation (Zheng et al., 2008). Incomplete contracts, on the other hand, have fewer clauses or clauses that are not observable and verifiable, allowing more room for interpretation, to stimulate cooperation. Consequently, incomplete contracts are less legally binding (Klein Woolthuis et al., 2005; Eversdijk & Korsten, 2015). Zheng et al. (2008) observed that gaps in incomplete contracts are being filled when contingences arise, making incomplete contracts flexible in the execution of the agreement. Klein Woolthuis et al. (2005) indicated that when parties have more flexibility, they will be more dependent on trust. PPP have contracts with a duration of up to 30 years. An incomplete contract offers more flexibility, making parties rely more on trust than on clauses.

Based on their own experiences, all respondents supported this proposition. For instance, R8 stated “our contract is an integrated DBMO contract, this is by definition a contract that leaves room for the contract-partner to achieve the agreed performance”. Comments made by respondents regarding complete contracts concern the number of pages and high quantity of rules and control. Based on the number of pages and requirements, five respondents appeared to have complete contracts. R7 stated that in the present day both parties believe the contract included clauses that should have been formulated otherwise: “we discuss these issues when they arise”. R3 mentioned that clauses of the contract tend to be outdated when required and due to the size of their contract, finding the right clauses takes more effort.

4.2 Proposition 2: Applying cooperation mechanisms in the tender process contributes to trust development

The subsequent phase in the PPP-process is tender and award, in which clients specify the outcome and award this to the best bid. Traditional procurement procedures focus on cost, time and quality. Innovative procedures focus on added value, innovation and cooperation (Eriksson & Westerberg, 2011). Nederhand and Klijn (2015) described that in a tender process of PPP, public and private organisations negotiate, which appeared to fit innovative procurement procedures. However, these authors observed that tender processes are often internally oriented and contain many deadlines. After performance targets are set, the contract becomes rather inflexible. Zheng et al. (2008) performed case study research and concluded that inflexible agreements are a consequence of little to no personal contact during bidding and negotiation in tender processes. Eriksson and Westenberg (2011) investigated the causes of difficulties in relations between client and contractor and pinpointed the importance of sustainable relational development during the tender process. Procurement-related choices effect whether the governance relies more on competition or on cooperation. According to Zheng et al. (2008) applying cooperative mechanisms will lead to more cooperation.

All respondents supported this proposition. Four respondents arrived to this conclusion principally because of their experience during the tender process. The other respondents based their answer on their knowledge of the process within their partnership as transferred by predecessors or colleagues and on own experiences with tender processes in general. The respondents suggested to minimise specification up front, perform dialogue in the bid invitation stage and evaluate bids on risks and soft aspects.

4.3 Proposition 3: A stable pool of employees with the right composition contributes to trust development

Forming a project is an important element of setting up the partnership. A stable pool of team members facilitates the formation of inter-organisational trust. Maurer (2010) suggested to choose a staff approach that results in the appropriate composition of team members and to allow team members to work full-time on the project. This way team members acquaint with each other (Maurer, 2010). Public organisations apply objective tender procedures. Therefore, the selection of team members should be objective. Kumaraswamy and Anvuur (2008) considered team composition to be critical success factor in project. They reviewed available literature on relational indicators and visualised the relevant relational indicators for PPP. Relational factors can be indicated from values and attitudes and are based on former performance of team members (Kumaraswamy & Anvuur, 2008). Due to today's complex and dynamic business environment, organisations are required to be adaptive and flexible. As team members arrive and depart during the project life time, Panteli and Sockaligam (2005) observed the importance of knowledge management in long-term contracts. Complexity and strategic impact of PPP calls for a careful selection of team members.

Almost all respondents supported that composing the team on competences, personal driving forces and knowledge/experience contribute to trust development. Team members learn to cooperate and the team becomes more diverse. In addition, team members of client and contractor should fit together. Respondents suggested composing on both intuition and mechanisms for objectifying competences and differences between individuals. Opinions on the stability of a team is more ambiguous; most respondents recommended to have a stable team composition in the first 1,5 till 2 years of the contract. Respondents stress the importance of interchanging team members and to ensure successful replacement due to 1) age and other

interests of individuals, 2) bad performance of individuals or team, 3) alignment with future staff requirements. And with replacements organise knowledge-transfer.

4.4 Proposition 4: Facilitating open communication and interaction between parties contributes to trust development

Trust develops when team members interact and communicate openly about their intentions and when team members work together on a project without abusing each other's vulnerability. Klijn and Eshuis (2013) noted that without interaction, trust will easily diminish and advises to set rules for interaction in the contract. When team members are more open to each other, this facilitates the learning process and stimulate innovation. Innovation is often one of the objectives of a PPP (Klijn & Eshuis, 2013). Saz-Carranza and Longo (2012) demonstrated partnership-challenges can be solved as members of both organisations learn to acknowledge each other's differences. In order to achieve this, parties should involve and communicate with stakeholders.

All respondents supported this proposition, as communication is seen as one of the most important elements in trust development. Respondents suggested several mechanisms which are all are meant to facilitate communication and interaction. Obtaining knowledge on each other will lead to acknowledging each other.

The suggested mechanisms can be distinguished in written and unwritten rules. Four respondents suggested to apply a project kick-off, meant to achieve an equal comprehension of each other's interest, expectation and organisation. R4 stated that a start-up offers contractors an acquaintance with the client's organisation. R7 commented that regular meetings are used to discuss relevant developments, but also to find each other. Additionally, R4 and R5 mentioned having a containing whiteboard with post-its actions and agreements, visualising the current status, which motivates team members. Beside these formal mechanisms (written rules) respondents suggested to apply other mechanisms which are categorised under 'unwritten rules', not set in the contract, such as team building (roleplaying, funny games, workshops or knowledge sessions) and personal attention for each other.

4.5 Proposition 5: Monitoring on relational performance indicators contributes to trust development

To set a performance management system, parties should start with the objective of the PPP, which is often value for money. Considering the complexity of PPP, one might expect parties desire to monitor relational aspects. Kamaraswamy and Anvuur (2008) reviewed the available studies on this on this topic and concluded that studies do not provide clear indicators and instruments. They suggested several relational aspects, which may be set as indicators, these includes people, communication, working-principles, way of dealing with conflicts, culture and distribution of roles, intention, compliance, interaction, affection and values (Kamaraswamy & Anvuur, 2008). Bult and Van Engen (2015) demonstrated that many performance issues are related to relational aspects in the cooperation and agreed studies lack of providing instruments to monitor and evaluate interventions on relational aspects. Kamaraswamy and Anvuur (2008) suggested applying an integrated approach that evaluates technical, sustainability and relational performance within projects.

Respondents reported to currently monitor only non-relational performance indicators such as; money, time, recovery terms, quality and change-progress. None of the respondents applied relational performance indicators. However, all respondents could imagine monitoring on relational performance indicators contributes to trust development, because this adds a personal

touch to the performance. Respondents suggested using ‘cooperation’ as performance indicator, as cooperation appears to have an important contribution on project performance.

4.6 Proposition 6: Applying objective and measurable project rewards (incentives) contributes to trust development

In order to stimulate superior performance, Bresnen and Marshall (2000) demonstrated that creating a situation both client and contractors benefit from performance contributes to trust development. Incentives that create win-win situations for both client and contractors can be set. Maurer (2010) indicated that project-rewards (a synonym for incentives) provide a context that enables trust development. However, organisations should be aware of the limitations of incentives. Incentives are often oriented at the organisation, but trust development and performance delivery is amongst others a result of the cognitive and social dimensions of the individual (Bresnen & Marshall, 2000). Eriksson and Westenberg (2011) demonstrated that applying incentives as additional payments increases the motivation to perform well. Financial incentives, time performance and satisfaction also could be included.

All respondents acknowledged that benefiting from performance contributes to trust development. Their opinion is based on different type of benefits. Some believed financial rewards or fines contribute to trust development, where others disagree because of the opinion that the contractor should just deliver what is agreed upon. In addition, respondents suggested non-financial rewards such as: gaining experience and acquiring knowledge, giving and receiving feedback, giving and receiving compliments and celebrating successes. These non-financial rewards appeared to effect the intrinsic motivation of team members to achieve a superior performance and this contributes to trust development.

4.7 Proposition 7: Prior experiences between parties contribute to trust development

When the contract is awarded and signed, the partnership is set-up, monitored and optimised. Studies demonstrated that the rules of trust are not as specified as written contracts. Trust is related to societal norms and values of specific behaviour between groups of people.

Ring and Van de Ven (1994) investigated the development of cooperative inter-organisational relationships and demonstrated this is based on individual choices. To investigate these individual choices, it is important to note that purpose, values and expectations are the basis for human choices. Therefore, to understand how partnerships develop, it is important to understand how people commit, negotiate and perform. Several authors mentioned the fact that trust grows on earlier experiences (Nooteboom, 2002; Maurer, 2010; Klijn & Eshuis, 2013). Maurer (2010) calls it the shadow of the past, which indicates that trust requires time to develop and is built through prior experiences. Relationships develop circular instead of linear, because trust is the cause and result of a partnership (Nooteboom, Berger & Noorderhaven, 1995).

Respondents reported that most issues are problems of the first year of the cooperation. Three respondents mentioned to have invested in each other in the beginning of the relation, as this contributes to trust development. Three other respondents supported each prior experience effects trust development, based on their comments this is depended on the individual’s action and reaction. They also stated that individuals deal different with prior experiences and this is dependent on the type of person. Some people have difficulties with letting bygones be bygones.

5 CONCLUSION

This study concluded that the content of a contract does effect trust development in PPP. The content of a contract can be divided into relational aspects and technical aspects. Both aspects have an effect on trust development. However, relational aspects have more effect then technical aspects.

Regarding the technical part of the contract, this study suggests to leave room for interpretation and only specify the most essential aspects of the product. This study concludes that composing specifications in the tender process instead of specification up-front contributes to trust development. Noteworthy is that though all respondents supported monitoring on relational indicators, none of the respondents in this study use these kinds of indicators.

Trust is summative of all prior experience with unequal weight per experience. Relations are mutual and depended on the competences and intentions of individuals; these will ultimately determine the way trust is developed.

6 RECOMMENDATIONS

Intrinsic motivation of team members is the foundation of trust development. Therefore, organisations are advised to: 1) include team members that have cooperation-skills, are able to address prior experiences, are able to learn from the past and focus on the future, 2) develop the team e.g. by team building and 3) create a positive environment where wellbeing of individuals receives attention, where people feel welcome, can learn and receive feedback and where successes are celebrated.

When designing the contract, organisations are recommended to apply technical and relational mechanisms in their PPP-contract. Furthermore, to include the facility/operation manager early in this process, as this person becomes responsible for the longest part of the contract. This way, transfer of knowledge from initial phases is facilitated. Organisations, who are currently managing the contract, are recommended to apply relational mechanisms, especially in the beginning of the partnership.

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Early involvement of FM-competencies in building projects facilitate long-term value creation

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ABSTRACT

Purpose: In Norway, commercial properties and publicly owned buildings in average serve for approximately 60 years. A significant part of these buildings' value creation for owners and users take place during the use phase. The present research investigates how involvement of Facility Management (FM) competencies in early phase and transfer of information and documentation during phase transitions in the building process may improve the building's value creation for owners and users.

Methodology: The present research is based on a cross-sectional observational design. Data were collected from June to September 2016 through a national online survey (N = 1034). The most important analytical methods are descriptive statistics and analyses of correlation.

Findings: There are significant relations between early involvement of FM competencies and transfer of information during phase transitions, and the buildings' value creation for owners and users.

Impact: Early phase planning represent only a marginal fraction of a building's total life-cycle costs, but many of the most important decisions concerning a building's fit for its intended purposes, operational costs, life-cycle costs, and value creation for owners and users are determined during the early planning phase. Thus, smart building owners and users involve FM competencies in early phase planning, and emphasise transfer of information and documentation during the building process' phase transitions.

Paper type: Research paper

Keywords: Building process, Canonical correlation, Facilities Management, Life-cycle costs, Phase transitions, Value creation.

1 INTRODUCTION

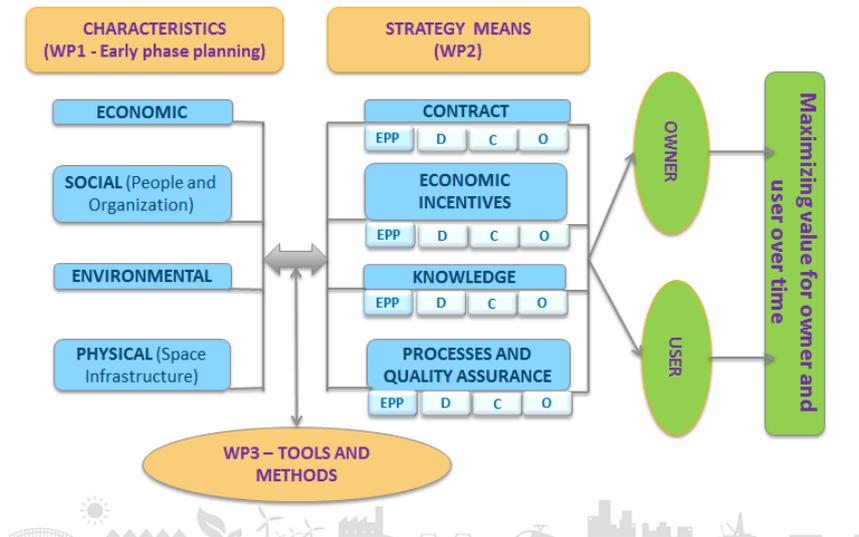
This paper presents some initial findings from the research project Oscar, which intention is to develop good decision and communication tools for projects and processes, and to facilitate good, adaptable and usable buildings over time. The project is based on some assumptions: There is a clear connection between early phase planning and design and value creation for owners and users; methods and tools can enable optimization of the building design; the Life Cycle Aspect is essential for early phase planning. In this way, buildings can contribute to good value creation during its lifetime – both for owners and users.

In Norway, commercial properties and publicly owned buildings in average serve for approximately 60 years. A significant part of these buildings' value creation for owners and

users take place during the operational use phase. A building’s life cycle typically consists of the conception or strategic analysis phase, early planning and design phase, production phase, commissioning phase, and the use phase. This cycle is partly repeated if the building owner considers renovation or refurbishment.

Oscar has four objectives, linked to work packages (WP).

Figure 1 Oscar’s Value contribution map.



Oscar’s Value Contribution Map is designed on the basis of the European FM standard EN15221 (CEN, 2006). Value creation is understood as a result of the interaction between “space and infrastructure”, “people and organization”, through value contributions from stakeholders (planners, architects, consultants, contractors, deliveries, facility managers and service providers). The early phase (WP1) includes characteristics, divided into four dimensions: economic, social, environmental and physical. The construction phase (WP2) includes the strategy means, which consist of contract, economic incentives, and knowledge, which interact with decisions made during early phase planning. Other abbreviations are: EPP - Early Plan Phase, D - Detail Design Phase, C - Construction phase and O - Operational use of the buildings. WP3 includes development of tools and methods to improve the interaction between the early phase and construction phase. The building process can be understood as a kind of relay race, where information and documentation phase transitions. Oscar’s last phase (WP4) is dissemination of the research results, tools and methods.

Studies undertaken during Oscar WP1 about early phase planning of buildings found the most important aspects within the economic dimension are investment costs, the building’s effect on core business, and energy costs. Building owners are more concerned about life cycle costs (LCC) than users. In the social dimension, the most important aspect during early phase planning is user involvement. In the environmental dimension, the most important aspects for building owners during early phase planning are energy efficiency and use of renewable energy sources. In the physical dimension, the most important aspects are accessibility and universal design and areas use (logistics, etc.). However, flexibility (the possibility to change the

building's floor plan, etc.), elasticity (the possibility to change the building's volume, use, etc.) and the building's generality (the possibility to change the building's function and use) were less interesting during early phase planning (Boge and Temeljotov Salaj, 2016; 2017). This last finding was somewhat surprising because a building's adaptability is of great importance for alternative uses and therefore also for the building's future value and value creation for owners and users (Bjørberg et al., 2016). Owners and users who get involved in early-phase planning and who would like to improve a buildings' usability and lifetime value creation should among others prioritize measures that promote environment, LCC and FM (Boge et al., 2018).

According to a Norwegian definition (NOU: 22:2004) "good property management is to give the users satisfactory and efficient buildings at the lowest possible costs/use of resources".

From literature reviews we can see an increasing focus on early involvement of FM teams with design and operation staff in early phase planning and construction of buildings (Boge et al., 2018, Bjørberg et al., 2017, Wong et al., 2014). However, it is still not common. The teams still often live separate lives. In Norway, the interest and focus on LCC has improved after the revision of the public procurement law (Listerud et al, 2012), which requires a net present value (NPV) calculations of the consequences of the investments over a defined period. The focus on high usability performance during the building life cycle is stressed by Alexander (2006) and Häkkinen and Nuutinen (2007). Many researchers addressed added value focus of FM (Jensen et al., 2012, Lindholm, 2008, Menon et al., 2005). For architects and building contractors, value is typically created during the detail design and construction phases. For building owners, value is usually created when the building has been taken over and sold to other investors, or where the tenants provide a steady cash flow. For end-users, buildings create value when they accommodate workplaces and facilitate the end-users' value creating activities (Støre-Valen, 2018). According to Haddadi et al. (2016), value is created when needs are fulfilled and strategic goals are achieved. Thus, a building's value creation in a life cycle perspective depends mainly on factors "fulfilment of the users' needs" and "fulfilment of owners and the corporate's strategy". Haddadi et al. (2016) presented a method that enables the project to focus on lifetime perspective, by starting the process early in the project, facilitating value-creating decisions (environmental, economic, physical and social) through the project's timeline until its finish.

Thus, moderate investments in early-phase planning may be very profitable for both building owners and users, because a building's usability and lifetime value creation is largely determined by decisions made or not made during early-phase planning. Whether organizations are able to implement successful FM during a building's use phase is also partly determined during early-phase planning; i.e. before construction and commissioning of the building (Boge et al., 2018).

This paper investigates two research questions:

- How do early involvement of FM competencies influence the building's value creation for owners and users during the use phase?
- How do transfer of information and documentation during phase transitions in the building process influence the building's value creation for owners and users during the use phase?

2 METHODOLOGY

The research design is a cross-sectional large N observational design (Gerring and Christenson, 2017, pp. 118-124), where the variations in the explanatory variables are analyzed across units

but not across time. The data were collected through a national online survey in Norway from June to September 2016. The main channels for distributing the invitation to the survey were business sector organizations such as Norwegian Building and Real Estate Association, the Architects' association, and the Consulting Engineer's association. Even employees in the organizations participating in Oscar's consortium, and several others received invitations, but the vast majority of respondents are employed by other organizations than those in Oscar's research consortium. The respondents (N = 1034) are not a result of random sampling. Thus, it is not possible to generalize the results.

The items in used in this paper were rated by the respondents on a Likert scale, ranging from 1 to 6 (Disagree-Agree). Involvement of stakeholders and pretesting of the questionnaire clearly improved the data's validity.

The survey data have been analyzed with IBM SPSS. The most important analytical methods are descriptive statistics (frequencies, tendencies, contingency tables, etc.), and analysis of correlations and canonical correlations. Cohen (1988) distinguished between small, medium and large effect sizes, and established .10, .20 and .50 as limits for respectively small, medium and large effect sizes for Pearson's Rho (r). These limits for effect size are also commonly applied on other measures of correlation.

Canonical correlation analysis is a multivariate analysis of correlation and also a method for data or dimension reduction, similarly as factor analysis or principal-component analysis, but canonical correlation analysis is used to study the relationship between two set of variables (variates) each consisting of more than two variables (Thompson, 1984, p. 10; Tabachnick and Fidell, 2014, p. 617). Thus, the canonical correlation coefficient (r_c) measures the strength of association between two variates or constructs.

Canonical correlation analysis can be understood as multiple regressions with several variables on both sides of the equation, which are combined into one independent (IV) and one dependent variate (DV). However, canonical correlation analysis is not based on any assumptions about causality. Definition of IV and DV has to be based on temporal or theoretical reasons. Canonical correlation can also be understood as an exploratory version of structural equation models (SEM), which are confirmatory (Tabachnick and Fidell, 2014, p. 617-618). Discriminant analysis is a special case of canonical correlation analysis.

3 RESULTS

This section presents the respondents and findings concerning early involvement of FM competencies and transfer of information during phase transitions.

3.1 The respondents

The 1034 respondents consist of 19.8% women and 80.2% men, with an average of 15 years' professional experience. The respondents' mean age is 51 years. 782 respondents have engineering education, the rest have educations in business administration, architecture, finance, investment or law, marketing and communication and social science. These respondents fairly well represent those involved in Norwegian commercial and public sector building projects.

Table 1 provides an overview of the respondents' roles sorted in diminishing order, based on the total number of answers for each role.

Table 1 The respondents' roles in their projects ranked according to frequency

Role	Total (N)	Women (%)	Men (%)
The building owner's project manager	286	40 (14)	246 (86)
Consultant engineer	229	46 (20)	183 (80)
Building owner	208	26 (13)	182 (87)
Steward or building manager	105	17 (16)	88 (84)
Internal project manager	94	18 (19)	76 (81)
Project group manager	75	10 (13)	65 (87)
Construction manager	71	5 (7)	66 (93)
User	54	10 (19)	44 (81)
Construction contractor	46	3 (7)	43 (93)
Architects	44	16 (36)	28 (64)
Construction contractor's project manager	37	2 (5)	35 (95)
FM service provider	30	11 (37)	19 (63)

Table 1 indicates the building and real estate industries are a men's world. Females are small minorities in most roles, except among architects and FM service providers. Most respondents have many years' experience in their roles.

Most respondents worked in new building's projects (642), but also in refurbishment and renovation, extension or appendage of existing buildings. The project size was measured by total costs inclusive VAT. 164 respondents worked on projects worth 700 million NOK or more. 240 respondents worked on technically complex buildings. 451 respondents have been actively involved in the early phase, 636 respondents in the project planning phase, 594 in the construction phase and 263 in the operational/use phase.

The projects the respondents have based their answers on include various categories of buildings.

Table 2 The respondents' building projects ranked according to frequency

Building category	Total (N)	Signal buildings (%)	Standard buildings (%)	Technically complex buildings (%)
Offices or business facilities	289	95 (33)	176 (61)	82 (28)
Primary or secondary schools	152	24 (16)	126 (83)	25 (16)
Housing	149	33 (22)	120 (81)	22 (15)
Facilities for assisted living	93	16 (17)	73 (79)	18 (19)
Cultural facilities	85	54 (64)	31 (36)	23 (27)
Universities or university college	78	32 (41)	26 (33)	36 (46)
Hospitals	73	11 (15)	32 (44)	52 (71)
Sports facilities	52	16 (31)	37 (71)	16 (31)
Prisons	4	2 (50)	1 (25)	2 (50)

Table 2 shows the kind of building projects respondents were involve in and the distribution of these building categories as signal buildings, standard buildings and technically complex buildings. Some projects involve more than one category of buildings. This is why the sum of categories for signal buildings, standard buildings and technically complex buildings may exceed 100%.

3.2 Early involvement of FM competencies in building projects

How do early involvements of FM competencies influence the building's value creation for owners and users during the use phase? Table 3 provides an overview of the correlation (r) between early involvement of internal or external FM providers and the completed building.

Table 3 Early involvement of FM provider vs. Completed building

Involvement of FM provider		Completed building		
		Technical systems and integration between systems worked as described	Training of the operational staff to optimize the operations	The project satisfy the value areas' expressed requirements (function, performance)
Early phase	r	.343**	.458**	.424**
	N	312	305	312
Planning phase	r	.359**	.471**	.437**
	N	332	325	331
Construction phase	r	.325**	.438**	.364**
	N	334	326	332

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 3 indicates significant associations between early involvement of FM providers during early phase, planning phase and construction phase and the outcomes concerning the completed building. The effect sizes are medium (> .30) to almost large (> .50). There are particularly strong associations between involvements of FM providers in the planning phase and technical integration between the building's systems, and training of the operational staff, and involvement of FM providers in the construction phase and whether the project satisfies the function and performance requirements.

Canonical correlation analysis of the data presented in Table 3 gave 3 roots (N = 292), but only the first of these 3 roots was significant (Wilk's Lambda = .725, F = 10.919 (4), p < .001, $r_c = .521$, $r_c^2 = .27$, Eigenvalue = .373). $R_c = .521$ indicates an association with large effect size. The canonical variables (IV); i.e. involvement of FM suppliers, explains 72% of the variance in the DV; i.e. the completed building.

Table 4 Early involvements of FM providers vs. Effects of project

Involvements of FM providers		Effects of project						
		Contributed to achievement of strategic goals	Development of own competencies	Profitability	Market position	Innovation	Reputation	Productivity and effectiveness
Early phase	r	.285**	.241**	.250**	.188**	.183**	.241**	.366**
	N	428	441	399	361	292	439	411
Planning phase	r	.311**	.274**	.316**	.225**	.230**	.289**	.394**
	N	449	462	419	380	310	458	431
Construction phase	r	.238**	.278**	.281**	.205**	.201**	.269**	.326**
	N	427	439	399	358	290	434	408

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4 similarly shows significant associations between involvement of FM providers during early phase, planning phase and construction phase and effects of the building project. Many of the effect sizes are medium ($> .30$). There are particularly strong associations between involvement of FM providers in the planning phase and contributions to strategic goals, profitability, market position, innovation, reputation, and productivity and effectiveness. These findings indicate that early involvement of FM providers can be very beneficial for a building project.

Even canonical correlation analysis of the data presented in Table 4 gave 3 roots ($N = 214$), and even here only the first root was significant (Wilk's Lambda = .766, $F = 2.723$ (21), $p < .001$, $r_c = .463$, $r_c^2 = .21$, Eigenvalue = .273). Thus, $r_c = .463$ indicates an almost large effect size between early involvement of FM providers and effects of the building project. The canonical variables (IV); i.e. involvement of FM suppliers, explains 44.94% of the variance in the DV; i.e. effects of the project.

3.3 Transfer of information and data during building process' phase transitions

How do transfer of information and documentation during phase transitions in the building process influence the building's value creation for owners and users during the use phase?

Table 5 Transfer of information during phase transitions vs. Completed building

Transfer of information during phase transitions		Completed building		
		Technical systems and integration between systems worked as described	Training of the operational staff to optimize the operations	The project satisfy the value areas' expressed requirements (function, performance)
Foundation from earlier phase presented and transferred	r N	.444** 344	.510** 329	.518** 345
Kick-off meeting for all those involved	r N	.379** 349	.432** 336	.376** 352
Owner's performance requirements conveyed during kick-off meetings	r N	.393** 439	.439** 337	.433** 353

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 5 shows significant associations between transfer of information during phase transitions and the outcomes concerning the completed building. The effect sizes vary between medium ($> .30$) and large ($> .50$). There are particularly strong associations between transfer of foundations from earlier phases and integration of systems, training of operational staff and function and performance requirements.

Canonical correlation analysis of the data presented in Table 5 gave 3 roots ($N = 304$), but even here only the first root was significant (Wilk's Lambda = .631, $F = 16.827 (9)$, $p < .001$, $r_c = .593$, $r_c^2 = .35$, Eigenvalue = .544). Thus, $r_c = .593$ indicates a large effect size between transfer of information during phase transitions and the completed building. The canonical variables (IV); i.e. transfer of information during phase transitions, explains 78.52% of the variance in the DV; i.e. the completed building.

Table 6 Transfer of information during phase transitions vs. Effects of project

Transfer of information during phase transitions		Effects of project						
		Contributed to achievement of strategic goals	Development of own competencies	Profitability	Market position	Innovation	Reputation	Productivity and effectiveness
Foundation from earlier phase presented and transferred	r	.403**	.325**	.379**	.350**	.310**	.419**	.380**
	N	474	495	454	419	346	489	455
Kick-off meeting for all those involved	r	.410**	.291**	.313**	.302**	.230**	.390**	.361**
	N	477	498	458	416	340	491	463
Owner's performance requirements conveyed during kick-off meeting	r	.474**	.355**	.346**	.368**	.229**	.428**	.449**
	N	469	489	448	405	334	484	449

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 6 shows significant associations between transfer of information during phase transitions and effects of the building project. The effect sizes vary between medium ($>.30$) and large ($>.50$), except for innovation and kick-off meetings. Conveyances of owner's requirements during kick-off meetings are strongly associated with achievement of strategic goals, development of competencies, market position, reputation and productivity and effectiveness. Foundations from earlier phases are associated with profitability and reputation.

Canonical correlation analysis of the data presented in Table 6 gave 3 roots ($N = 255$), but even here only the first root was significant (Wilk's Lambda = .636, $F = 5.079 (21)$, $p < .001$, $r_c = .582$, $r_c^2 = .34$, Eigenvalue = .512). Thus, $r_c = .582$ indicates a large effect size between transfer of information during phase transitions and effects of project. The canonical variables (IV); i.e. transfer of information during phase transitions, explains 22.88% of the variance in the DV; i.e. effects of the project.

4 CONCLUSION

The data in this paper stems from a national online survey accomplished in Norway between June and September 2016. The sample was a result of random sampling, but Table 1 and 2 shows the respondents very well reflect those working with RE and buildings projects in Norway. Table 3 shows medium to strong correlation (effect size) between early involvement of FM providers and completed buildings. The canonical correlation r_c between early involvement of FM providers and completed building = .521, which is a large effect size. Table 4 indicate weak and medium correlation between early involvement of FM providers and effects of the project, but the canonical correlation r_c between early involvement of FM providers and effects of project = .463, which is almost a large effect size. Table 5 indicates medium and large correlation between transfer of information during phase transitions and completed building, and the canonical correlation $r_c = .593$ indicates a large effect size. Table

6 indicates medium to almost large correlation between transfer of information during phase transitions and effects of project, and the canonical correlation $r_c = .582$, which is a large effect size.

The present research's design is not able to determine causal associations. Further research should thus aim for determining possible causal associations between early involvement of FM competencies in building projects, transfer of information during phase transitions, and buildings that create value for owners and user. However, the present research has identified significant associations between early involvement of FM competencies in building projects and successful projects, and significant associations between transfer of information during phase transitions and effects of the building project's value creation. Thus, smart building owners and users involve FM competencies in early phase planning, and emphasise transfer of information and documentation during the building process' phase transitions.

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Green leases and green leasing: a terminological overview of academia and practice

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ABSTRACT

Purpose: Through the use of existing literature and desk research from academia and practice, this paper will outline the degree to which there is a difference between the terms ‘*Green Leasing*’ and ‘*Green Leases*’ in academia and practice. Over the last decade, Green Leases have become an increasingly recognised and applied method by which to improve the sustainability of building stock. However, a lack of research into the differences between the terms ‘*Green Leasing*’ and ‘*Green Lease*’ have the potential to stifle a consistent use of these terms. This paper endeavours to better establish this difference in order to provide credibility in the usage of both terms.

Methodology: The data for this paper was accumulated through sourcing academic literature (mainly from academic peer reviewed journals) where Green Leasing and Green Leases are of a primary or substantial focus. The analysis establishes how each paper uses each of these terms. Practice based literature will be sourced and analysed similarly in order to establish better definitions of Green Leases and Green Leasing.

Findings: This paper establishes (with some noted exceptions), that the terms ‘*Green Leases*’ and ‘*Green Leasing*’ are used in both forms of literature in a manner that is relatively close to the dictionary definition terms of ‘*Lease*’ and ‘*Leasing*’. With these findings in mind, it is established that a Green Lease is the lease document itself, whilst Green Leasing is the process of renting and operating a rented sustainable building that may or may not have a Green Lease.

Impact: This study has the potential to affect the terminological uses of both terms in order to provide consistency that will benefit both market penetration and academic research and dissemination. This study is also applicable outside the field of real estate, as it also has a relevance to the study and practice of law, Sustainable Facilities Management (SFM), architecture and the study of the built environment more broadly.

Paper type: Literature Review

Keywords: Green Leases, Green Leasing, Sustainable Facilities Management, Corporate Real Estate, Offices

1 INTRODUCTION

In a world that has been focusing increasingly on the environmental impact of our daily activities, the fields of both Real Estate (RE) and Facilities Management (FM) are finding that sustainability and its related issues are having a noticeable impact on the way that they operate and do business. There are numerous drivers for this change, ranging from the likes of demand from customers, to corporate social responsibility (CSR), to the advantages of a Green building certification such as the United Kingdom (UK) founded but globally franchised ‘Building Research Establishment Environmental Assessment Method’ (BREEAM) (Collins et al., 2016).

A shift to a focus on the likes of issues such as sustainability will require new approaches by which to tackle them effectively. This in of itself is as numerous in approach as it is its scope, ranging from legislative proposals such as the implemented and later repealed ‘Carbon Pricing Mechanism’ in Australia ("About the carbon pricing mechanism," 2014), to technical solutions such as the development of Passive Houses. Office rentals is one area of the RE sector that offers significant potential in reducing a company’s carbon footprint. For example, one of the reasons is due the high level of energy consumption from the likes of computers and lighting, which could see a tangible reduction through the behavioural change of users (Mulville et al., 2013, p.80), which in turn could be an important factor for FM to consider in a wider building context.

Amongst other means by which to consider improving the sustainability of rental offices, is so called ‘*Green Leasing*’ and ‘*Green Leases*’, which have become an increasingly prevalent part of the RE landscape over the past decade (Bright et al., 2014, p.7). These types of leasing agreements are not only challenging to industry and scholars alike to rethink the roles of owners, tenants and their responsibilities, but are also facing new challenges such as those of terminological consistency that risk placing further pressures on Green Lease and Green Leasing development.

2 RESEARCH DESIGN

The purpose of this paper is to establish how the terms ‘*Green Lease*’ and ‘*Green Leasing*’ are being used in both academic and practice, and if there is scope to offer a more consistent definition that could be used by both sectors.

This paper will attempt to answer the following research questions:

1. How is the term ‘*Green Lease*’ being used in literature in both academic and practice?
- *To what extent are there grounds for a common understanding of this term?*
2. How is the term ‘*Green Leasing*’ being used in both academic and practice?
- *To what extent are there grounds for a common understanding of this term?*

Each question will be considered in turn, and this paper will then conclude by discussing the extent to which the findings could lead to a more common understanding as to what constitutes the terms ‘*Green Lease*’ and ‘*Green Leasing*’

The data for this paper was accumulated from existing literature, sourced from the research search engine ‘Google Scholar’ in the case of academic literature, along with trade publications and the regular Google search engine for practice based literature, along with further literature from the library which the author has amassed over 4 years. The literature used for analysis is dated 2007 until 2018.

3 METHODOLOGY

3.1. Sourcing Literature

The data collected for this paper consists of desk research of existing literature from both academia and practice. The search for industry and academic literature is from 2007 to 2018. These years are important, primarily due to the more common usage of the terms entering RE and FM lexicon in around 2007, as stated by Bright *et al* (2014). In the case of literature from academia, this consists primarily of high impact academic journal articles. The benchmark for the quality of these journals is the ‘Norwegian Register for Scientific Journals, Series and

Publishers' (NSD), which provides Norwegian academics with a list of acceptable scientific publications for citation. The majority of articles were sourced through Google Scholar using the search terms '*Green Lease*', '*Green Leasing*' and '*Green Leases*'.

In order to reduce the search results, the publications were checked to ensure that they were connected to and directly discussed the sustainable built environment. The articles primarily came from the disciplines of the built environment, law, facilities management and real estate. Literature from books or other texts amassed by the author over 4 years which, adhere to the same academic benchmarks as those sourced from Google Scholar were also included in the analysis.

The standard Google search engine was primarily used to source from practice and the same search terms as the academic literature were used. Similarly as in the search for academic publications, pruning in connection to the built environment was conducted. This ensured that publications on relevant subject matters to study such as the '*leasing of green vehicles*' were not factored in to the results. Almost all of the sources from practice have been procured from online resources. This was due to their availability and the lack of easily accessible hard copies available. In order to ensure their reliability, all of these sources are from organisations and not from private blogs or other less reputable sources.

A vital criteria for all of the literature featured in this article was that it had to feature any of the terms '*Green Lease*', '*Green Leases*', and '*Green Leasing*' in their text. Documents and literature that featured these terms only in their titles, subtitles or literature list were excluded from the results. Documentation and literature that discussed these concepts but did not use the terms were also excluded from analysis in this paper.

3.2. Analytical Framework

The key analytical framework consisted of comparing the usage of each term in the text compared to the preliminary definitions that will be presented in the next section of this paper. The terms '*Green Leases*' and '*Green Lease*' were analysed together due their evident contextual similarity and the likelihood of them being used in the same context. The reasoning behind this approach was to see the extent to which their usages is consistent, and if there is a difference between academia and practice in how such terms are used.

In terms of a definition by which to establish an analytical benchmark, standard dictionary definitions will be used. In the case of '*Green Lease*'/ '*Green Leases*', the Oxford Dictionary definition of "*a contract by which one party conveys land, property, services, etc. to another for a specified time, usually in return for a periodic payment*" ("Definition of 'lease' in English," 2018) will be the benchmark by which to compare the terms in the literature analysed. In the case of '*Green Leasing*', the 'Free Dictionary' definition of "*the hiring out by one firm (the lessor) of an asset... to another firm (the lessee) in return for the payment of an agreed rental*" ("leasing," 2018) will be the benchmark.

The nature of this analytical framework also presents limitations. The limits of the paper in terms of the word count will limit the depth of possible analysis, and the possibility of thousands of results places restrictions on the feasibility of the scope. With this in mind, the results of this paper are indicative, as opposed to definitive.

4 LITERATURE REVIEW

4.1 A contextual definition of 'Green Lease' and 'Green Leasing'

Although the primary focus of this paper is to unravel the conundrum of definition of both terms, a contextual definition of both is an important basis by which to focus the analytical lens of the results and discussion.

At the present time, there is no universally accepted definition of what constitutes a 'Green Lease', with many in academia and practice viewing its meaning as fairly malleable. Despite this, the British chapter of the Better Buildings Partnership (BBP), a collaboration of building owners aimed at furthering the sustainable credentials of their buildings stock, created one of the more cited definitions in their 'Green Lease Toolkit'. They define a Green Lease as a "standard form lease with additional clauses included which provide for the management and improvement of the Environmental Performance of a building by both owner and occupier(s). Such a document is legally binding and its provisions remain in place for the duration of the term" (Bugden et al., 2013, p.2). They state that example Green Lease clauses could consist of "agree(d) targets and strategies to improve the Environmental Performance of the Premises and/or the Building on a regular basis", or "reduction in or improved efficiency of water consumption" (Bugden et al., 2013, pp. 14,16 and 22).

In the case of 'Green Leasing', finding any kind of definition at all poses a very sizable challenge to research. One of the only definitions found in literature was offered as a part of Australia's 'National Green Lease Policy', which describes Green Leasing as "the full set of environmental activities, considerations and impacts that occur throughout the entire leasing process. This process includes the period leading up to the lease agreement, the term of the lease and the end of a lease" (National Green Leasing Policy, 2010, p.5). Much like the case with Green Leases, there is yet to be a definition that is universally accepted.

5 RESULTS

5.1. Green Lease and Green Leases

5.1.1. Academia

In an investigation of academic literature, a Google Scholar search for "Green Lease" yields 578 results. In a look through these results, almost all of these hits correlate well with research into buildings ("Google Scholar Search for "Green Lease"," 2018). A search for "Green Leases" presents a similar picture with 600 results, almost all of which are relevant to the previously stated benchmarks. The search for both terms also contain the majority of the same documents.

A systematic search through the results shows that the majority of hits have a link in conjunction with discussions on tenancy agreements, as such keeping it mostly in the realms of being a 'lease' as per the dictionary definition. This is particularly the case where Green Leases are the primary focus of the article. Sayce *et al* (2009) for example states that a Green Lease is a set of environmental obligations that are codified within a lease (Sayce et al., 2009, p.276).

Brooks (2008) claims that the contents of a Green Lease can be variable, but he is specific in its definition. He defines it as a "lease document", where the degree of repercussions for breaking a clause is up to the landlord (Brooks, 2008, pp. 8,11). In the academic study of FM, there has been an increased focus on Green Leases. Although Green Leases can be found in

many FM publications through various degrees, it is only Atkin *et al* (2015) who appear to provide a definition. They describe a Green Lease as a “*use of incentives to align parties towards sustainable business practices within the terms of a lease agreement*” (Atkin *et al.*, 2015, p 342), keeping it firmly in the realms of being a lease document.

However, not all of the academic references to the terms ‘*Green Lease*’ and ‘*Green Leases*’ are solely about documentation. Whilst looking through the authors library and Google Scholar results, there was a repeated reference to so called ‘*Green Lease Schedules*’, a term that yields 44 results on Google Scholar (“Google Scholar Search for “Green Lease Schedule,” 2018). Christensen *et al* (2007), states that a Green Lease schedule is an Australian Government invention aimed at setting out the duties, values and step wise processes. In addition they state that they are employed in order to “*use the building in an ecologically sustainable manner by co-operating to directly reduce energy and water consumption and to participate in measures to bring about sustainability in the use and operation of the building in which the tenant is housed*” (Christensen *et al.*, 207, p.2). Whilst the ultimate goal of such a schedule is to create a tenancy agreement of some kind, the fact that it is a set of processes (as opposed to a document) places it more within the realms of the dictionary definition of ‘*leasing*’.

5.1.2. Practice

On the standard Google search engine, a search of the term “*Green Lease*” yields 49,000 results. Removing terms such as “*bowling green*” reduces this by nearly 1000, meaning that a sizable amount of the original results are not relevant to the study of buildings (“*Google Search for “Green Lease,” 2018*). A search for “*Green Leases*” delivers a higher level of hits, with 109,000. Similar levels of pruning reduced this to 30,000 with comparative levels of relevance, broadly speaking (“*Google Search for “Green Leases,” 2018*). As with academia, a sizable amount of the results showed the same publications for both terms.

A look through some of the most relevant search results also indicate a significant link with that of a lease or other kind of tenancy document. Law firm DLA Piper (2014) for example discusses leases featuring “*Green Lease Provisions*”, as a core part of their Green Lease dialogue (Piper, 2015). The United Nations Environment Program (UNEP) also discussed the Green Lease concept in their ‘*Greening the Buildings Supply Chain*’ report. Their discussions on the topic feature significantly in the context of Green building lifecycles, and more specifically the ‘*In Use*’ phase. They cite two major ‘*Green Interventions*’ in this process. Firstly, Green Facilities Management and the benchmarking and follow up associated with this. Secondly, they suggest “*Green Leases*” to be embedded into the lease structure of a Green building (UNEP, 2014, p.11).

Documentation is once again a concern for the majority of references to landlords. Property owner ‘*Rom Eiendom*’ for example view Green Leases as a core part of their sustainability strategy and within this context focus is the tenancy agreement. They endeavour to have such agreements in 30% of their buildings stock by the end of 2015 (“*Innfører grønne leiekontrakter,*” 2014).

There were however some (but ultimately very few) examples where ‘*Green Lease*’ and ‘*Green Leases*’ were used in the context of the dictionary definition of ‘*leasing*’. To UNEP for example, this kind of agreement is not binary, and is considered to be as much a ‘*leasing*’ process as it is a document, stating that this can result in “*best practices in facility management*” as well as simply the lease in isolation (UNEP, 2014, p.14).

5.2. Green Leasing

5.2.1. Academia

A Google Scholar search for the term “*Green Leasing*” returns 216 results. Whilst the vast majority of these results are relevant, a small amount of pruning was required to remove references related to leasing cars. This changed the number of results to 157 (“Google Scholar Search for “Green Leasing”, 2018). In terms of the use of ‘*Green Leasing*’ in academic literature, their use is rarely mentioned in the same terminological context as ‘*Green Leases*’ and ‘*Green Lease*’, but instead has more hits that orientated towards ‘*Leasing*’.

In terms of examples, Rameezdee *et al* (2017) use the term extensively, primarily in conjunction with what they describe as “*leasing practices*” (Rameezdee *et al.*, 2017, p.10), along with the practices in buildings that include improving employee wellbeing (Rameezdee *et al.*, 2017 p12). In the case of Janda *et al* (2016), they emphasise the separation of terminology and discuss patterns “*of leasing and lease wording*”. Indeed they define ‘*Green Leasing*’ specifically as “*the environmental processes, engagement and practices adopted by landlords and tenants in relation to the building*” (Janda *et al.*, 2016, p.2), without ever mentioning the lease document. Bright *et al* (2014) use the term in the same context as the previous authors, referring to “*Green lease practices*” in their article (Bright *et al.*, 2014, p. 8).

The author was unable to find any relevant usage of the term ‘*Green Leasing*’ that referred to a lease document.

5.2.2. Practice

A search on the standard Google search engine for the term “*Green Leasing*” returns 110,000 hits. With some pruning to reduce the search terms by removing hits relating to “*cars*” and “*banking*”, this reduced to 36,000 hits (“Google Search for “Green Leasing”, 2018). This a number too large to analyse in its entirety, however the first ten search pages which produced relevant results for the study of buildings. Similarly to the terms in academia, almost all results are related to the benchmark dictionary definition of ‘*Leasing*’. However there are some notable examples that deviate from this.

An example of this usage can be found in ‘A Better City’ (ABC), a Boston based non-profit organisation that deals with improving the city through sustainability and other initiatives. This organisation is clear on the difference between ‘*Green Leases*’, and ‘*Green Leasing*’, as evident in their work on looking into the barriers and drivers for implementation. They view a lack of knowledge on Green Leases (the document) as one, and unfamiliarity with “*Green Leasing practices*” being the other ((ABC), 2014, p.2). This is an opinion seconded by Craig Roussac of ‘Buildings Alive’, who when interviewed for TheFifthEstate’s Green Leasing guide called ‘The Tenants and Landlords Guide to Happiness’ notes that the lack of progress in the development of Green Leases is partially due the Green Leasing ‘process’ itself (Lynn, 2015, p.13).

The ‘Institute for Market Transformation’(IMT), an American institution that promotes the energy efficiency and greening of buildings along with founding their own ‘Green Lease Leaders’ program, has numerous mentions of ‘*Green Leasing*’ in their literature. Their wording however focuses on the benchmark definitions of a ‘*Lease*’ document. In their pamphlet ‘What is a Green Lease?’ (2015), they describe a lease document as “*high performance leasing*” (Feierman, 2015, p.6) and later in the paragraph they discuss it as a growing practice in real estate, once again referring to it as a document (Feierman, 2015, p.21).

6 DISCUSSION

Although the format imposed limits of this paper place restrictions on depth, a look at the existing literature appears to indicate some degree of terminological consistency in the terms '*Green Lease*' and '*Green Leasing*'. This has been considered within the context of the degree to which the terms have a similarity with the benchmark definitions of the terms '*lease*' and '*leasing*' featured in the methodology section.

When considering '*Green Lease*' and '*Green Leases*', in academia this was focused primarily on lease documents, as opposed to any process related usage. There were some deviations from this in the usage of '*Green Lease Schedules*', however this example was in relative isolation when considering the work overall. When looking at practice literature, the experience was similar to academia. In some practice literature however, there was also a closer link to considerations for FM approaches in some cases. This arguably straddles the benchmark definitions of '*lease*' and '*leasing*'.

There was a common ground in the consistent usage of terms in academic and practice publications. Although there were some stresses towards certain disciplines that were not found in others (such as the case of 'FM' in practice literature), this can be considered to be indicative of the subject matter that is the focus of their writing, and less about a difference in the use of the terms.

When examining the usage of the term '*Green Leasing*' in academic literature, the author found no deviation from the benchmark term of '*leasing*'. All of the citations found through the literature search indicate that the term is used to describe the process of leasing out a building, following the clauses of the lease, or enacting processes that may lead to the development and signing of a Green Lease. In some cases, the lease document was not a goal or a part of the process. The relatively marginal use of the term '*Green Leasing*' however does place restrictions on scope. In practice, the usage of the term was more malleable. Although the usage does weight towards '*leasing*', organisations such as the IMT who have used the term to describe the development and expanded implementation of Green Lease documents.

With regard to consistency between academia and practice, this is less solidified than with a '*Green Lease*'. Although the vast majority of citations are in the context of the benchmark '*leasing*', a deviation on this use in practice mandates the need to be contextually aware when looking at practice documentation.

7 CONCLUSION

In conclusion, the research in this paper seems to indicate that broadly speaking there is a pan discipline understanding to the terms '*Green Lease*' and '*Green Leasing*' across both academia and practice. This however does not cover all of the uses of these terms, as considerations found in literature from the likes of the IMT demonstrate that there are still sectors where the usage of terms are not consistent. In an interesting twist however, there appears to be more consensus on the usage of these terms than there is a universally accepted definition of a '*Green Lease*' itself.

Another curious finding in this terminological discussion is the terms occasional link with FM. Whilst it is already understood that there is a substantial degree of importance for linking FM to a Green building (Collins et al., 2015), there appears to be a strengthening of this link as a literature focus on Green Leases and Green Leasing increases.

As mentioned earlier in this article, these results are 'indicative' and not 'definitive'. An in-depth literary study, which includes a longer publication that could offer possibilities to

increase the consistency in the use of these terms in the built environment, architecture and FM.

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A future of positioning FM: Observations and assumptions

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ABSTRACT

Purpose: We are living in a special time period, characterised by new inventions, new insights in societal and business developments. We are talking and experiencing ‘disruption in turbulent times’. In this article we will focus especially on strategic aspects of organising that are in the midst of the struggle to find adequate structural solutions for problems perceived. One of the main discoveries is the formalisation of a principal distinction in organisations between the productive side and the enabling side of organisations. Enabling is defined as: *Making resources available to help starting up and subsequently making it possible to properly execute tasks (with a productive purpose), without ensuring the success of these tasks.*

Approach: In this article Facility Management will be the core focus, and seen as exemplary for the other disciplines. The enabling disciplines can be seen as a kind of broker between an external supplier and the organization. The changes detected are steadily taking place in several organisations, with a number of consequences in several management fields. Certainly with respect to enabling. Focusing on Facility Management as an enabling discipline (making things possible) triggers the attention for more strategic views on the discipline and the recognition that FM is contributing to the value adding process in an organisation. An initiating role around the theme of the future working place, where working is becoming more essential than place.

Furthermore, the internal developments in organisations have the tendency to lead to a growing feeling for and a tendency to resume more responsibility by producers in an organisation for innovative tasks in the production line. On the other hand, there is a manifest tendency that suppliers get a more vested influence in the enabling part of the organisations. The combination of the two types of tendencies leads to a revision of the principal schemes and beliefs about how organisations structure themselves.

Findings: Focusing on strategic issues we have concluded that the techno core of organisations comes more and more near to the application field in the production line, or is even included in that field, the role of policy or strategy intermediate of the techno core is reduced or also adopted by the production line in direct relationship with the (what is called by Minzberg) the strategic apex.

Impact: We can assume and tentatively predict on the basis of the outcomes of the successive research projects in the multi-annual research program of Ifmec, that:

- Strategic focus is developing in the enabling part of organisations, thus re-ordering or re-inventing, total organisations.
- Step by step the notion is getting foothold that organisations are (already for ages) composed of two main parts (the production and the enabling part) both in sound collaboration caring for the success of “the company”.
- Innovation, so necessary for organisational success, is realized optimally by the collaboration of producers, enablers and suppliers.

- Organisational innovation is especially facilitated by enabling disciplines.

Paper type: Viewpoint

Keywords: Facilities Management, Enabling, Innovation, Collaboration, Suppliers

1. CONCEPTS, PRACTICES, DEFINITIONS

We are living and working in a special time period, characterised by new inventions, new insights in societal and business developments. New fast developing innovations, not only in a technical sense, but also in a social-organisational sense. New forms of relating and restructuring are introduced, practised and followed in and between organisations. We are talking and experiencing ‘disruption in turbulent times’, in such a way that we accepted the acronym VUCA (Lewis, M.W., Andriopoulos, C & Smith, W.K., 2014) as a core characterization of our time:

- *Volatility.*
- *Uncertainty,*
- *Complexity and*
- *Ambiguity*

In this situation at the beginning of a new century, we have to cope with old challenges in new interpretations, new challenges are strongly influenced by new technologies and challenges are often triggered by human interventions in management, government and politics

Answers to the challenges are diverse, varying on the one side from redefinition of core concepts in organisation theory and practice, and esp. refocussing on the challenges manifest as well as latent as growing pains, to on the other side introducing hands-on practical solutions for daily organisational problems.

In this article we will focus especially on strategic aspects of organising that are in the midst of the struggle to find adequate structural solutions for problems perceived (or expected) by leaders and workers in organisations. One of the main discoveries during research and practical interventions in organisation projects is the formalization of a principal distinction in organisations between, what we have labelled, the productive side and the enabling side of organisations, popularly denoted as the two faces of every organisation (Van Dalen, 2009). The triggers to make this distinction so prominent were based on observations in the daily advisory practice as well as the theoretical findings in systems literature and research (Hanken & Van Dalen, 1986). A first publication on this topic was a presentation at the 2009 GEFMA congress in Frankfurt (Van Dalen, 2009).

Enabling is defined as:

Making resources available to help starting up and subsequently making it possible to properly execute tasks (with a productive purpose) without ensuring the success of these tasks (introduced in Van Dalen, *The art and craft of Enabling Leadership*, forthcoming).

Although the focus of the research is on all enabling disciplines, in this article Facility Management (FM) will be the core focus, and more or less seen as exemplary for the other disciplines, like HRM, ICT, Finance, Real Estate, etc. Interestingly all the enabling disciplines are resource based, representing the total picture of the necessary resources, for successful survival of an organisation. Differences between organisations do not only depend on the possession of resources but perhaps even more on the differences in capabilities to exploit

resources in the best way. The enabling disciplines can be seen as a kind of broker between an external supplier and the organisation.

2. OBSERVATIONS

Ifmec, as an institute, is grossly divided in two parts, each with different business units. The two parts are dedicated to

- Academic education and research
- Projects and advisory.

Both parts are dedicated to solving “problems” in organisations with respect to practices and principles of Facility Management and Leadership as well as the outcomes and impact of FM activities and strategies. By tradition and historical focus the problems to be solved as well as the solutions generated are heavily operations oriented, while the search for strategic puzzles and challenges are just recently developing and gaining more interest in leadership circles. In this respect the development of the knowledge base of Ifmec mirrors the development in the FM field quite well.

The connecting line between the activities undertaken by Ifmec is the multi-annual research program, dedicated to the developments of the FM-discipline, in practice and theory. Driven by practical reasons, every year is characterised by a research theme. Like the last four years:

- Re-inventing Real Estate from a Facility Management Perspective
- Collaboration between FM a HRM
- Facility Management as an Enabler of Change
- Value Adding/ Added Value,

And for this year:

- Focus in Collaboration.

Each year the theme is elaborated by connected research projects, each leading to practice-based reports of relevant findings. All together, a valuable source of observations and their interpretations (van der Ploeg, 2014; Hamstra, 2014; van Hallem, 2014; van Dommelen, 2015; Daling, 2016; Seffinga, 2017; Stitou, 2017). The challenge for the engaged researchers is to detect provisional conclusions about the yearly projects but also to conceptualise step by step more concretely their connections over time with respect to the overarching theme “the future of the position of FM as an enabling business discipline”. In this sense the title of this article is characteristic: mentioning it is about observations and assumptions.

The researches as they are successively executed, generate together a “growing” perspective on the changing roles and positioning of Facility Management in organisations. In a summarising sense this process can be characterised by a number of observations in the real developing world of Facility Management. During successive researches step by step an Enabling paradigm was developed, shortly composed of a reference model making a distinction between two general subsets of structures, processes, cultures and strategic principles in every organisation (Van Dalen, J.Chr., *The art and craft of Enabling Leadership*, forthcoming):

- A subset of *enabling* activities, departments, groups, etc. dedicated to make the activities and structures possible or
- The other *production* subset, dedicated to the factual; production of goods and /or services.

This way of observing and considering organisations offers a collection of new ways to analyse, design and evaluate organisations in general (like some auditing groups are doing). Especially

issues like collaboration and focussing become more apparent and lead to new original structures. That occur not seldomly spontaneous and unintended (if permitted by current management and leadership)

Some striking observations that are catching the eye are as follows:

- Technological and organisational innovation with respect to production moves away from the separate highbrow (enabling) design and innovation departments to the production organisation (in Minzberg’s terms “technostructure”)
- The role and impact of suppliers is growing and leads to new collaboration forms, and growing importance of demand management, informally called: the supplier.

3. THE DIVISION OF LABOUR, INFORMATION, MATERIAL AND OTHER RESOURCES IN HISTORICAL PERSPECTIVE

The changes defined in paragraph two are steadily taking place in several organisations with a number of consequences in several management fields. Especially, with respect to enabling. Think about purchasing; in- and outsourcing; new roles and functions and new forms of collaborating. All together, a set of impacts that demand another, more sophisticated set of capabilities at personal and at organisational level.

Given the great changes taking place in the environment of organisations, with respect to technologies, with new government rules, with the care for customers’ safety, with respect to speed of operations as well as strategic actions, it is not surprising that critical changes have to take place. To put these changes in perspective, we make a short tour through organisational history. Two milestones will be mentioned explicitly because these two milestones explicitly represent the great changes that took place in the past and the ones that are underway now.

Organisations are the vehicle necessary to produce services or goods for the needs and tastes of users/customers. To organise this vehicle in a manageable, efficient and effective way; successful, growing, organisations are partitioned in departments, business units, working groups, projects etc. simply to create workable structures, with outcomes that are envisaged by leaders, workers and customers. However, every smart organisational structure somewhere in its lifetime, is recognised as being not efficient, not effective and losing relevance and the interest of its stakeholders. So, changes in structure, processes and relationships are inescapable. To say it in a hands-on way: problems arise, conflicts are born and solutions have to be designed and installed for a successful continuation of the lifetime of organisations.

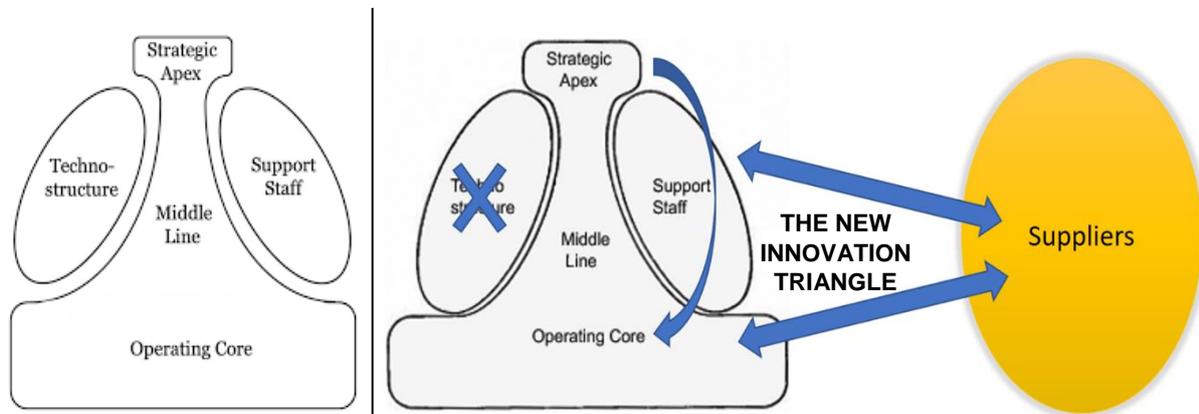
Taking a shortcut through organisational history, leaving out highly interesting structures from the antique world, we can start with Taylor (1856-1915). His solution, in short, was to extract a number of activities from the production workers’ workload, and bring it in eight separate departments:

<i>Time and cost</i>	<i>Maintenance</i>
<i>Work instruction</i>	<i>Quality Check</i>
<i>Process preparation</i>	<i>Technical Supervision</i>
<i>Work Processes and the way in which they are executed</i>	<i>Employer Management</i>

A next leap through organisational history brings us to Minzbergs’ (1979) *Structures in Fives* (figure 1), with the option to design variations like a potter who is modelling exquisite pottery. However, the core of Taylors’ honourable intention to unburden production workers from

“non-direct productive” tasks is still maintained. Thus, creating a discrepancy with modern opinions about involving people in innovation.

Figure 1 Structures in Fives (adapted from Mintzberg (1979))



The most recent step, discovered during the execution of Ifmecs’ multi-annual research program, is triggered by the recent developments in technology, as well as in developments in the composition of work activities, technology literacy and the striking development of the concept of *value added* as core evaluator of the successfulness of organisational processes as perceived by customers.

Up until recently the emphasis in organisational innovation has been on a strong continuation of an operational orientation, so characteristic for the success of Facility Management in the past. But also a ground for lack of appreciation and valuation by the “outside” stakeholders of the facilities profession. This is not only relevant for the FM-profession, but also for the other enabling disciplines.

Focussing on Facility Management as an enabling discipline (making things possible) triggers the attention for more strategic views on the discipline and the recognition that FM is contributing to the value adding process in an organisation. Recognising that the new qualification of FM (embedded in the collective “enabling”) is “making things possible”, FM has not only a following role in the total composition of production processes, but also an initiating role in scanning markets, conferences, research, etc. around the theme of the future working place, where working is becoming more essential than place (in the specific interpretation of big buildings with to limited options for agility.) The world of working is opening many windows to a future that is (and must be) more flexible, more demanding and more rewarding for organisation and workers

4. THE DEVELOPMENT OF THE FACILITY MANAGEMENT DISCIPLINE AS AN EXAMPLE

As already signalled by researchers and practitioners a number of changes took place in the field of technology, in the field of work constellations and in the field of strategy development. Furthermore, the internal developments in organisations have the tendency to lead to a growing feeling for and a tendency to resume more responsibility by producers in an organisation for innovative tasks in the production line at the cost of techno structure (viz. Mintzberg, 1979). On the other hand, there is the tendency that suppliers get a more vested influence in the enabling part of the organisations. Think about ICT suppliers, recruitment offices, financial

controllers, marketing specialists, sustainability etc. The combination of the two types of tendencies (more innovation integrated in the production line and more participation by suppliers) leads to a revision of the principal schemes and beliefs about how organisations structure themselves, instead of being structured by specialists with some authority assigned by the top leadership of an organisation.

Given these interesting and fruitful changes, we must admit that organisations develop not all together at the same speed into the same direction. Diversity is the main message for leaders and workers. Especially with respect to the challenge to survive in VUCA-circumstances.

5. FOCUSING ON STRATEGIC ISSUES

The observed changes in organisations cannot be discussed without taking into account, that strategy formation, adoption, change and evaluation is penetrating more and more through the whole organisation, at each level, each discipline, each field of responsibility. This tendency has another far reaching influence on the functioning of organisations and persons and groups in the organisation. Whereas we have concluded that the techno core of organisations comes more and more near to the application field in the production line, or is even included in that field, the role of policy or strategy intermediate of the techno core is reduced or also adopted by the production line in direct relationship with the (what is called by Minzberg) the strategic apex.

As a consequence, the translation of strategies and policies into workable production practices is a more and more crucial task of the leadership of an organisation and the enabling disciplines.

Summarising we can assume and tentatively predict on the basis of the outcomes of the successive research projects in the multi-annual research program, that:

- Strategic focus is developing, sometimes fast, sometimes slow in the enabling part of organisations; thus re-ordering (or as some researchers are saying re-inventing) total organisations (viz. several publications published by McKinsey);
- Step by step the notion is getting foothold that organisations are composed of two main parts (the production and the enabling part) both in sound collaboration caring for the success of “the company”.
- Innovation, necessary for organisational success, is realized optimally by the combination of producers, enablers and suppliers.
- Organisational innovation is especially facilitated by enabling disciplines.

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Student preferences & open learning spaces

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ABSTRACT

Purpose: Open learning spaces (OLS) are semi-public workspaces for students and educational staff, providing space for semi-educational sessions and facilitating meeting and working together. This study explores spatial preferences of first-year students of the built environment domain at a University of Applied Sciences in the Netherlands regarding OLS.

Methodology: This mixed-method study consists of four in-depth interviews with corporate real estate managers; three focus groups with students and one with lecturers, students', an online student survey, and observations at the School of Business, Building and Technology, Saxion Universities of Applied Sciences in Enschede .

Findings: Students rank educational real estate and facilities rather low but appreciate functionality, atmosphere, and proximity to lecturers and fellow students, rather than design and ambiance of the OLS. Verbal and non-verbal data collection methods on student preferences show different results, which gives broad perspectives and added value to input for corporate real estate management (CREM).

Impact: The evaluation of spatial experiences is an important design asset. The importance of adaptations by end-users, knowledge of characteristics of the student population, atmosphere and experience-based management is showed important.

Paper type: Research Paper

Keywords: Universities of applied sciences, Student preferences, Open Learning Spaces, Corporate Real Estate, Facility Management.

1 INTRODUCTION

The focus of this study are UASs accommodations which facilitate the “new ways of learning” (NWOL) in an open learning space (OLS). An OLS facilitates collaboration and is being used by universities in Europe, as well as in Australia, Asia and America. OLS have an open,

informal character, and offer different transparent arrangements, set-outs and furniture. The lessons learned from the “new ways of working” (NWoW) in regard to first-year students in bachelor programmes of an UAS in the built environment domain are part of the focus of paper. Since the Bologna Declaration (1999), higher education has transitioned from knowledge to competency-based education (Procee, 2001). Dutch higher education is a binary system with a bachelor-master structure and refers to higher professional education at an UAS and education at research universities. The Dutch government aim is a knowledge-based economy in which universities of applied sciences (UASs) are important (Rijksoverheid, 2015). The Dutch government's aim is a knowledge-based economy and focus on higher (technical) education, which is important for economic growth and prosperity. Social and technological developments occur at a fast pace (EY, 2015). Students and lecturers are increasingly connected by diverse, versatile communication capabilities and digitization. The relationship between student performance and their learning environment, in particular information on which aspects have a direct influence, will give valuable insights for corporate real estate (CRE) strategies of UAS. Performance- or study success of students is part of the performance of an UAS. According to Bitner (1992), the design of environments has an impact on achieving these objectives. Spatial needs for learning activities have become more focused on meeting other people and to collaborate on group assignments (Beckers & Van der Voordt, 2013), leading to a decreasing demand of traditional classrooms and increasingly open space layout. Technology drives learning in a virtual environment and the physical learning environment must provide spaces for informal learning, self-study and collaborative learning (Beckers, 2016). Beckers (2016) concluded also that individual work is done at home and students will go to a physical building for lecturer-based learning, group work and social activities.

2 LITERATURE REVIEW

Inappropriate environments could lead to conformity and anonymity rather than cooperation and creativity (Bjerrum & Bødker, 2003). Bijl (2009) described that NWoW could be efficient and effective. According to Vergunst (2011), NWoW includes the physical environment such as the building and workplaces, the virtual environment for instance ICT facilities and the mental environment, which can be defined as the perception and corporate culture. Project spaces or open work areas have a positive influence on interaction and collaboration between knowledge workers (Appel-Meulenbroek, 2009). The physical environment supports efficiency; aspects such as openness, sound, lighting, and temperature may have an effect on productivity (Maarleveld, 2011). With the support of technology and improving productivity, job satisfaction, work-life balance, competitiveness and reduction of environmental impact, NWoW seems most appropriately in knowledge-intensive organisations (Van der Kleij *et al.*, 2013).

Beckers and Van der Voordt (2013) concluded that the principles of NWoW are increasingly applied in other contexts, including (higher) education. There is a need to operate independent of place and time, therefore a school will be more a meeting place (Beckers, 2012). Similarities between NWoW and NWoL, like flexibility in work spaces, open areas and efficient use of floor area are increasingly acknowledged. NWoL can be explained as new approaches to education based on the combination of connectivism, digitization, other methods of communication and a new generation of students (Beckers & Van der Voordt, 2013). Technology, spatial efficiency, shared workplaces, focus on knowledge sharing and collaboration, are making UASs aware of well-designed and equipped buildings (Den Heijer, 2011). Corporate real estate (CRE) strategies must be developed to create a link between what

is learned in- and outside school (Voogt & Pareja Roblin, 2010). Whilst NWoW make room-independent work simple, there is a need to facilitate educational activities in buildings (Herdlein & Zurner, 2015). New learning environments in higher education are obvious subjected to development similar to that of office buildings, providing formal and informal adjustable settings. Beckers (2016) endorses the interrelationship between organisational buildings and end users, complexly influenced by many variables, both physical and human in nature (Beckers, 2016). Educational real estate is also affected by an increasing pressure of student numbers, rising tuition costs, advanced technological applications and the availability of (free) online open courses (Bishop & Verleger, 2013). Developments in education require less traditional space, such as classrooms but require more spaces that facilitate self-study and collaboration. This is, in essence, a mismatch between demand and supply (Beckers, 2016). Student success and productivity can be synonymous with performance, effective and efficient work. Student satisfaction is the key indicator in the annual National Student Survey. Students are questioned about e.g. learning environment, facilities and buildings are questioned. A recent study concluded there is hardly any input from students to regard to (the management) of CRE (Driessen, 2016). Therefore, this paper addresses students' preferences regarding a typical NWoL context: open learning spaces (OLS).

3 METHODS

This mixed-method study consists of a qualitative part and a quantitative part. Data were collected at the School of Business, Building and Technology (BBT) of Saxion Universities of Applied Sciences (Saxion) in Enschede, Hogeschool Utrecht (HU), and Hogeschool Arnhem Nijmegen (HAN), The Netherlands. The methods are described in chronological order.

Three qualitative methods were used. First of all, in depth interviews were held with CRE Managers of Saxion, HU and HAN, to define definitions and to explore views and policies regarding OLSs. Respondents are real estate experts, familiar with developments, issues and challenges that educational CRE face. The expert from HU was selected because this UAS just rounded off an elaborate housing programme. The two experts of HAN are involved in the plans for future real estate developments at HAN.

The second approach was three focus groups. A focus group is a group of individuals brought together to discuss a particular topic or issue. A facilitator provides guides the meeting and promotes discussion (Bruseberg and McDonagh-Phips, 2000). Three focus groups of in total 12 first-year students discussed their experiences of OLS, frequently visited areas and the use of facilities in general on the UAS. A fourth focus group with lecturers reflected on characteristics of first-year students (education or coaching).

For the quantitative approach 250 first-year-students of the bachelor programmes built environment of Saxion and HU were invited to fill in an online questionnaire about aspects of and experiences with the use open learning spaces at their UAS. The response rate was 48%. The outcome of this student survey was discussed within the focus group consisting of lecturers. Furthermore, this focus group reflected on characteristics of first-year students (education or coaching).

The last approach involved mood-boards. Moodboard are a common method in design research (Moreira and Wood-Harper, 2015); a moodboard is a collection of images, selected and assembled by participants in response to a brief explanation by a facilitator. This technique is suitable to be generated to represent participant's feelings, emotions and experiences about tasks or situations. Eight students from focus groups were selected to develop moodboards illustrating main aspects regarding OLS, including their motivation on preferences.

4 RESULTS

4.1 Definition of OLS

The CRE managers and the focus groups defined OLS as semi-public areas. OLS are specifically delineated as building sections with work space for students, connected with (flexible) workspaces of educational staff. Because the connection between students and lecturers is important, it is part of an institute, identifying the domain, connected to public space and facilitating workplaces for students groups, individual students, and informal educational (activity-based) activities. An OLS needs to facilitate students' major activities regarding (group) work. This requires diversified furniture and space dividers. Obvious conditions are ambiance, facilities, climate and Wi-Fi. OLS play also a role in attracting new students. According to the experts, the OLS is part of the identity of an educational programme or institute. First-year students are the most frequent users, due to the bachelor programme, which is mostly face-to-face lecturing in the first year. Most students don't go to other building sections to do group work and stay within a short distance of the institute's OLS and working spaces of lecturers. Therefore, UAS need insight in students' preferences regarding OLS.

4.2 The case study

The layout of the observed OLS of Saxion's BBT can be best described as a centred core area with private rooms beside it, divided by a dead-end corridor. The distance from the main entrance to the OLS of BBT is an approximately 5 minutes' walk. The OLS has a minimalistic appearance, dark colours, untreated (unpainted) wooden elements, glass facades, glass doors to private rooms, white walls, gray walls, gray carpet used. Many contemporary designed lamps, many seats. Tables are pushed together to become effective workplaces.

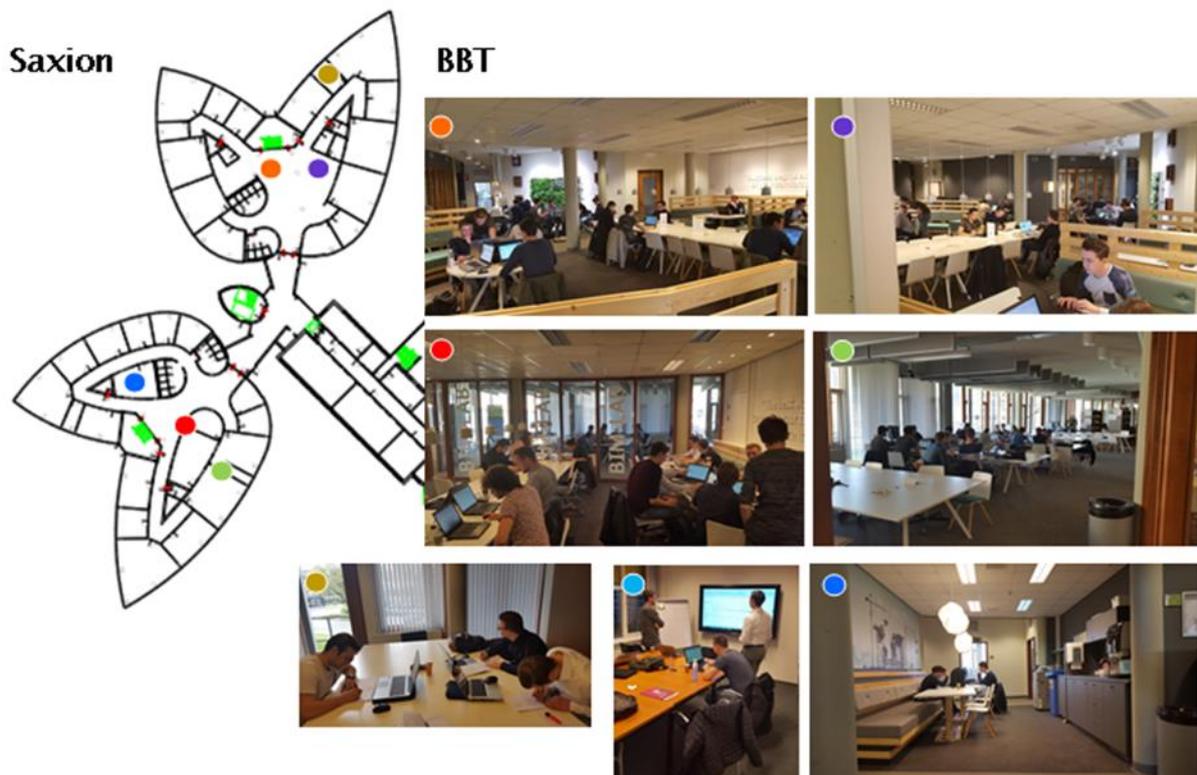


Figure 1: The OLS of the BBT programme at Saxion.

The objects that are present in the OLS have an (unconscious used) function as central points. An information desk is clearly a point of recognition as well as the coffee corner (open and enclosed and in use as a meeting place). The Xerox and a wall of plants, screens, whiteboards, beamers, comfortable seats and private benches complete the OLS.

The second case, at Hu, shows comparable features.

4.3 Characterisation of the users

The lecturers focus group supplied the dominant profile of first-year students. The majority of the students is male, between 17 and 22 years old, modest, slightly conservative, “do-ers”, down-to-earth, honest, and moderately ambitious. Most students stay at their parents' or caregivers' home. This positively influences connection with study and study success; they experience less problems and are more intrinsically motivated compared to students that live on their own. The student survey confirmed these results, but also provided more in-depth information. Most of the respondents were first-year bachelor students (81%), male (78%), with a mean age of 19 years. They choose their particular education due to general interest in the field. They reported an average commuting time of 45 minutes, by public transport. 79% of the respondents indicate that time spent in a UAS is with regard to scheduled lessons or activities such as meetings, group work, face-to-face contact with lecturers. Activities not related to education are hardly a reason for visiting the UAS.

4.3 Students' preferences regarding OLS

Survey and student focus groups show that the three preferred areas for group work are project rooms, (empty) classrooms, and OLS. The focus groups mentioned that physical space and personal contact with fellow students contribute to their focus on the (group) work. Hereby the relationship with (a) physical space and identity, “feeling of belonging” could also be important. Half of the respondents of the survey consider the OLS a 'home base', a recognizable area to work with fellow students (Table 1). The other half of the students pointed out that OLS are crowded, noisy areas, without a “home” feeling. The survey showed what students find most important in the OLS (Table 2 and 3): outlets, indoor climate, and daylight. Students prefer functional chairs and tables, rectangular shaped rather than round, that can be arranged according to needs (separate and adjustable units); areas that may be separated from the main area, by means of room dividers, for tasks that require concentration. Student focus groups reported that, in general, interior decoration is not considered very important; the appearance of an OLS (cleanliness and colour use), on the other hand, is considered important, to create recognition, identity, and a pleasant working atmosphere.

It should be noted that among the prioritized items, facilities (including the buildings) are ranked sixth (Table 1). This could indicate that, although the importance of real estate is well proven, the importance for educational real estate by students is more a facilitating then conditional. OLS are the third most preferred educational space, regarding group work (Table 1). A clear preference for semi-private spaces emerged for group work. Factors of choice of place for group work are: comfort, functionality and functional furniture. Project rooms and empty classrooms were indicated as most preferred spaces to do group work. These spaces can make the impression to be easily adaptable to individual needs or privacy. The most important functionalities are outlets, functional furniture: chairs, adequate daylight and comfortable climate aspects such as temperature (Table 2). Regarding the qualitative research, in the mood

board (Figure 2), plants are illustrated, the shape of furniture and use of colours are indicated. Also the importance of enough outlets is visualised. Aforementioned aspects were also named in the focus groups: “functionality is more important than design”.

Table 1: Overview Preferences to do group work (student survey, N=120).

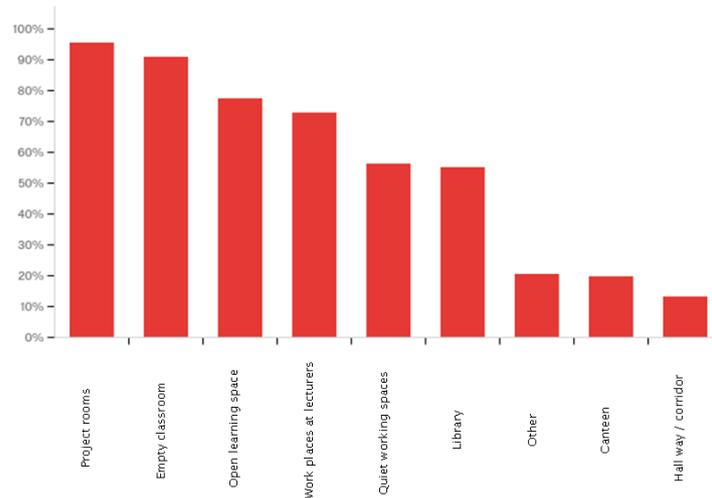
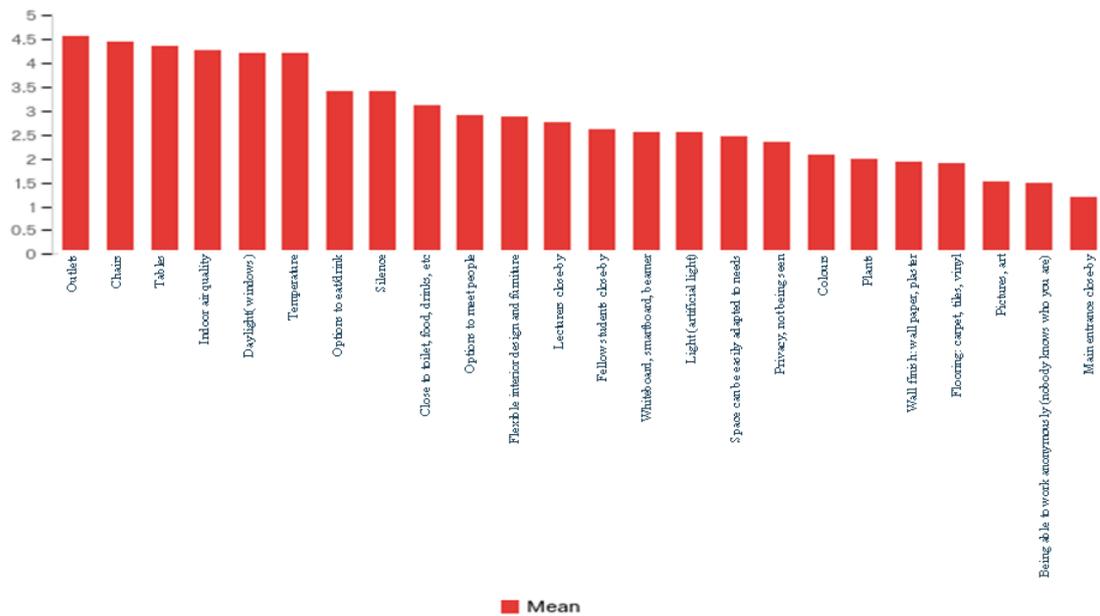


Table 2: Overview ranking important aspects OLS (student survey, N=120).

	Mean	s.d.
Outlets	4,51	0,72
Chairs	4,41	0,85
Tables	4,34	0,89
Indoor air quality	4,27	0,79
Daylight(windows)	4,18	0,8
Temperature	4,15	0,79
Options to eat/drink	3,54	1,12
Silence	3,5	1,12
Close to toilet, food, drinks, etc	3,17	1,18
Options to meet people	2,94	1,35
Flexible interior design and furniture	2,74	1,29
Lecturers close-by	2,68	1,29
Fellow students close-by	2,63	1,16
Whiteboard, smartboard, beamer	2,56	1,44
Light (artificial light)	2,51	1,12
Space can be easily adapted to needs	2,41	1,24
Privacy, not being seen	2,37	1,19
Colours	2,06	1,02
Plants	2,04	1,24
Wall finish: wall paper, plaster	1,95	1,1
Flooring: carpet, tiles, vinyl	1,87	1
Pictures, art	1,61	0,98
Being able to work anonymously (nobody knows who you are)	1,46	1,03
Main entrance close-by	1,21	0,83
Total		

Table 3: Overview Functionalities OLS (student survey, N=120)



According to the CRE experts a specific evaluation of user satisfaction of the OLS is not part of the overall monitoring and evaluation cycle of the real estate departments, even though OLS play a significant role in the layout and use of a building section in all cases. This indicates a lack of knowledge on the part of the schools, as well as the usefulness of the research presented in this paper. Unlike decoration and finishing, the climate (light, air, temperature) factors are very important, although students are aware of design issues for semi-public spaces and that a personalized climate is unattainable. Also proximity of lecturers and fellow students and functional fit-out influence the overall student satisfaction. Literature discusses a sufficient design, layout and conditions, with various contexts. Despite this abundant input, a focused study of students in the built environment pointed out that various elements are influencing student satisfaction. To conduct group work, OLS are fairly popular among first-year students of the built environment. In general, activities taken place in an OLS have a (semi) educational background. The CRE managers stated that purpose, general appearance, and design of an OLS gets much attention. However, the “invisible” aspects such as climate, comfort, and functionality are demonstrably more appreciated by end-users. In fact, these aspects have a greater impact on student satisfaction than design, appearance and ambiance. Consistent with findings of the survey are outcomes from the focus groups regarding necessities, furniture, atmosphere, and facilities. In contrast with the divided opinion on OLS as a home, the focus groups indicated that the OLS is a central point in their customer journey in the UAS premises.



Figure 2: Moodboard showing preferences for students regarding OLS.

5 CONCLUSIONS AND DISCUSSION

An OLS facilitates collaboration and is known to be used by universities all over the world. In case of Saxion, the OLS of BBT and its end users were examined. A vast majority of students live at their parents or caregivers house. This could have an effect on the use of educational buildings and OLS, for instance, individual learning can take place at home and the specific need to go to school for group work is much higher. However, literature concerning on OLS and performance has proven the relation.

5.1 Conclusions

First-year students benefit more from working in the OLS than using it as a meeting space. Spatial needs to learn are more focused on meeting and collaborate on group assignments (Beckers & Van der Voordt, 2013). To fully use an OLS, it is important that it can be adjusted easily. It is proven that, overall, students are hardly involved in CREM projects (Driessen, 2016). Within facilities, functionality, atmosphere and student influence on privacy are considered important. Aforementioned is contradicting the assumptions of CRE managers initially established. It is even more remarkable, because earlier studies indicated that students gave little priority to space issues related to satisfaction (Temple, 2007). This is also the case in this study, due to the rank of real estate and facilities, part of the National Student Satisfaction items. On the contrary, when focussing in on an often-used space, students tend to be more critical and want to have their say in the design. Similar issues for OLS are ambiance factors and the desire for personal control. Van der Voordt (2003) stated that privacy is important for productivity. This statement is also underpinned by the findings in this study. Personal control over climate, comfort, and atmosphere is an effective way to stimulate productivity. Commonly used design solutions may seem efficient, but may have a negative impact on effectiveness. An example is the use of round shapes, that was not appreciated by students involved in this research. In order to eliminate these unwanted effects, UAS should

stimulate the practical participation of the population of students in the development of the design brief, as this could be effective by deepening the understanding of user group-specific needs and wants. Although the design principles regarding personal control or influence in a semi-public space are complex, it is recommended to pay attention to a personal (sense of) control. Technological advantages could help in customizing (private) areas or sections of OLS. Distractions from uncontrollable conditions will reduce satisfaction and therefore performance. OLS are frequently used for semi-educational activities, therefore these activities should be top-priority in the design process, rather than contemporary design, shapes, and furniture, that are now evaluated as inappropriate.

5.2 Recommendations

The occupation of the OLS should be monitored, on use and preferences, to indicate the factors that are important and matters to students. Also, the number of workspaces should be appropriate and fit the population of the domain. A post-occupancy evaluation is important, data could be generalized and be used as input for new initiatives. However, a low frequency of evaluation moments can cause a diffuse status, certainly in this era, where social and technological development expands at a fast pace. By applying occupancy-measuring sensor techniques, management information applications, facility layers and atmospheric control applications, an OLS could become “responsive” and gain insight to fit the demand at high occupation. A focused assessment and monitoring on the use of OLS and evaluation of atmosphere, climate, comfort, and functionality could increase the student satisfaction. By measuring student population and determining most dominant characteristics, OLS could become customized. To align supply and demand of needs, preferences and expectations of end-users, a closer examination of this relation is recommended. Based on the OLS observations in this study, some initial starting points of the design changed when student characteristics and proposed specific (semi) educational activities were better examined, hence in the beginning of the design process. To summarize aforementioned recommendations, six strategic starting point (figure 4) can be incorporated in CRE strategies.

Table 4 Overview Strategic Starting Points

STRATEGIC STARTING POINTS	
1.	Design for adaptations
2.	Increase input for student populations, match dominant students characteristics and design a persona during the design brief.
3.	Customize spaces and explore personalizing atmosphere of OLSs
4.	Make evaluation, monitoring and experience-based observations part of building evaluation protocols
5.	Use a mechanism which enhance the UAS’s real estate added value to the learning process
6.	Data collection of pre-occupation should be more intensively from a user’s perspective

6 LIMITATIONS AND FURTHER RESEARCH

This paper shows that students of UAS programmes that concern the built environment consider educational real estate more as a facility or service than an asset. This contradicts with

obvious assumptions and policies, generally European views, where appearance and design of buildings are important. So, even though the research was conducted among students from a limited number of programmes, this paper does show that CRE- and facility managers of institutions for higher education should listen to their users, a.k.a. the students, in order to develop and maintain university buildings. The cases studied for this research. This is a valuable lesson for CRE and facility managers of any organisation, but especially for educational institutions. Further research into students' preferences at international UASs or universities in general is recommended.

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Utopia for whom? Project and operational perspectives of energy efficient buildings

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ABSTRACT

Purpose: The purpose of this paper is to explore project practice visions for energy efficient buildings within the definitive phased project approach, which is in contrast to the holistic perspective of sustainability as it disconnects from the operation of the building. In addition, there is examination of the discipline of facilities management as a potential integrative role for knowledge transfer in the project process in order to link energy efficiency goals to functionality and usability.

Methodology: Case study approach of the energy reduction in a renovation of a care home in Norway. Discourse analysis on eight individual interviews and two focus group interviews with building owners, facilities managers, consultant engineers, an architect, residents and one staff member.

Findings: The definitive project phased approach enables disciplines to enact their own disciplinary driven utopian vision of energy efficiency projects, but they cannot see the impact of this perspective due to the phase and task orientation approach of the project process. Visions enacted in the project process to meet goals of energy efficiency can be in conflict to usability goals and the time limitations of the project reduces preparation for operation of the building. As a result, project participants return to fix unforeseen problems during the operational phase – leading to dystopia. Findings indicates that there needs to be presences of facilities management representation throughout the project process rather than just at the beginning. This will aid in reducing unforeseen problems and enable harmonious goals for attainable energy efficient targets and usable buildings in operation.

Impact: The findings have implications on facility management practices in terms of needing to increase their integration in the project process. The work contributes to research in terms of highlighting what the limitations are of the time-oriented phased approach in project processes and the impact it has on operations. The study also has implications on study programs in facilities management in developing representation as part of the project process rather than in just the early stages (project definition) and the end stage of a project (handover).

Paper Type: Research Paper

Keywords: Energy efficiency renovation; facilities management; project process; knowledge transfer

1 INTRODUCTION

Energy efficiency projects claim to reach energy performance targets but such claims can to be once a building is operational. Defects not found in the construction phase often prevail in operation. These defects results in an energy performance gap between design and actual energy performance of the building (Forcada et al., 2015, Fedoruk et al., 2015) and become the responsibility of facilities managers to close. The commissioning phase is one mechanism used to reduce the gap being a systematic process of ensuring that all building facility systems

perform interactively in accordance with the design documentation and intent (Djuric and Novakovic, 2009). However, the timeline often reduces for the commissioning phase because of project delays and facilities managers inherit unresolved problems of technical systems during the initial phase of operation. In order to resolve these problems, contractors must return. However, facilities managers often have difficulty to get subcontractors to return after the handover of a building to rectify problems. In addition, the handover documents received by facilities managers to maintain and operate the building after construction completion are often incomplete or missing information (Whyte et al., 2013, Forcada et al., 2015). Also, commissioning can only address certain aspects before the operation of the building as some functional defects are not seen until the building is in use (Fedoruk et al., 2015, Whyte et al., 2013). Defects after handover are not just technical in nature and the usability/functionality elements need careful consideration. The work takes a close look on how the project participants understand the goals of energy efficiency and the impact of their visions in the long-term operational phase.

2 LACK OF UNDERSTANDING BETWEEN PROJECT PRACTICES AND FACILITIES MANAGERS

“Usability depends on how a product can be used by specified users to achieve specified goals” (Blakstad et al., 2008).

Involving facilities managers in order to increase the likelihood that a building will meet the specified goals of the users is no easy feat. There is a disconnection between practices of the construction project and facilities management practices. Social interaction is required for knowledge transfer (Javernick-Will and Levitt, 2010) and for these practices to exchange experiences and requirements. It is easier to find patterns of connections if knowledge transfer is within one company rather than across several independent companies (Argote et al. 2003). Facilities managers may have opportunities to provide input at the tendering stage of a project and their requirements are documented within Data Handover procedures but do not tend to be part of the project process. This is challenging when they are provided with documentation at the end of a project and a building in which they have limited input in development. In addition, different practices do not easily transfer knowledge even if they are in the same organization (Brown and Duguid, 2001, Lindkvist and Whyte, 2013) as actors understand knowledge within their own context (Enberg et al., 2010). Architects and construction contractors work on different timelines and view the building differently to facilities managers, but they are primarily responsible for delivering a building and its associated handover documentation. There is a lack of continuity between disciplines of the built environment as contractors and disciplines come and go depending on the project phase. Indeed, the task orientation of project teams means the bigger picture, which facilities manager can see from the operational perspective, is often lost. Project teams are given specific tasks to work on but do not always see how results are integrated to the wider project or fully understand the technical context in which they are to be integrated (Enberg et al., 2010). The clear distinct phases of design, construction, operations and occupancy results in disconnections between practices with very little overlap. Indeed the definitive phase in construction projects is in contrast to the underlying ideas behind sustainability and the need for long-term holistic perspectives.

3 METHODOLOGY

The case is a care home based in Norway built in the the mid-1970s. In 2014, the care home underwent renovation, which aimed for an energy reduction demand of 68%. The data

collection for this study occurred from February to April 2015, four to six months after completing the renovation. During this time, replacements and adjustments on the energy efficiency solutions installed during renovation were ongoing. The study contains eight individual interviews and two focus group interviews with project and operational/user practices of the renovation and care home.

Table 1 Interview Participants

Role	Number
Focus group	
Facilities managers	3
Residents	2
Individual interviews	
Facility manager	1
Building owner representatives	2
Contractors	3
Architect	1
Staff of care home	1

Interviews were conducted in the place of business of each of the stakeholders except for two where interviews were at research institutes. There were 14 hours of recording with interviews lasting between one and two hours each resulting in 135 pages of transcript, which were analysed. Discourse analysis approach is taken in order to not just focus on what interviewees' state but to also understand the context in which statements are made.

4 FINDINGS

The following outlines findings from the different perspectives of developing the building into an energy efficient care home. The first part of the findings focus on the project perspective and the second part is on the operational perspective. The last part examines the scope of building connections between the project and operations.

4.1 Project practices perspective

4.1.1. Architectural discourse

Facilities managers tend not to be involved or have a minimal role during the project process, but decisions during the project process shape the final output of the building and they are responsible for maintaining this output. Being present in the project influences the type of energy efficiency outcomes of a project. The discourse of the architect of this care home includes statements of *“tidy expression”* *“artistic decorations”* *“creative process of the architect and the artist”* indicating the type of utopian goals that an architect sees in designing this energy efficient building. The design of integrating energy efficiency was driven within this discourse and being present at decision points meant such a discourse could be integrated into the building. One example of this is the decision on sunscreens where the optimum energy efficient sunscreens would reduce the architectural quality of the building. It was here that the architect could open discussion with the building owner about how to integrate sunscreens into the building but without compromising on architectural concerns.

“It was important with sunscreens in the [energy efficiency] context. But, the architectural perspective was most important to us, so there we felt that the [energy efficiency] project had to give way to architectural concerns.” (Architect)

Such discussions of developing a facilities manager perspective at decision points in the project process do not emerge, as they are not part of the project process. Instead, such discussions occur after handover of the building, when it is too late to make changes.

4.1.2 Contractors discourse

Consultant engineers contracted to implement the energy efficient solutions were excited to work on an ambitious energy efficient project. They believed it to be both a project about ‘change’ and ‘thinking differently’ in how they developed energy solutions for buildings and one that would be “innovative” on heating and ventilation. While there was clear enthusiasm to work with energy solutions, there was also a lack of overview of the wider impact of these solutions. Indeed, there was a lack of time to learn what the wider impact would be or what these decisions would mean.

“The time pressure, as we were already in a detailing phase, meant that we agreed to a short pre-project phase and detailing phase based on the information we had then, without fully understanding the scope of the (energy efficiency project) parts” (Consulting engineer)

The time pressure means that each phase in the project has a certain amount of time to be active before they move onto the next phase. The time pressure reduces the ability to see beyond the next phase and so project contractors focus on contract commitments. However, developing energy efficient solutions that leads to a change from standard solutions and are innovative often involves experimentation. The contract limits the experimentation as it sets out a target that the contractors have as a goal to reach but without description on how to reach that goal. While the contractors had a utopian vision of the project as being innovative, the contract guided them in what they were required to deliver within their project phase.

“We are required to comply with the contract commitments, and achieving airtightness is important for reduced energy use...” (General contractor)

While the contractors start with a utopian vision that they can create change and experimentation as the project progresses these visions becomes limited due to time constraints so the focus becomes what is required on contracts. The idea of developing something new does require testing but as there were delays in the schedule, innovation depended on what could be achieved within the different phases and those involved in the project. The inability to test equipment in a timely way within the project phase means problems that could have been found through testing become the problems for facilities managers in the operational phase. Within this context of continuous time pressures and the inability to see beyond the task means the integration between tasks to meet project goals of an energy efficient care home becomes disconnected. The contractors in this study focused on the energy reduction of the building but do not refer to the functionality of the building as a care home. As facilities managers are responsible for supporting core business and core business here was a care home, they could potentially link the energy efficiency goals for the building facilities to supporting the core business of the care home. In this way, being the bridge between keeping contractors on task but providing the bigger picture of functionality and usability.

4.2 Operational perspective

The utopian vision of the outcome of the renovation process was multiple. A number of needs initiated the project, which included maintenance needs, needs of the municipality to meet

environmental goals and the needs of the customer – residents and care home staff. However, these needs come from different directions and require a multi-directional approach. The requirement of reducing energy met the environmental goals of the municipality and upgrading the maintenance of the building would make the building more functional as a care home. However, goals of energy efficiency and needs of the care home were often considered in conflict with each other by project participants and end users. Indeed, the notion emerged that energy was in contrast to usability rather than complementary.

“In a care home we need the solutions to be robust. It needs to be simple for the users and energy consumption can pull in the other way, you see” (Building owner representative)

The focus on energy use and the disconnection to the “customer’s point of view” became apparent when the building went into operation. There was a discourse that the building was very technical for a care home. The below facility manager emphasizes the use of sensors and that the use of such sensors on many parts of the building is unusual for a care home.

“Sensors for everything ... it is quite complex because you have it in every room... I am not sure if this is unusual in a hospital, but in a care home building, this is not usual.” (Facility manager2)

This view reflects the discourse not just the discourse of facilities managers but also care home staff in terms that the technical aspects were associated with the energy reduction solutions and the technical solutions overshadowed care home needs. Frustrations with technological solutions heightened as the building went into full operation and many of the technical aspects did not work as planned. There was a lack of time for testing and commissioning before the building went into full operation. The time for testing and commissioning reduced to two weeks due to delays during the renovation. However, the deadline date of the project did not change because the building was required for patients allocated a move-in date that was not changeable. Tests that were done within this 2 week period were successful, the types of tested were limited to room by room and did not account for full operation of the building. When the building went into full operation with all patients and staff in the building *“the system collapsed”*.

The operational aspect of the building is not a priority within the project process as deadlines are tight. There were delays in handing over the control system to manage the technical solutions put in place in the home, which resulted in challenges for facilities managers to have an overview of energy use in the home. While facilities managers of the building were quite positive toward the solutions in reducing energy, they felt that the lack of overview that they would have received from the control system would have aided in managing initial problems and highlighting when staff were using energy inefficiently in the building.

“I think the systems in the building are quite good and smart and reduced the energy ...but if you don’t control it before you start using the building, the staff who are going to work there can do many things that produce more energy....” (Facility manager 2)

Facilities managers act as a bridge between the usability and functionality of the building and the energy goals developed in the project process. However, this bridge only comes to be and utilized in the operation phase of the building. The lack of utilization of facilities managers in the project phase means they cannot bring in the critical understandings that could prevent defects in the operational phase.

4.3 Dystopia – project phase overlapping into the operational phase

As some systems were not working as planned, contractors had to return to fix problems. This is not the situation which is set up during the start of the project where there are clear phases

put in place in the project process. Project and operations are separate. Indeed, such situations are unwanted by parties involved in project and parties involved in operations. During the first initial months of the operation of the care home, contractors from the project phase were fixing problems while residents and staff were using the care home.

In this way, the energy efficiency goals of the project required it to be complementary to the care home needs. However, there was a lack of insight into how a care home works by participants involved in decisions on energy efficiency due to the task orientation to what they are required to deliver in the contract. The contract does not necessarily contain the wider overview of the operation of the care home by the various end users. In this study project participants did want to know the results of their decisions, but they are disconnected from end users and the time pressures of the project does not allow for learning to take place. However, in some ways, the alleviation of this type of dystopia where project participants become part of the operational phase is possible by the presence of facilities managers in the project process who have knowledge of usability and functionality.

There is an assumption that if everyone put together common goals early in the project, it is possible for common understandings amongst practices associated with the project to be reached.

“It would be better to make sure that everyone has the same goals and the same ambitions.”
(Building owner)

However, practices and disciplines of each stakeholder look at the building differently. In this case the project goals was to have an energy efficient building and a livable care home but practices have their own goals developed from their disciplinary understanding of the building which is embedded in the definitive project phases. Developing the same understanding of project goals amongst practices of projects, facilities managers and end users is challenging, as they will understand these goals based on their own disciplinary practice and interests in the project.

5 DISCUSSION AND CONCLUSION

The core business in the case study is the care of patients, but this core business is also influenced by wider municipality goals to reduce energy demand. In order to do high energy performance solutions, there was strong motivation for innovation but the project phase approach puts time restrictions on what can be achieved and in the end the requirements of the contract becomes the priority. This is not a unique context where the client or ‘strong owner’ is reduced to a contract giver (Morris and Hough, 1987). In addition, projects are not the core business of client organisations and therefore it is difficult for clients to learn from them (Winch and Leiringer, 2016). However, recent studies indicate capabilities of the strong owner in linking operations to the project (Winch and Leiringer, 2016, and Zerfjav et al., 2018). Indeed having facilities manager representation in the last 6 months of handover in the London Olympics increased certainty that information handed over for maintenance and operation was usable for future use (Whyte et al., 2016). The extension of facilities managers as part of the project process may aid in creating a long-term vision for project that includes an operational overview rather than the disciplinary visions enabled by the definitive project phases. This holistic and integrated approach to project is much more in line with the sustainable agenda. There were clear indications in the case study on how being present in the project process does increase the likelihood of consideration of visions and discourses at key decision points, as when the architect in this study ensured an architecture discourse was present in developing an energy efficient building. Primarily, facilities managers are in a different time and context to project

practices, which creates challenges for social interaction required for knowledge transfer. As projects are task orientated (Enberg et al., 2010), in order for project participants to develop insight in how energy efficiency solutions are played out in operations, there needs to be a long-term vision. Facilities manager and end user representation needs to be part of the project process in order to avoid division between energy efficiency goals and usability goals. Project practices have their own utopian vision of what is an energy efficient building based within their own disciplinary context. An integrated vision from across disciplines will support sustainability goals, as it is necessary to consider both short-term goals of the project and long-term goals based within the operational phase.

The study indicates that facilities managers are in a good position to take an integrative role and bridge project visions for energy efficiency and visions of a core business. Currently this role is utilised in an unplanned way when problems arise in the operational phase in the initial months after handover. There is a missed opportunity of utilising facility managers during the project process. Utopian visions for energy efficient buildings based on individual discourses of the disciplinary practice are one-dimensional and leads to diverse goals by different practices. Some of these goals may be harmonious in some respects but conflicting in others. For a true utopian vision of an energy efficient building, an integrated knowledge approach is required on an ongoing basis linking the disciplines of the project phases to the operational phase.

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Tools and methods to establish a feed-forward loop from operation to design of large ships and buildings

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ABSTRACT

Purpose: This study compares ways to transfer knowledge from the operation stage to the design stage in construction projects of large ships and buildings. Previous studies show that integration of operational knowledge in design of new buildings is important to ensure a high performance of the buildings, though studies show that it is difficult to establish such a feed-forward loop in practise. Comparatively little research has been carried out in knowledge transfer in construction projects of ships.

Methodology: The study was done in three steps. First, five practitioners experienced in ship construction projects, as either ship owners or ship designers, were interviewed to gain insights into the integration of knowledge from the operation stage. Secondly, a literature review was conducted for insight on knowledge transfer in building design. Finally, a workshop with five other practitioners representing both the building industry and the marine industry was held to validate the findings.

Findings: The analysis identified similarities and differences between the shipping and building industries with respect to knowledge transfer from operation to design. The findings are divided on two aspects: A) General conditions and B) Practical tools and methods. The study furthermore investigated two approaches to knowledge transfer; a technocratic approach and a behavioural approach. The study identified examples of both approaches. Some tools and methods were used by both the shipping and building industries, e.g., project reviews by operational staff and commissioning. Other tools and methods were only used in either building or ship projects and could potentially be adopted by the other type of project.

Impact: The study informs practitioners on ways to establish a feed forward loop from operation to design of either buildings or large ships. Furthermore, the study points at several important aspects of knowledge transfer from operation to design to be further investigated by researchers as well as practitioners.

Paper type: Research Paper

Keywords: Operational knowledge, building design, ship design, construction projects, knowledge transfer

1 INTRODUCTION

The European Commission (2017) has set ambitious goals to reduce energy consumption and greenhouse gas emissions among the member states. Improving new buildings, renovating

existing buildings and optimising building operation towards being more sustainable are among the essential measures to achieve such goals (Thuvander et al., 2012).

The operational stage of buildings is by far the most important, when it comes to use of energy and limited resources. In a literature review, Maslesa et al. (2017) concludes the operating energy for non-residential buildings accounts for 80-90% of the total environmental impacts. Decisions made in the design stage have a crucial role on the environmental performance of facilities in operation (Valle Kinloch and Junghans, 2014).

Researchers have identified the design stage as the stage that has the most influence on the future operation of the facility. When the facility is in the operation stage, it is difficult or impossible to change the design to improve the performance (Rasmussen et al., 2017). To consider the operational phase in early design phase, it is necessary to bring in experience and knowledge from facilities already in operation. A feed forward loop needs to be established to ensure that building projects are built by use of experiences from former projects (Jensen, 2009; 2012). However, studies (Jensen and Chatzilazarou, 2017; Rasmussen et al., 2014) show that even experienced building clients with internal operational division struggle with exploiting the knowledge they possess in the new building projects they develop.

Like buildings, ships are large complex physical structures designed and constructed for individual customers. Both types of projects are engaged with large complex physical structures, they are project based, and they go through similar life stages of conception, design, construction and operation. Besides, both type of facility have a long life span, where the operational phase is responsible for the main part of the whole life cycle cost as well as the whole life cycle environmental impact (Knotten et al., 2016).

The difficulties and complexity of knowledge transfer are confirmed by the rapidly growing theoretical field of knowledge transfer (Heisig, 2009). Two approaches to knowledge transfer have been widely discussed: 1) A technocratic approach focusing on knowledge codification and 2) a behavioural approach focusing on the people aspect (Alversson and Kärreman, 2001; Ahmed-Kristensen and Giovanna, 2015). Research within knowledge transfer from operation to design of building projects shows, that the practical tools and methods lacks input from the behavioural approach (Rasmussen et al., 2017).

This study investigates ways to establish a feed forward loop in the design process of buildings ships. The purpose is to bring new insights to research and inform practitioners about tools and methods used in practise to improve knowledge transfer from operation to design.

Two questions guide the investigation:

Q1: What are the similarities and differences between the design process of buildings and large ships to establish a feed forward loop from the facility operation to the facility design process?

Q2: Which tools and methods that support a technocratic or a behavioural approach regarding knowledge transfer can be adapted from ship building projects and applied to the design of buildings?

2 THEORETICAL BACKGROUND

Given the opportunity of improving building design though knowledge transfer, researchers have developed lists and categories of the various tools and methods available. For example, Rasmussen et al. (2018) created a list of 42 initiatives a building client can implement to enable transfer knowledge from building operation to building design. This list incorporated the methods for transferring knowledge identified by Jensen (2009; 2012), augmented it with

additional tools from a literature review and case study. These were then distributed to a three-partite structure of buildings clients, consisting of Top Management, Building Client Division and the Operation Division, see figure 1 (Rasmussen et al., 2018).

Figure 1: The three-partite building client (Rasmussen et. al., 2018)



Other studies have created different classification systems. For example, Rasmussen et al., (2017) provide a list of “things to do” to transfer knowledge from Facilities Management (FM) to building design differentiated between “tools” and “awareness”. Tools are hands-on recommendations such as projects reviews and Life Cycle Costing. Awareness are more diffuse recommendations such as “more attention to FM” and “good communication”. Rasmussen et al. (2017) stresses the need for further investigation into the “awareness” aspects of knowledge transfer.

Previous research on knowledge transfer from building operation to building design does not apply much theory from the scientific field of knowledge management, including knowledge transfer (Rasmussen et. al., 2017). This implies a risk that previous research has not fully explored the complexity of the topic in relation to design processes. Similar to the categories of “tools” and “awareness”, this study investigates two different approaches to the phenomena of knowledge transfer. On one side a technocratic approach focusing on knowledge codification and on another side a behavioural approach focusing on the people aspect.

Alvesson and Kärremann (2001) distinguish researchers of knowledge transfer (KT) between those who are interested in the ‘technological side’, and those interested in the ‘people side’. They find the latter more widely emphasised in knowledge transfer theory. The opposite is the case, when researchers within FM or construction management investigate KT (Rasmussen et al., 2017). Ringberg and Reihlen (2008) presents a similar distinction, in the field of KT: “*Two major research approaches are dominant in the field, namely positivism and social constructivism*” (p. 913). They advocate for adding a third approach, the socio-cognitive approach, where not only social context and interaction, but also private and cultural mindscapes influence the transfer of knowledge. In contrast, the positivistic approach sees knowledge as ‘an objectified asset’ (p. 929), which can be directly transferred, for instance, using words.

Recently, some studies have applied knowledge transfer theory to research of construction management. Vianello and Ahmed (2012) investigate knowledge from service to design in the oil industry. Wong, et al. (2008) investigate knowledge transfer from maintenance to airplane engine design. Both studies are heavily based on theory from knowledge management and knowledge transfer. Vianello and Ahmed (2012) make a distinction between a technocratic

approach and a behavioural approach in KT, “*The behavioural approach focuses on the behaviour of individuals and on the social relations and cultural factors (...). The technocratic approach focuses on the information systems which are designed to manage knowledge, for instance IT infrastructures, applications, databases and technical procedure*”. Furthermore, the technocratic approach is dominant within the engineering field (Vianello and Ahmed, 2012).

3 METHODOLOGY

A cross-sectional study (Saunders et al., 1997) was employed using expert interviews (ships), literature review (buildings) and a workshop (ships and buildings).

Five interviews were conducted with representatives from the ship design industry between November, 2017 and February, 2018. The same interviewer conducted all interviews, and the interviews were held in the native language (Danish) of both interviewee and interviewer. Citations in this paper were translated by the interviewer.

The interviewees were chosen for their experience in integrating operational knowledge in design, and were been chosen with the purpose of getting the widest possible picture as a maximum variation sampling (Bryman and Bell, 2003). Collectively, the set of interviewees had experience with ferries and other large ships as both clients and designers. Table 1 shows how the experts were divided on branch and working areas. Snowball sampling (Bryman and Bell, 2003) was used. All interviews were held at the interviewees’ respective workplaces.

The interviews were in-depth, semi-structured (Bryman and Bell, 2003), and based on a protocol. The interviews had an explorative nature (Saunders et al 1997) and the interview protocol included a list of open questions that the interviewer used as a checklist during the conversation. The interviews were between 34 and 76 minutes in duration (Table 1). All interviews were audio recorded and transcribed. Atlas.ti software was used for coding. Two of the five interviews were conducted, transcribed and coded, before moving on to the following three, allowing for the evaluation of the process and adjustment of the interview guide and the transcription style.

Table 1: Distribution of interviewees and duration of interviews

Role	No.	Interviewee	Interview time
Ship designers	1.	Naval architect, self-employed consultant.	58 min.
	2.	Naval architect, owner of ship design company.	76 min.
Ship owners (building clients)	3.	Former head of new ship division at shipping company. Now head of research centre.	66 min.
	4.	Head of new ship division at shipping company.	57 min.
	5.	Head of new ship division at shipping company.	34 min.

For the matter of building projects, a literature review of previous research on ways to transfer knowledge from operation or FM to design was conducted. Findings of the review along with the researchers’ own experiences as practitioners served as basis for comparison.

Preliminary findings were presented and discussed at a workshop held in March, 2018. The validation workshop included five other practitioners: three from the building industry and two from the shipping industry.

A thematic analysis was done (Saunders, 1997) where themes arose from data.

4 FINDINGS

Findings of similarities and differences are divided in to A) General conditions and B) Practical tools and methods. Practical tools and methods includes both examples of a technocratic approach and a behavioural approach to knowledge transfer. The list of tools and methods used only by ships (B2) includes examples, which potentially can be adapted by the building industry. However, the list of general conditions shows that a large number of conditions are similar (A1), but an even larger number are different (A2). For both lists, only a few items are elaborated further in this paper due to word limitations.

4.1 General conditions

General conditions are the conditions related to the context and the specificity of the two industries, for instance in terms of products, competences, markets, technology, regulation etc. Table 2 presents the findings from the interviews for general conditions; distributed on A1) Similarities, and A2) Differences.

Ships are often built in series of e.g. ten identical ships built in a row. Buildings are occasionally built in series, examples are housing complexes with identical units built in a row.

Table 2. General conditions

<p>A1: General conditions, similarities:</p> <ul style="list-style-type: none">• The three partite client.• Shared goal and team spirit (between building client and operation) is important.• Challenged by different focal point when design team and operational staff work together.• Limited learning from operation to design within series.• Limited use of IT based tools to store and transfer operational knowledge to design.• The cost of operation stage is by far larger than construction cost.
<p>A2: General conditions, differences:</p> <ul style="list-style-type: none">• Overlapping competences in ship design• Naval architects are engineers with a background from technical universities or similar• Building architects are “artists” with an aesthetic focus from academies of fine arts or similar.• Public building clients for large ships are rare• Ships are mobile and built at locations independent on where they are going to be used• New ships are decided with strong business case focus• Ships are in general more alike (more possibility to learn across series)• Different professions do the first design sketches in a new project.

Three-partite client

The three-partite client identified in relation to buildings is also recognized in the ship owner companies. The three parties in ship owner companies, like building owner companies, hold different competences. The new building division primarily employs naval architects and engineers, whereas operation division primarily employs staff with a non-academic background such as navigators and machine engineers. Having in most cases both builders and

operators internally, offers a great opportunity to bring knowledge and experience together, described by one interviewee:

“I actually think we are quite privileged here. Where we sit, our operating division is 20 meters away. And we have a morning meeting every day at 9, where we all get up and in just 5 minutes; ‘What happened over the night since yesterday?’ And if there have been any operating problems on a ship, I always have “big ears.” And then I will go ask further (...) and especially, if it is concerning some of the ships I've helped build, that's even more interesting.” -Head of new ship division, ship owner.

Shared goal and team spirit

While being co-located has its advantages, the interviewees furthermore emphasize the importance of having a shared goal and team spirit. The interviewees are aware that operational staff and design staff have different foci:

“There are a lot of discussions here when you bring in operational staff... they typically have this perspective that it (the ship) must be reliable... most of them are not much concerned about the overall budgets and the return of investment and profit margins of the company. A captain, who does not arrive at the harbour on time, or a machine engineer, who (...) cannot start an engine, it is so heavily present in an operational division ... therefore the focus of their side is very much on reliability, maintenance and safety aspects.” -Former head of new ship division, ship owner.

Private versus public clients

With only a few exceptions, large ships are owned by private companies. The opposite is the case for buildings, where many large projects have public clients (e.g., hospitals and university facilities). In contrast to public clients, private clients are not obligated to make national or international tenders. They are free to choose whoever they find most fit for the task, regardless if it is competitive. This can help the private ship owners establish long-term relations with design companies or shipyards. Trust and good experience are mentioned as factors influencing the choice of the design company.

1.2 Tools and methods

The term ‘tools and methods’ covers specific procedures that are used to support communication, collaboration and decision-making in the design process in the two industries. Table 3 presents B) Tools and methods; distributed on B1) Similarities, B2) Only or mostly used in design of ships, and B3) Only or mostly used in design of buildings

Table 3: Tools and methods

B1: Tools and methods, similarities:

- Reviews of the design on different stages by operational staff.
- Workshops with different stakeholders, including operational staff, on different stages
- Key numbers (measurements) for parts and interior.
- Commissioning
- Case studies or study trips for stakeholders for inspiration on different aspects of the design.
- Total Cost of Ownership/Life Cycle Cost is important, but with short pay-back time

<p>B2: Tools and methods, ships only (mostly)</p> <ul style="list-style-type: none"> • On-boarding operational staff to the design team. • On-boarding design staff to operation (the design managers board a ship for a week or two) • Captains report. • Survey among operators of "problematic suppliers" • Extensive model testing during design • Classification (Certification schemes)
<p>B3: Tools and methods, buildings only (mostly)</p> <ul style="list-style-type: none"> • Environmental Life Cycle Assessment (LCA) • Iterative design process. • 5 year guarantee period

As shown in Table 3, some of the tools and methods are used in both ship and building design process, but some are used differently in the two types of projects.

Commissioning

Commissioning is an example of a method that building projects have adopted from ship building. However, commissioning of ships consists primarily of testing functionality and performance of the new built ship. The commissioning process starts around three months before the shipyard hands over the ship to the owner. In building projects, commissioning – at least ideally - starts already in the early stages by setting up exact and measurable demands. Thus, commissioning serves as an example of the need of transformation if a tool from one sector is transferred to the other.

On-boarding operational staff

On-boarding operational staff to the design team is definitely not a common method in design process of buildings according to the workshop participants from the building sector. In contrast, it is according to the interviewees a very often the case in design process of ships. They are full time employed in the project along with designers and engineers. One of the ship owners gives this description:

"On the project we are doing out in China now, we have hired a machine engineer and a captain from the fleet. They have agreed to approve drawings and discuss with the designers, etc., and in that way, getting their operational experience in to the project. It will typically be a full-time assignment here (...) it's a really good set-up, because they've participated, let's say in the basic design stage and now they're also present at the shipyard. (...) it's not getting any better. (...) they have spent approximately two years (...). Afterwards, they either have to return to the sea or move on to another project." -Head of new ship division, ship owner.

On-boarding design staff

On-boarding design staff to operation is the opposite situation. The design manager or part of the design team boards an existing ship of the ship owner typically for a week or two.

"Then there may be a small shipping company down in Italy where you go on board for 14 days or a week on the ship and talk to people on board and that's typically the project manager, the designer who will do the project or the one who is going to write the specification." -Ship designer.

A variant of the on-boarding method is a shorter visit, where design staff study a particular important design issue, described like this:

"You can take for example the mooring system, which is a very good example, right? The mooring system is important for several reasons (...). So we got into the field and studied, how it was done now. And we had someone taking pictures of it and filmed it, measured the time (...). And then you could show it to some people and do some workshops and like saying ... What's this? What's happening? How can we improve this process?" -Former head of new ships division, ship owner.

'On-boarding' are rare examples of tools, which draws mostly on the behavioural approach, and are as such interesting to the building sector to notice.

5 DISCUSSION AND CONCLUSION

The analysis identified similarities and differences of knowledge transfer from operation to design in ship projects compared to building projects. The three-partite building client was very similar in the two industries and the need to create shared goals and vision between the design team and the operation team is also recognised in both industries. Commissioning is an example of a tool from ship projects being transferred to building projects, but the need of translating the method or tool to fit the new context became clear.

The participants of the workshop representing the building industry suggested that the financial investment in the design process is possibly larger in ship projects than building projects. Their experiences are that the design process in general is kept at a very low cost. This would obviously be a barrier to adopting the two on-boarding methods. However, Lavikka et al. (2017) provide an example of on-boarding of FM-staff in a building project both during design and construction with a case study of a successful building project of a medical centre in California. They argue that an important reason for the success was that the head of the on-boarded FM staff had experiences from both building projects and building operation. All the interviewees from ships had a background involving both design and operation suggesting a stronger overlapping of competences in ship projects.

At the workshop, it was also suggested that ships are closer to the core business of the ship owners and clients than buildings are for most building owners and clients. This is particularly the case for corporate and public real estate. The similarity to ship owners and clients is probably greater for commercial real estate, where buildings are seen as investment objects.

Technical or behavioural approaches

The study aimed to investigate how the two approaches to knowledge transfer are reflected in tools and methods used in ship projects. In building projects, tools and methods to transfer knowledge from operation to design are strongly influenced by the technical approach, and it was examined if this was also the case for ships. The study does not give a clear answer to this question, although the list of tools and methods clearly includes both a technical and a behavioural approach.

On-boarding of operational staff to the design team is an example of a behavioural approach. Long-term on-boarding allows for establishing a shared goal and team spirit, mentioned as important by the interviewees. This can be challenging in technical-oriented tools like the captains report, where the sending and receiving parties do not necessarily meet face to face.

From the interviews it is unclear how the reports are stored, transferred and applied to new building projects.

Research methodology

Neither the list of general conditions nor the list of tools and methods are exhaustive. The interviewer found that it was difficult for the interviewees to describe what they actually did to transfer knowledge, illustrated by this citation:

“Before you came, I thought that I wouldn’t be able to say a lot about this subject. I also made a brief brainstorm with my colleagues, and we did not come up with much... but now having talked to you (author comment: for 47 min) it is clear to me, that we actually do a lot. And that we are actually good at it, too...” -Head of new ship division, ship owner.

The expert interviews were effective for outlining and exploring the issue, and provided some insight into the general conditions as well as tools and methods that are used for transferring knowledge in the shipping industry. However, it is difficult to obtain deep insights into knowledge transfer through this method alone. Even if knowledge transfer is something that people do as part of their daily work, their knowledge about it is mostly tacit.

Further research

Further research into knowledge transfer should also incorporate observational data on specific cases, as well as interviews with people while they are working on a specific project. This would supplement and validate the current findings, and would lead to greater robustness in understanding the process of knowledge transfer within the shipping and building industries. It would thereby present even more opportunities for applying general conditions and tools and methods from one industry to the other.

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The implementation impacts of IT systems on energy management in real estate organisations

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ABSTRACT

Purpose: Real estate organisations change over time, but they must always have a proper overview of their building portfolio and performance to ensure efficient facilities management. IT systems and access to valid data can provide the overview and bring other benefits to real estate organisations. The paper studies which impacts the implementation of IT systems Integrated Workplace Management System (IWMS) and Energy Management System (EMS) has on energy management in real estate organisations and for their customers/tenants.

Methodology: The theoretical framing includes aspects of change management and organisational theory. The research is based on a case study of IWMS and EMS implementation. The case is The Danish Building and Property Agency (BYGST) that manages a large property portfolio (over 4.000.000 m²) and currently implements IWMS and EMS as part of an organisational change process. The empirical data is collected through field observations and document studies. Document studies include project initiation documents, system design documents on energy management and observation notes. The study is a snapshot of the implementation and covers period March-December 2017.

Findings: The study indicates that the implementation of IWMS and EMS can provide more consistent data on the building portfolio and ensure better overview of actual building performance. The successful deployment of IWMS and EMS is though conditioned by several prerequisites such as availability of internal resources and their competences, and clear definitions of which business processes the new IT systems should support. The results indicate that energy management can be improved when valid core building data and consumption data is provided, combined, and properly presented to different stakeholders such as energy specialists, facilities managers and tenants. Furthermore, the systems can be used for reporting and benchmarking of energy consumption across the building portfolio.

Impact: The paper shows how real estate organisations, including FM departments, can use IT systems IWMS and EMS for energy management. The study shows that new, exhaustive insights on energy consumption and usage patterns increase focus on actual energy performance across the building portfolio and highlight possibilities for further energy optimisation and energy savings in practice.

Paper type: Research Paper

Keywords: energy management, IWMS, EMS, dynamic data, building performance

1 INTRODUCTION

Buildings in the EU are responsible for 40% of energy consumption and 36% of CO₂ emissions (European Commission, 2018). The average specific energy consumption in the non-residential sector is 280 kWh/m² which is at least 40% larger than in the residential sector. While hospitals, hotels and restaurants represent the highest energy intensive type in specific terms, offices, wholesale and retail trade buildings, on the other hand, represent more than 50% of energy use. Education and sports facilities account for 18% of the energy use while other buildings account for 6% (BPIE, 2011).

IT systems and valid consumption data can improve energy management and bring other benefits to real estate organisations. However, successful IT implementation is an extremely complex process which normally concerns the whole organisation. It is a process beginning as a concept and ending with the implementation, and must therefore be managed as an organisational change project. The implementing conditions become more favourable when the benefits of the IT system are demonstrated during the implementing process (Madritsch and May, 2009).

In facilities management, IT software systems can be divided in Data Containers (e.g. FTP servers, databases and BIM) and Workflow Systems (e.g. CMMS and CAFM) (Ebbesen and Bonke, 2014). This paper studies the workflow system Integrated Workplace Management System (IWMS) and the supporting Energy Management System (EMS).

The research and advisory company Gartner invented the term “Integrated Workplace Management System” in 2004 and defined IWMS as an enterprise suite that includes five components: capital project management, real estate/property portfolio management and lease administration, space and facilities management, maintenance management, and sustainability/facility optimisation and compliance (Schafer, 2014). In other words, IWMS supports organisations in managing and optimising real estate portfolio and business processes including lease administration, project management, space management, maintenance management and environmental sustainability. In the European context, IWMS comes very close to the understanding of Computer Aided Facility Management software (CAFM) (Madritsch and May, 2009).

The purpose of this paper is to demonstrate how real estate organisations (including FM departments) managing non-residential buildings can improve energy management through the implementation of IWMS and EMS. The goal is achieved by studying the research question: What are the implementation impacts of IWMS and EMS on energy management in real estate organisations? The research question is answered through findings from a case study of a public real estate organisation.

The paper begins with theoretical framework in section 2 and describes the research method in section 3. It then presents the case study in section 4. Findings and discussion are in section 5 and the conclusions are in section 6.

2 THEORETICAL FRAMEWORK

Technology is usually the element indented to stabilise a rather fragile change. Three dimensions are important when technology is used for change: coverage, functionality and dynamics (Kamp et al., 2005a). Coverage explains technological coverage of a company as the supplier imagines it. Functionality defines what the technology can and is usually described in modules or blocks. Dynamics highlights that technology is not static, but develops over time. Many dynamics are at stake after planned change. Internal and external development impacts

organisational change both intentionally and unintentionally. There are for example intended internal changes in the organisation, and unintended external changes like suppliers offering new system versions, modules or systems that by implementation change parts of the organisation.

There are, according to Mintzberg (1980), five basic organisational configurations (Simple Structure, Machine Bureaucracy, Professional Bureaucracy, Divisionalized Form, and Adhocracy) and five basic mechanisms of coordination (mutual adjustment, direct supervision, and standardisation of work processes, outputs and skills) in an organisation. Implementing an IT system like IWMS to real estate organisations could e.g. contribute to standardisation and change the organisational configuration.

The strategic improvements in business value are called benefits and are usually achieved through programme and project management. The creation of business value depends therefore strongly on programmes and projects delivering the expected benefits, as illustrated in Figure 1 (Serra and Kunc, 2015).

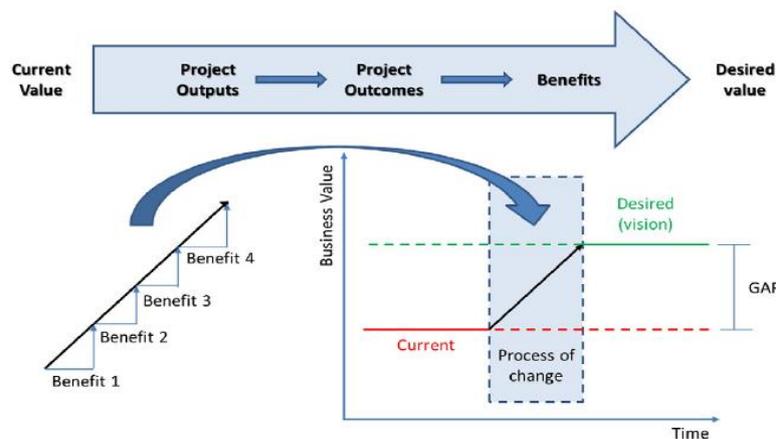


Figure 1: Moving from current to desired business value requires changes. (Serra and Kunc, 2015)

Business Process Reengineering (BPR) considers IT as a tool for supporting and enabling changes in business processes. Reengineering restructures business processes across entire organisation through radical thinking, while IT is only a lever for such process changes (Hviid and Sant, 1994). IT systems must inevitably support activities relating to cross-disciplinary business processes and solve issues with long lead times, high management, administration and overhead costs, and break down barriers between subject areas, functions and between organisation and its surroundings in general. The focus is on customer needs and value creating processes (Kamp et al., 2005b; Jensen, 2008).

IT implementations are cross-disciplinary and include different stakeholders (e.g. top management, consultants, system users). Determining the relationship between different stakeholders and new IT systems, as well as the impacts of implementing process on the organisation, is therefore important. The implementing process can include different impacts on: improvements and changes of the technology (*product innovation*), the work processes which the technology is meant to support (*process innovation*), and cause or require improvements and changes in the organisation (*organisational innovation*) (Ebbesen and Bonke, 2014).

Implementing IT systems changes the way organisations operate and perform. Change management includes two basic concepts for managing changes in the organisation:

quasistationary equilibrium and permanency (Ebbesen and Bonke, 2014). Quasistationary equilibrium reflects the level of behaviour between forces pushing for and resisting change. The relationship can be changed by either adding forces, or removing the resisting forces (Hayes, 2010). Removing the resisting forces, rather than adding forces, is more likely to result in a more permanent change. Permanency defines that successful change requires three steps: unfreezing, movement and refreezing. Unfreezing means destabilizing the balance of driving and restraining forces. Movement modifies the driving and restraining forces towards a new state. Refreezing reinforces the new state and avoids a relapse. When studying an implementation process, it is important to highlight in which step the study takes place.

IT implementation changes the technological component and thereby triggers changes in the other components of the organisation (Ebbesen and Bonke, 2014). The expansion of knowledge requires extensive input from the field. Communication and user involvement in the organisation in the early stage is crucial, especially because IT implementation typically runs over several years (Foley, 2012).

Identifying which changes will occur and ensuring realisation of desired vision can be complicated. Successes in IT projects depends on categories such as system quality, information quality, information use, user satisfaction, individual impact and organisational impact (Ebbesen and Bonke, 2014). IT systems that are not in line with company traditions and root processes have higher failure rate (Kamp et al., 2005c). Some IT systems are more complex than expected and bring unexpected and changed routines to the organisation. Studying different categories can reveal whether the implementation leads to failure or success.

3 METHODOLOGY

The research is based on a qualitative case study of IWMS and EMS implementation (Yin, 2014). The Danish Building and Property Agency (BYGST) currently implements IWMS and EMS as part of an organisational change process and is therefore selected as a case.

The implementing process involves three companies: Trimble, KMD, and Implement Consulting Group (ICG). Trimble is a global software developer and provides IWMS solutions. KMD is a large Danish IT company responsible for delivering Trimble's IWMS and own EMS solutions to BYGST. The first author is industrial PhD candidate affiliated to KMD and has as such achieved access to research data presented in the paper. ICG is an external consulting company hired by BYGST and is responsible for the implementing process.

Field observations and document studies are used for collecting the data. The study is based on observations from 6 implementation meetings, 4 workshops, and 7 observation days on-site. Implementation meetings cover internal KMD meetings, and meetings between KMD/Trimble business specialists and BYGST's energy specialists on energy management design solution. Workshops cover team sessions including representatives from all four organisations involved in the implementation. On-site observations are personal observations from BYGST's headquarter.

Furthermore, the study is supported by document studies of project initiation documents, system design documents on energy management, and notes from meetings, observations and workshops.

The system implementation is still ongoing, and the complete solution will go live December 2018. The EMS is partly implemented and has collected consumption data from office buildings since May 2017. The study presented in this paper is a snapshot of the

implementation and covers the period March-December 2017. The results are therefore preliminary, and a follow-up study is planned.

4 CASE STUDY AND RESULTS

4.1 About BYGST

BYGST is the Danish state's property enterprise and developer whose main task is to provide work spaces and office and research environments on market terms for its customers, including universities, central administration, police and the courts. BYGST was established in October 2011 as part of Danish governmental formation. Several governmental agencies (part of the Agency for Palaces and Properties, University and Building Agency, Business and Construction Agency) have been consolidated into BYGST, and the agency is still undergoing organisational changes. BYGST solves its task by owning and renting out buildings of the state through new construction and modernisation, and by redistribution of private leases to the state institutions. The agency has about 300 employees that manage 1.800 leases covering more than 4 million m² of building area. About 1,2 million m² are private leases and public-private-partnerships, 2 million m² are used by the universities, and approximately 800.000 m² are office buildings owned by BYGST (Bygningsstyrelsen, 2017a).

BYGST's current IT system landscape is diverse due to former reorganisations, different employee needs, working cultures and local IT-solutions emerged over many years prior to the consolidation. The IT system landscape is a product of long-term accumulation of silo-based systems that support individual needs of different departments at BYGST. The agency has characteristics of Divisionalized Form and faces challenges in maintaining and developing many diverse IT systems. Furthermore, several IT systems contain same type of data that is updated individually in each system, leading to missing coordination and poor data quality. BYGST therefore needs a more consolidated IT system landscape that can reduce the amount of IT systems and secure consistent, valid data across the entire organisation. For solving the problem, BYGST visited several real estate organisations using IWMS outside Denmark (The Dutch Building and Property Agency and 4 companies/municipalities in UK). Based on the experiences and recommendations from a market survey, BYGST decided to introduce IWMS (Bygningsstyrelsen, 2015). The internal need analysis and the market survey was initiated in 2012. The tendering and contract sign-off took place in 2016. The implementing process (design-build-test) was initiated in early 2017 and runs till the end of 2018.

BYGST has a vision of being the preferred property manager for customers and the state. The strategic goal is to build up a strong, data-driven knowledge organisation concerning work spaces and efficient building processes, construction and facilities management. A stronger, data-driven knowledge organisation is expected to create the basis for advising and decision-making that will result in cost effective solutions for the agency and their customers (Bygningsstyrelsen, 2012). By introducing IWMS and EMS to Business Process Reengineering, BYGST wants to combine data, knowledge and professional experience to change the organisational configuration and deliver improved customer service.

The external implementation consultants ICG and BYGST have developed benefit realisation diagrams for defining changes and goals of IWMS and EMS implementation. Several benefits from IT implementation must be realised to achieve strategic vision: higher customer satisfaction with BYGST's service, more time for new tasks, decrease in IT-costs, increased process coherence, more valid data, and better IT security.

4.2 Energy management – benefit realisation diagram

BYGST does not consider the IWMS/EMS implementation as a definite IT project, but as an organisational change process consisting of several module-specific implementation projects. Each module has its own benefit realisation diagram and implementation track.

Regarding energy management, BYGST has a special role in pointing out possibilities for reducing the energy consumption in buildings and instructing tenants on energy savings (Bygningsstyrelsen, 2012). By implementing new IT systems, BYGST also puts focus on energy management of the property portfolio. The benefit realisation diagram in Table 1 shows which changes and goals IWMS and EMS must realise to deliver energy management benefits for the agency.

Table 1: Benefit realisation diagram for energy management at BYGST. (ICG 2017)

Deliveries	Skills	Behaviour	Effect	Goal
<i>User (BYGST employees) training</i>	<i>Energy dept. can use EMS and IWMS</i>	<i>Consumption is calculated through distribution keys</i>	<i>Energy savings for customers through increased focus on consumption</i>	<i>Contribute in creating a solid foundation for BYGST's eligibility</i>
<i>IWMS (Energy module)</i>	<i>Energy dept. can create energy reports in IWMS for different organisational levels</i>	<i>Appointing responsible BYGST employees for monitoring and optimisation proposals of energy consumption</i>	<i>Time savings on data retrieval</i>	<i>Better customer service</i>
<i>EMS</i>	<i>Energy dept. can set necessary alarms for i.a. higher energy consumption</i>	<i>Monthly e-mails to customers regarding their individual energy consumption</i>	<i>Time savings for reporting on energy data</i>	<i>Savings on energy consumption</i>
<i>Web module for Tenants</i>	<i>Exchanging data between IWMS and EMS</i>	<i>Quality control of energy data once a week</i>	<i>Increased customer satisfaction with energy management</i>	<i>Valid energy data</i>
<i>Importing building data in EMS</i>		<i>E-mail notifications to BYGST's energy responsible in case of higher energy consumption</i>	<i>Increased customer enquiries regarding energy saving measures</i>	<i>Increased employee satisfaction</i>
<i>Two-way integration between IWMS and EMS</i>			<i>Less customer enquiries regarding data validity</i>	

The deliveries encompass the implementation of IWMS and EMS with connected webservice for tenants. The data must be imported in the systems, and two-way interface between IWMS and EMS must be developed. BYGST employees must also receive user-training in the systems.

Changes are reflected through developing new skills and behaviour in the organisation. The Energy department must be able to use and exchange data between IWMS and EMS, and to create reports for different organisational levels. The Energy department must also develop skills in configuring notifications for e.g. higher energy consumption. Customers will receive monthly notifications regarding their energy consumption. BYGST's energy responsible person will receive notification in case of higher energy consumption. Once a week, quality control of energy data is performed. The aim is to provide energy savings for tenants (external development) and time savings on data retrieval and reporting (internal development). The deployment of IWMS and EMS must increase tenant focus on energy management and energy savings, and reduce enquiries regarding data validity.

4.3 Design solution

Figure 2 shows the design solution for energy management at BYGST. The model is designed to support different stakeholder needs on consumption data in and outside of BYGST. The implementation includes a module-based IWMS “Manhattan Software” (called “KMD Atrium” in Denmark) covering Core, Lease, Customer Relationship Management, Project and Energy modules. Each module has its own implementation track in a project. Besides IWMS Energy module, the EMS “EnergyKey” and the connected webservice “Webtools” are also included in the energy management track. EnergyKey manages energy data collection, meter readings, data analysis, consumption visualisation and reporting. Webtools is an add-on module to EnergyKey and displays energy consumption to end-users, in this case BYGST’s tenants. Since IWMS is master on building data and EMS on consumption data, a two-way application programming interface is developed for data exchange.

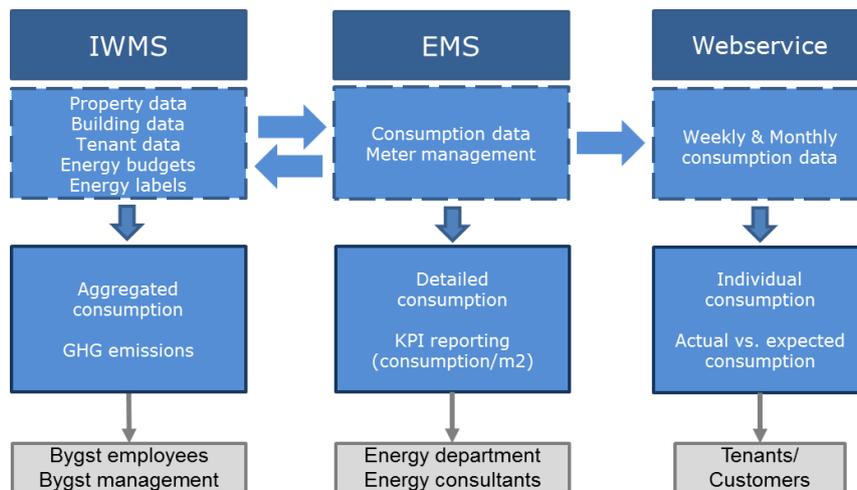


Figure 2: Energy management model at BYGST. (based on system design document)

Energy management reports electricity (kWh), heating (kWh) and water (m³) consumption on different building levels (property-building-lease unit) and for different tenants.

EMS is internally used by BYGST’s Energy department and operates as an engine for meter management and consumption readings. It provides deep insight on energy performance in each BYGST lease unit, building and property. The consumption readings in office buildings were earlier collected in different formats, by using data loggers, automatic meter readings and manual meter readings. This reading process caused data inconsistency due to different reading formats, frequency, and technical failures. The 95% of electricity, 65% of heating and 35% of water consumption in office buildings is now delivered directly from the utility companies to EMS through remote readings (Bygningsstyrelsen, 2017b). The remaining consumption is still collected through dataloggers, but will over time be delivered directly from utility companies. The Danish Meteorological Institute delivers degree-day data to EMS daily, and heating consumption is benchmarked right away, regardless of weather conditions.

IWMS is a master system on core data and delivers data on buildings, energy budgets and tenants to EMS. By combining core data from IWMS and own consumption readings, EMS calculates energy consumption for each tenant and provides performance indicators (consumption/m²) on different building levels. IWMS receives aggregated monthly consumption data from EMS through an interface and calculates greenhouse gas emissions. The monthly consumption and emissions are available to relevant BYGST employees for reporting purposes on the property portfolio.

The tenants have access to the webservice, where they can login and follow their own electricity, heating and water consumption. The tenants can monitor their monthly/weekly/hourly consumption and compare it with expected (last year) consumption.

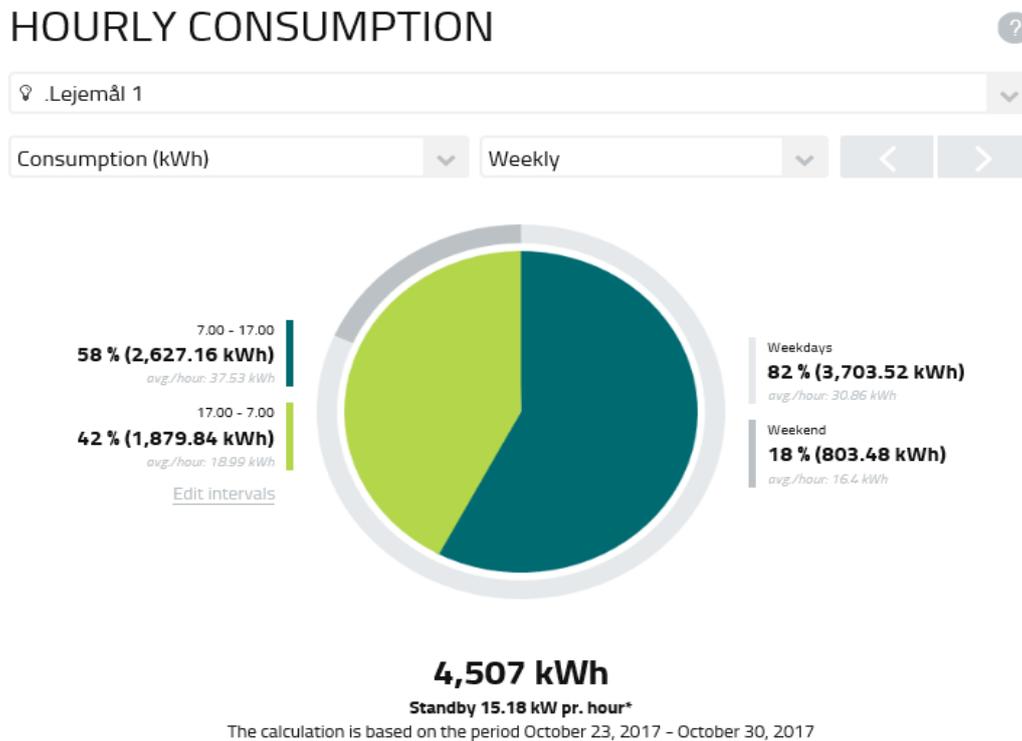


Figure 3: Webservice solution for BYGST's tenants. (Webtools)

Figure 3 shows the webservice solution for weekly electricity consumption for Lease 1 (Lejemål 1) in a multi-tenant office building. The webservice displays consumption for working hours (7.00-17.00), non-working hours (17.00-07.00), and weekends. The associated facilities managers have access to the data and can e.g. observe that 42% of electricity consumption is used outside of working hours, and that 18% of electricity is used in weekends. Since an office building has working hours 7.00-17.00, this information can be useful for identifying potential energy losses. The data is also useful for benchmarking energy consumption between tenants, and for monitoring stand-by consumption.

Another example of how IT systems impact a real estate organisation was observed few days after the deployment of EMS. A facilities manager observed that the electricity consumption in one lease unit was higher than expected during non-working hours. The observation led to identifying defects in some light sensors that were replaced afterwards, and electricity consumption was normalised.

5 FINDINGS AND DISCUSSION

Implementing IWMS plays a key role in the change management process at BYGST. The system is used for internal, mutual adjustment, and aims to create common data platform for BYGST's employees and to deliver better service to BYGST's customers. However, the implementing process is complex since it impacts all three innovation spheres (product, process and organisational innovation). The product (IWMS) is further developed during the implementation and configured to match BYGST's needs. BYGST's business processes are reviewed in parallel, meaning that they can be changed to match the system functions. During

the implementation, several key persons from BYGST (e.g. IT project manager, Head of IT department) have left the agency, illustrating unfreezing and movement steps in a change management process. Also planned user trainings demonstrate unfreezing and movement steps since the trainings will change users' IT skills.

Business Process Reengineering characterises the implementation since IT is used for supporting organisational change and focuses on value creating for customers. The implementation supports standardisation of work processes, outputs and skills, and is expected to improve interoperability, transparency and data reliability.

IWMS can support users in solving their tasks and improve business processes, but it can only happen if the system configuration matches the needs of organisation. The system itself is not an off-the-shelf solution, but highly dependent on user inputs during the implementation. On the other hand, real estate organisations must at the same time critically review their business processes, e.g. through BPR.

Due to the scale and complexity, the implementation is still ongoing. The implementation takes long time and underlies the importance of benefit realisation diagrams for tracking, whether the implementation follows the initial plan and delivers planned benefits.

Even though the systems are not fully implemented yet, the results indicate that several goals for energy management are already realised. For example, BYGST and tenants in office buildings have now access to valid energy data, and the agency provides better customer service through the webservice. Savings on energy consumption are also observed. However, the question remains, whether full systems implementation will deliver all, or only some benefits? To which degree will the complete solution fulfil the actual needs of different stakeholders? Will benefits to one stakeholder bring disadvantages to another? This will be investigated further in the follow-up study.

6 CONCLUSION

The implementation of the IT systems IWMS and EMS creates several impacts on energy management in real estate organisations. The study shows that new, exhaustive insights on energy consumption and usage patterns increase focus on actual energy performance across the building portfolio and highlight possibilities for further energy optimisation and energy savings.

IWMS and EMS can provide more standardised data on property management and ensure better overview of actual building performance. The successful deployment is though conditioned by several prerequisites such as availability of internal resources and their competences and clear definitions of which business processes IT systems must support. The IWMS implementation is a complex process involving many different stakeholders and takes long time to complete.

Energy management can be improved when valid core data and consumption data is provided, combined, and properly presented to different stakeholders such as property managers, energy specialists, facilities managers and end-users/tenants.

Further studies will develop an IWMS implementation guide and propose a method for improving environmental building performance thorough IT systems and dynamic data.

7 ACKNOWLEDGMENTS

We thank Bygningstyrelsen for allowing us to study the implementation of IT systems in their organisation. We are also very grateful to KMD for including the researcher in the implementation process and for supporting industrial PhD project on this research topic.

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Integrating life cycle sustainability analysis with BIM

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ABSTRACT

Purpose: Sustainability analysis tools such as Life Cycle Costing and Life Cycle Assessment address the economic and respectively, the environmental aspects of sustainability. Both methods assist stakeholders to make well-informed decisions during the early design phase of buildings and infrastructure. This paper considers how the real benefits for users and society emerge when life cycle tools are integrated with Building Information Modelling. In this way, it will become easier to compare different solutions in the design phase and select the one that contributes best to user's well-being and the sustainable aims of society.

Methodology: Mixed research methods were used: 1) a literature review focused on Building Information Modelling and life cycle sustainability analysis; 2) expert interviews with real estate, facility management and sustainability consultants; 3) an online questionnaire; 4) small case study.

Findings: The research highlights first the importance of collaboration and awareness in the development of an integrated Building Information Modelling-Life Cycle Costing-Life Cycle Assessment model. Then, the factors which support or challenge the integration were identified based on which a first integration model is proposed. Using such approach can contribute to sustainable development and subsequently to the wellbeing of people. It is important to consider the long-term implications of design because buildings and infrastructure use a significant amount of energy. However, research shows the environmental impact and lifecycle costs are often not seen as key factors in decision making about best value solutions, yet they have a huge influence over the entire life. The new developed approach can overcome these problems by empowering stakeholders to collect and exchange information critical to life cycle sustainability analysis therefore enabling economic/environmental trade-offs and validating the calculations.

Impact: Life cycle analysis with Building Information Modelling tools will assist decision-making in the early phase of a project by focusing the investment appraisals on life cycle costs and environmental impact. The new approach encourages collaboration between planners, design teams and facility managers and can be applied to support the design, construction and operation of more sustainable assets. The value of the integration model comes from improved and new functionalities such as increased accuracy, collaboration, more design options assessed. A win-win scenario can be achieved to maximize the potential financial benefits, while minimising the environmental impact of the design over the entire life cycle.

Paper type: Research Paper

Keywords: Sustainability, Life Cycle Costing (LCC), Life Cycle Assessment (LCA), Building Information Modelling (BIM), Facility Management (FM).

1 INTRODUCTION

One of the most remarkable benefit of new technological developments is their potential for sustainable development. In line with this, the study addresses the use of Building Information Modeling (BIM) for sustainability life cycle analysis, in particular Lifecycle Costing (LCC) and Lifecycle Assessment (LCA). The motivation for this study is the fact that the integration of BIM with LCC and LCA (The “BIM-LCC-LCA Approach”) in the architectural design stage will lead to sustainable building operation because it provides insight into project alternatives to detect the option which has minimum operational costs and ecological footprint.

A mixed-method approach is adopted in order to develop the BIM-LCC-LCA method. First, the aim of this study is to create a base for the integration. On one side, it aims to bring forward the challenges and the negative factors. On the other side, the article will identify key success factors which can be triggered on different levels to overcome the barriers of using BIM for LCC and LCA. Based on that, an integration model is proposed as a result of a practical validation conducted through a case study.

BIM-LCC-LCA will provide facility managers, owners or real estate investors a method to compare different building alternatives based on longer operational life period of the asset rather than just focusing on the short-term capital acquisition period. In this context, additional investment costs for sustainable buildings can be justified. There is a need to look for solutions to integrate BIM with LCC and LCA in order to meet long-term sustainability requirements.

2 LITERATURE FRAMEWORK

Buildings accounts for 36 percent of EU CO₂ emissions which is continuously growing (EC, 2018). After construction, over a life span of 60-80 years, buildings continue to produce CO₂. The negative consequences on the environment such as ozone pollution and global warming have a direct influence on humankind. Together with the scarcity of economic and social resources this can affect the life quality of next generations (Brundtland, 1987). To address this threat, all stakeholders involved need to reconsider the environmental, economic and social impact of built assets over their entire life cycle (Pitt et al. 2009) to create healthier places to leave and work.

2.1 BIM, LCC and LCA

BIM is defined as a collaborative working environment through the entire life cycle of an asset, “underpinned by the creation, collaboration and exchange of shared 3D models and intelligent, structured data attached to them” (CIC, 2017). In order to emphasize the importance of information, the term Asset Information Model (AIM) is often used (Sanchez, Hampson, & Vaux, 2016). Cost and environmental life cycle information represent the most important BIM parameters for sustainable construction and operation.

BIM related studies have moved towards integrating new dimensions into the workflows, such as economic and environmental data (n-dimensions of BIM). LCC and LCA are part of

sustainability assessments of buildings which include the environmental, social and economic dimensions (Druhmman et al., 2016). LCC by definition deals with “assessing the total cost performance of an asset over time, including the acquisition, operating, maintenance and disposal costs” (ISO 15686-5:2017), (IFMA, 2011), whilst LCA analyses focus on the environmental impacts from a product’s cradle to its grave (BRE, 2016), (ISO 14044:2006).

2.2 Challenges of integrating BIM with lifecycle tools

One main barrier is the management and flow of information in the BIM process. The building life cycle information needs to be developed and maintained from the initial design to the operational stage (Dawood & Vukovic, 2015). Well-defined and accessible BIM information makes life cycle analysis possible in any stage of the project. However, the economic analysis alone is not sufficient, the relationship with the environmental impact is recommended (Basbagill et al., 2013).

Several studies address the need to integrate existing software tools rather than creating new tools (Petrillo et al., 2016). They highlight interoperability as an issue because the analysis requires accessing and combining data from different sources. BIM data is stored in relational (e.g., ODBC), objects (e.g., IFC), or XML (e.g., ifcXML, gbXML) databases. However, cost and environmental data is stored in relational databases or text files, HTML, XML (Autodesk, 2015), (Eynon, 2016). A way needs to be found to bring these together.

Liu and Issa (2013) discuss the necessity of bridging the gap between the design and operational phase of a project. They highlight the issue that design and construction teams are often not familiar with the FM needs in the operational phase of a project. The main reason is that often the FM team is not involved at the beginning of the BIM process. This has the impact that essential FM knowledge regarding use and operation are not considered in the design phase.

The literature highlights the main challenges of integrating BIM-LCC-LCA as:

- Software Incompatibility (Shin & Cho, 2015);
- Lack of technical skills (Eastman, 2011);
- Databases with cost and environmental data not linked to BIM (Eynon, 2016);
- High level of detail of BIM models for sustainability analysis (Ristimäki et al., 2013);
- Lack of BIM protocols (i.e. classifying objects, properties), (Santos et al., 2017);
- Limited accessibility to cost databases (Smith, 2014);
- Resistance to change (Eastman, 2011);
- Time issue (sustainability analysis performed usually at the end) (Basbagill et al., 2013);
- Lack of building component life cycle performance in design phase (Preidel, 2016).

Several studies address the possibility of applying BIM in environmental impact calculations of building components (Antón & Díaz, 2014). However, a literature gap has been identified with regard to the integration of BIM with both LCC and LCA.

3 METHODOLOGY

3.1 Mixed method

The paper investigates the hypothesis that BIM-LCC-LCA can be integrated to support sustainable development. The use of quantitative and qualitative research techniques enabled the collection of comprehensive data that reflects different points of view (Creswell & Clark, 2011). Also known as „triangulation”, aspects of complementarity or divergence are generated by different data collection methods. The research design is sequential and exploratory involving two main phases: (1) First, semi-structured interviews were conducted. (2) The findings were subsequently explored with a larger sample size using an online survey. In addition, a case study was conducted to validate the resulting integration method. The literature review set the scene by identifying the research gap, formulate the research questions as well as informing the selected methodological approach.

3.2 Semi-structured interviews

Nine semi-structured interviews were conducted with experts from the fields of architecture, sustainability consultancy, software development and facility management. The participants were selected based on their experience with BIM, LCC, LCA. The interview data was analysed using thematic analysis, a data reduction technique following Creswell (2013). Codes were extracted and organised into themes that describes patterns in the data. The relationships between themes were further investigated (Guest et al. 2014).

3.3 Survey

The questionnaire survey was designed to collect data from industry experts, based on the results of the interviews and literature review. The survey has three main parts as described in Table 1. In total, 53 questions were asked. First eight questions explored participants expertise, the last seven questions were related to property.

Table 1 Survey structure and samples of questions

1	BIM	10 questions, 13 sub-questions
e.g. Do you agree with the following statement: "BIM adaption can facilitate a more efficient lifecycle management of buildings"		
2	Economic Sustainability	5 questions, 11 sub-questions
e.g. Would you find that assessing different design options with BIM based on lifecycle performance would lead to better investment decisions?		
3	Environmental Sustainability	5 questions, 14 sub-questions
e.g. Please rate how important are for you the following BIM benefits for sustainable construction: Support the calculation of environmental impact for the whole building lifecycle.		

After data screening, 80 complete responses were validated for data analysis giving a response rate of 37.38 percent. Descriptive statistics were applied to summarise the findings with the use of charts, frequency and percentages.

3.4 Case Study

One method of integration was developed and tested through a small-scale case study which was conducted under the framework of the research project SIDAC2 (an integrated system for asset controlling of real estate). During the project, the main functions of SIDAC2 (data acquisition, data management and simulation) were further developed. In this context, the integration of BIM with LCC was developed for real estate investment appraisal. The two components used in the integration exercise were the BIM model of the ZHAW IFM education facility and the SIDAC2 software platform developed by QualiCasa AG, which includes an innovative LCC module.

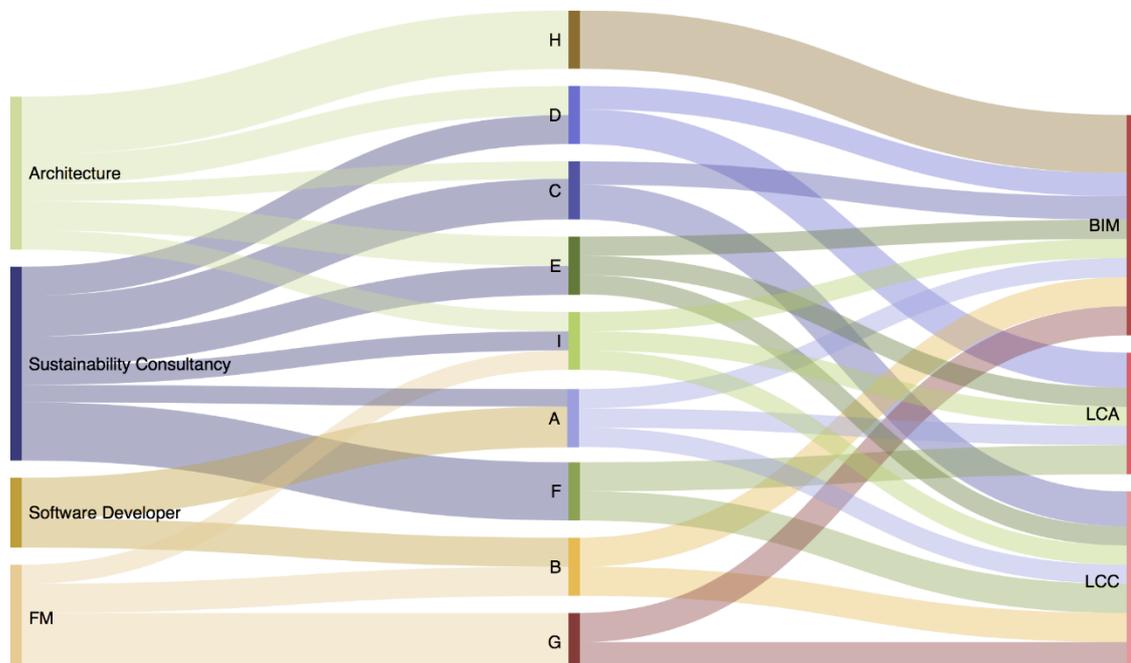
4 FINDINGS AND DISCUSSION

The first round of analysis highlights the importance of BIM, LCC, LCA awareness and collaboration for BIM-LCC-LCA integration. Afterwards, in response to the research questions, the paper identifies the factors that would enable or interfere with the development of an integrated system. The results were further applied in creating an integration model.

4.1 The Need for Collaboration in BIM-LCC-LCA Integration

The process of using BIM enabled simulation technologies with environmental and economic lifecycle flows is not limited to one profession. On the contrary, the expert interviewees background show that it emerges from the collaboration between several professions. Figure 1 illustrates the complexity of these relationships between professions, individuals and knowledge areas. The letters A-I in the middle, represent the interviewees and on the sides, the analysis of interdisciplinary connections.

Figure 1 Interviewee's interdisciplinary expertise



The expertise of the survey participants was diverse, comprising a wide representation of stakeholders involved across the building life cycle. 46.25 percent of the participants are involved in building operation and 35 percent in the planning phase of the building project.

Further analysis revealed that the highest percentage of participants were facility managers (33.75%), followed by architects (16.25%) and BIM experts (11.25%), (see Table 2).

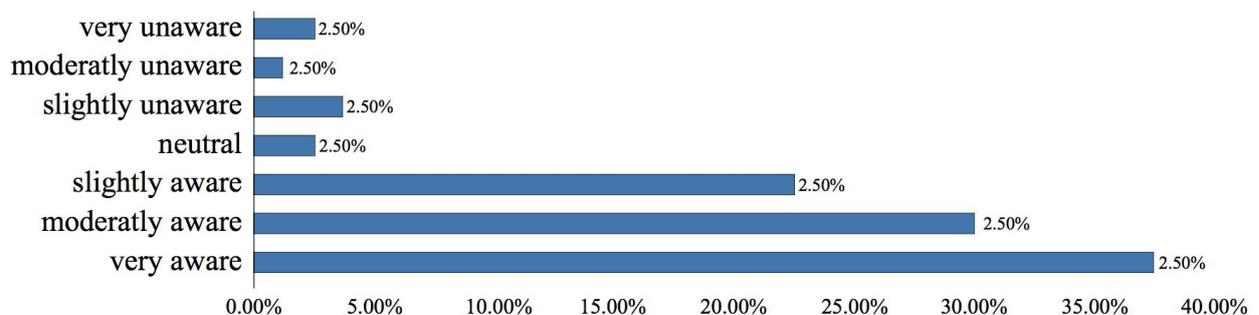
Table 2 Participant role in building life cycle

Expertise	Percentage
Facility Manager	33.75%
Architect	16.25%
BIM Expert	11.25%
Academia	8.75%
Other	6.25%
Owner	5.00%
Property Manager	3.75%
Real Estate Developer	3.75%
IT	3.75%
Sustainability Consultant	2.50%
HVAC Engineer	2.50%
Building Contractor	1.25%
Structural Engineer	1.25%

4.2 Levels of BIM awareness and use of LCA and LCC

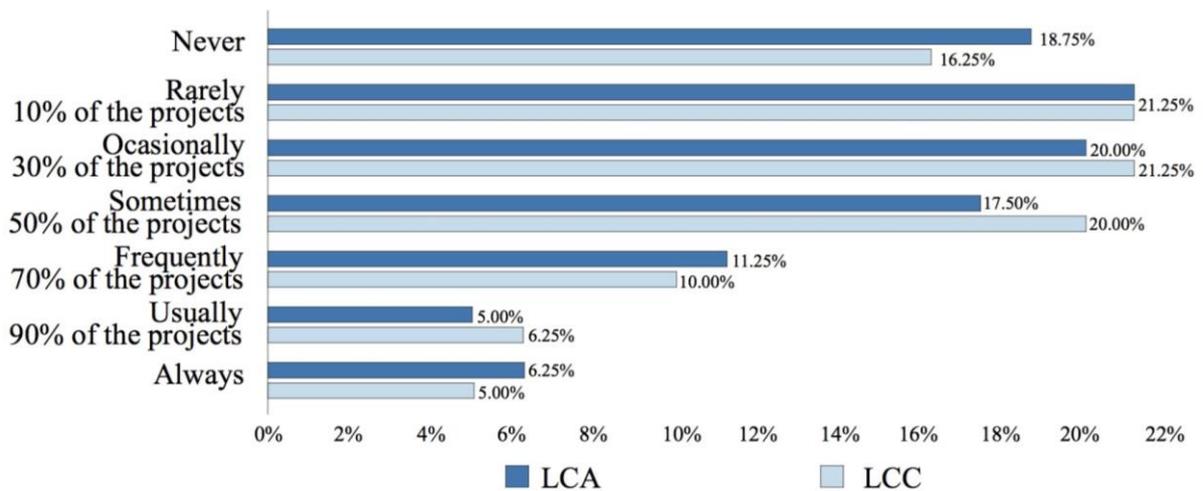
Participants were asked about their level of BIM awareness and the findings indicate it is growing with the majority of respondents, 37.50 percent very aware of BIM (see Figure 2). With respect to the respondent's years of BIM experience, 40.00 percent had no experience and the rest of 60.00 percent had varying degrees of BIM experience with the highest percentage (23.75%) having between 3-5 years of experience and 20 percent having more than 5 years of experience.

Figure 2 BIM awareness



As indicated by the Figure 3, LCA and LCC analysis are insufficient applied in projects. The results are consistent with the interview findings. Furthermore, it can be inferred that there are not significant differences between the frequencies of the analysis.

Figure 3 The frequency of conducting LCC and LCA



4.3 Integration Factors from the Interviews Findings

In order to identify the factors that play a role in BIM-LCC-LCA integration, interviewees were asked semi-structured questions regarding different integration aspects. The data analysis identified 3 categories, 8 main themes and 29 subthemes summarised in the table below (see Table 3).

Table 3 Summary of interview findings

Category	Themes	Sub-themes
Strategic level	The role of international standards and guidance	BIM standard – PAS 1192-2 Industry Foundation Classes (.ifc), COBie LCC ISO standard LCA ISO standard
	Meeting Sustainability requirements	Certifications (DGNB, SGNI, BREEAM) Sustainability goals Environmental Sustainability Economic Sustainability
	Support the decision-making	Economic and environmental trade-offs Design alternatives comparison Implementation costs
Application and processes	Application in the early project phase	Early access to maintenance data Collaboration System thinking CDE (Common Data Environment) Complexity of LCC and LCA
	BIM based sustainability simulations	Material comparison Estimating energy performance and costs Accessibility to databases
Technical and operational level	Workflows	Interoperability Quantity take-off Increased accuracy Mapping Calculation
	BIM information and geometry required	Cost database link Environmental database link Level of Detail
	Automation of the calculation of LCA, LCC sustainability certification credits	LCA credits LCC credits

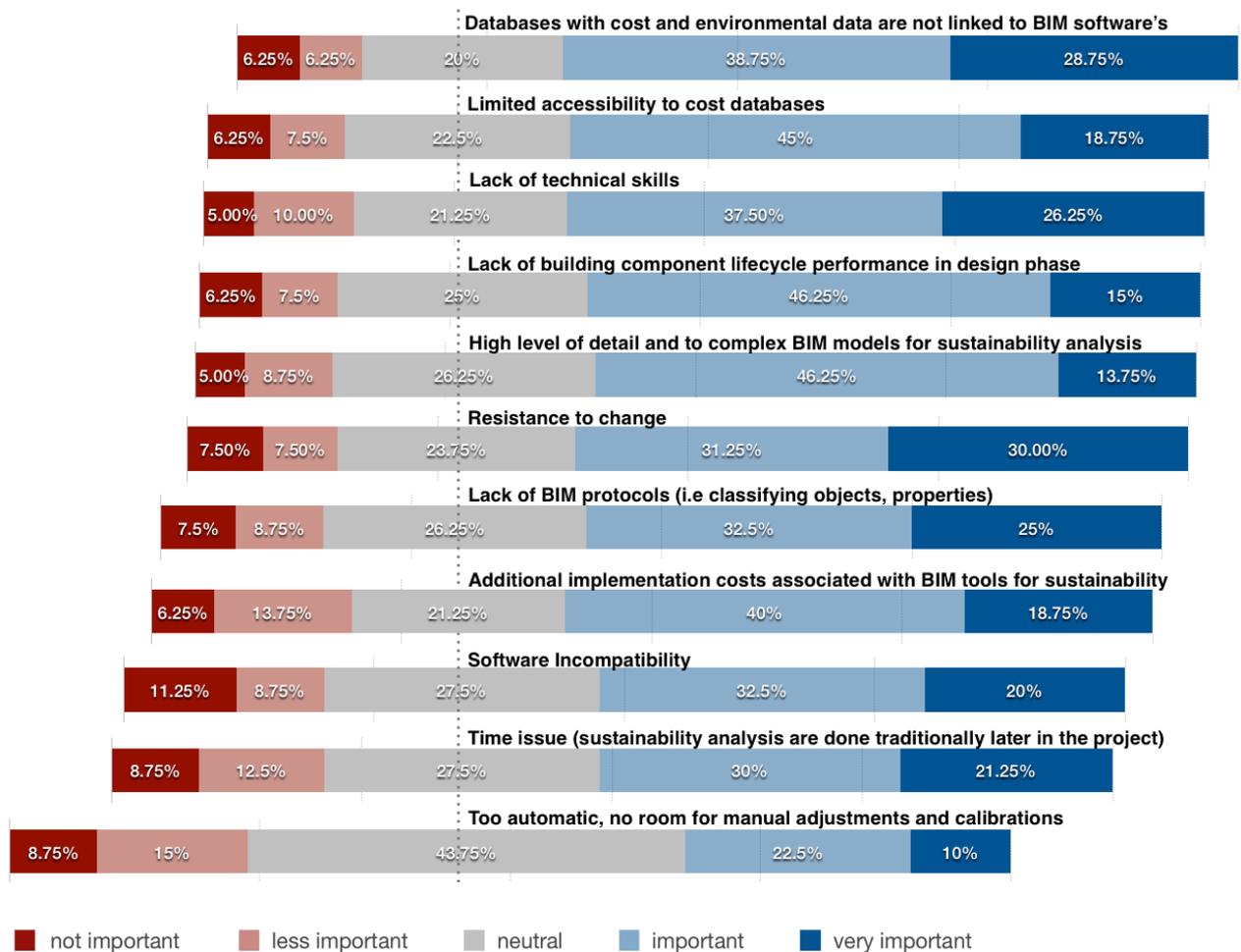
The results were used to further analyze and explore the integration factors on a larger sample size (n=80).

4.3 Integration Factors from the Survey Findings

Based on the interview findings, the factors that play a role in the BIM-LCC-LCA integration were explored via a survey to establish negative and positive perceptions. First, the findings identified 11 factors which are challenging the process because of barriers identified at the strategic level, the application, processes or operational level (see Figure 4). Secondly, another 11 factors identified, push forward the integration (see Figure 5). The factors have been assessed on a Likert scale (1-5).

The highest-ranked factors which interfere with the BIM-LCC-LCA integration were: 1) “databases with cost and environmental data are not linked to the BIM model”, 2) “limited accessibility to cost databases” and 3) “lack of technical skills“. Figure 4 below indicates the impact rating of all the integration barriers on a 5 point scale. Surprisingly, the fact that the LC assessment does not leave room for manual adjustments was not rated as a major negative factor. On the contrary, the factor was considered important during the interview discussions.

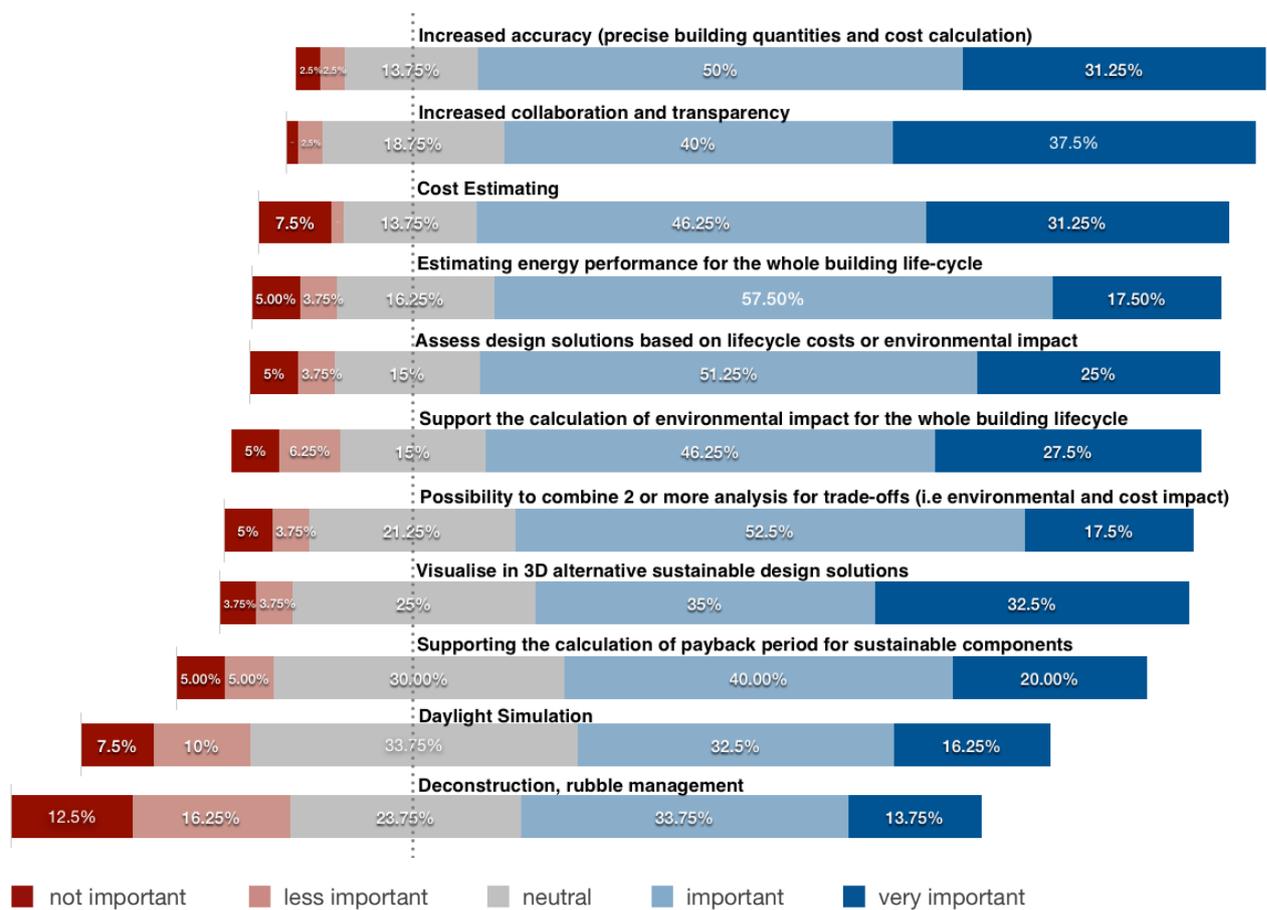
Figure 4 Negative factors for BIM-LCC-LCA integration



With regard to factors that facilitate the BIM-LCC-LCA integration, the importance of 11 factors was investigated as shown in Figure 5. In response to the research problem, the survey findings indicate that the three highest-ranked factors are: 1) “increased accuracy for quantities take off”; 2) “increased collaboration and transparency“ and 3) “cost estimating calculation”.

The interview findings highlighted the fact that at all levels, increased sustainability demands push forward the integration. As reflected in the literature, BIM is acknowledged for enabling sustainability simulations. Moreover, it can be argued that the integration increases the potential of sustainable construction because of the synergies created between LCA, LCC and BIM.

Figure 5 Positive factors, BIM-based sustainability simulations



4.4 Initial Steps Towards an Integrated Model

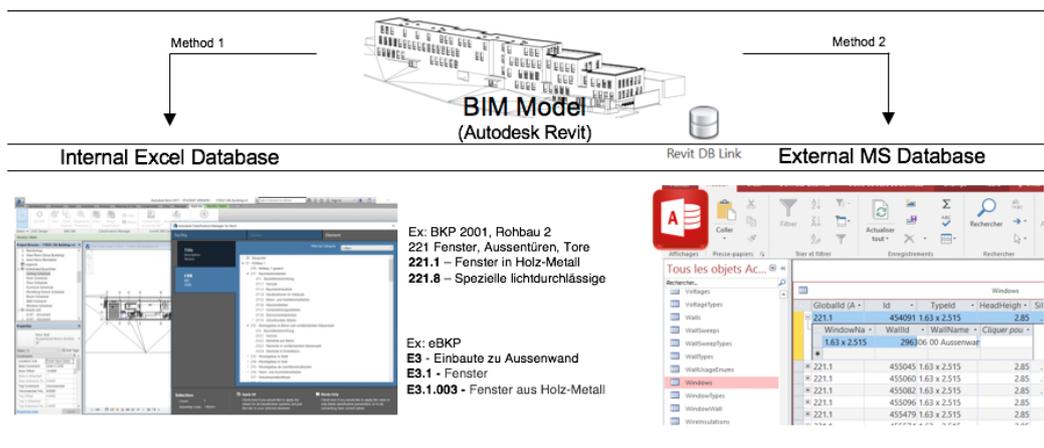
As shown by literature, LCC and LCA methods are often complex, therefore the need to address accessible workflows. Another aspect highlighted by the interviews is that cost and energy performance can become new dimensions in the typical BIM workflow. As stated by Atkin, Brooks (2015) a better assessment of the design-impact on operation is possible with this new dimensions.

The following case study describes the development of a model for using BIM data in the SIDAC2 life cycle platform. The SIDAC2 software is dedicated to monitoring, risk analysis and planning of real estate portfolios and it was developed by QualiCasa AG, a real estate valuation company in Switzerland. The case study results highlight the most important aspects to be considered when using BIM in conjunction with LCC:

4.4.1 Classification Systems

The coordination between BIM and SIDAC2 classification systems was a key aspect for successful integration. The SIDAC2 LCC module was composed of a wide range of reference building projects subdivided into building components and subcomponents structured according to the eBKP Swiss standard. For consistency, the BIM model was mapped with the same classification system for organising digital information which was developed by CRB (2012). To increase automation, two different mapping methods for BIM were tested as shown in Figure 6. The first method was a bi-directional link of the entire BIM database located outside Revit. The second method consisted of setting up an Excel database dedicated to eBKP parameters which was accessible directly in Revit via the Plug-in “Classification Manager”.

Figure 6 BIM link with databases



4.4.2 5D BIM – Cost Parameters

5D BIM proved to be a good base for LCC calculations because, as stated in the literature, 5D includes already the project costs in addition to the 3D model and the time dimension (Agarwal, Chandrasekaran, & Sridhar, 2016), (Smith, 2014). Cost parameters were inserted and configured into Revit. Even though not explored in detail, cost and environmental databases can be linked with the Revit model via a bi-directional MS Access connection. This attribute is important for further LCC estimations and gives an example of how other BIM parameters such as environmental data can be inserted.

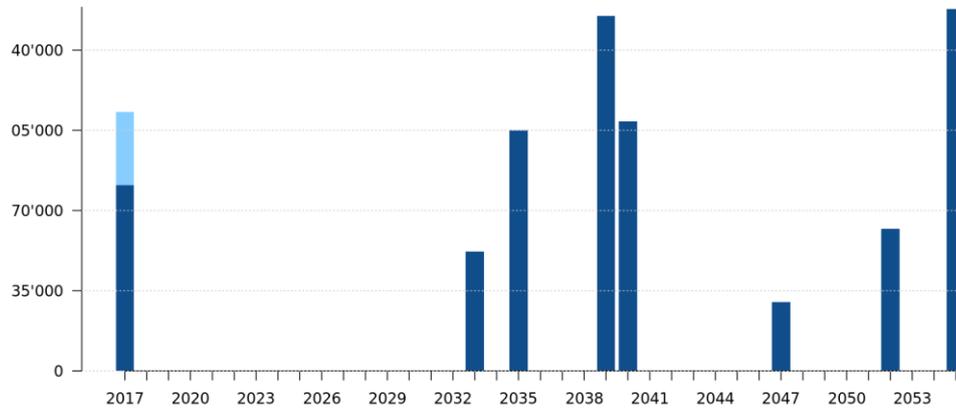
4.4.3 BIM Quantity Take-Off

One of the most important benefit of using BIM which was investigated was accurate and real-time extraction of quantities. This was tested using Revit schedules which were set-up and the bill of materials extracted.

4.4.4 BIM-SIDAC2 Interoperability and LCC Analysis

The transfer of information from BIM to SIDAC2 web interface was successfully done via a spreadsheet format. Afterwards, the SIDAC2 LCC module automatically generated the renovation costs per year as shown in Figure 7. Taking into account multiple indicators (e.g. inflation, runtime), the vertical axis displays the renovation costs and the horizontal axis displays the renovation year.

Figure 7 LCC analysis output from SIDAC2



Overall, the advantage of this linear approach is that the data is introduced only once, in the BIM model and can be used further in the LCC software.

5 CONCLUSION AND FUTURE RECOMMENDATIONS

The purpose of this study was to set the common grounds for the development of a BIM-LCC-LCA method, which can assist in making informed decisions in the early phase of a project by assessing the real estate investment based on life cycle costs and environmental impact. From this, the following conclusions were obtained:

- The BIM-LCC-LCA integration is successful when factors from three different levels are considered: the strategic level, the application and processes level and the technical workflows.
- High level of awareness of BIM/LCC/LCA and collaboration are needed for a successful integration
- The factors that support the integration are “increased accuracy for quantities take off”, “increased collaboration and transparency” and “cost estimating calculation”.
- The integration is challenged by the following factors: “databases with cost and environmental data are not linked to the BIM model“, “accessibility to cost databases“, “lack of technical skills“.
- The case study showed how the complexity of the analysis is reduced and made accessible to a broader range of practitioners. On the other hand it highlighted the advantage of BIM in several steps: good classification of BIM elements for the cost break down, setting-up BIM parameters, accurate quantity take off and data transfer.

Despite the acknowledged benefits of using BIM in conducting LCC-LCA analysis in an integrated way, there are only few integration concepts. Therefore, further studies are needed which should also target the transfer of these models into practice.

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Student housing as a facilities service: new insights to campus management

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ABSTRACT

Purpose: Student housing is one of the essential services which need to be redefined as part of the campus or city service offering. The objective of this research is to understand and analyse the present and future student housing in transformation from standard student house product to living as service concepts. Research questions asked are: what are the demands of students for future student housing and how the supply of student housing can or cannot response to these needs?

Methodology: The nature of the research is explorative. The sequential explanatory method is a two phase design where the quantitative data is collected first followed by qualitative data collection. The purpose was to use the qualitative results to further explain and interpret the findings from the quantitative phase. The data from students was gathered by survey. The topics of the surveys were clarified by interviews of students. Additionally two concept workshops were organised, summarised and analysed as complementary data. The second set of interviews was conducted with the student housing service providers in Finland.

Findings: The results include four student profiles based on their living preferences. Additionally the results provide perspectives for facilities management to respond to diverse needs of future students by focusing on student-dominance logic. Student housing as a service need to include flexible alternatives. The new concepts for co-learning and co-living are simultaneously partly design solutions but also service offerings. Service development need to be developed in service ecosystems by using service platforms and and digital delivery channels. Student housing as service is based on integration, hybrid solutions and ecosystems in urban, city and campus planning

Impact: The results provide new insights for facilities managers in university campuses. The new services for diverse student profiles include hybrid solutions in- and off-campus based on sharing economy.

Paper type: Research Paper

Keywords: Student housing, Campus development, Future, Services

1 INTRODUCTION

University campus is a knowledge power plant for the city. Lot of emphasis has been put to campus development in terms of creating a varied and inspiring environment for students, scientists, staff, entrepreneurs and visitors. Alongside an innovative learning and working

environment, the campus can provide various other facilities, which need to be managed: not only as a separate functional space segments but as a holistic learning- and servicescape. In supporting cities and universities as learning hubs, facilities management can support also lifelong connections, unforgettable experiences and symbiotic exchange. Student housing is both campus and city development.

Student housing has profound influence on students' overall socio-political life such as leadership development, behaviour, academic performance, citizenship and sense of belonging. Student housing, integrate the social and psychological functions to satisfy the student's needs, aspirations and expectations as an ecological environment for learning activities. Ecological in the sense that it function as means of interaction between students and the academic environment and vice versa which have significant influence on the students (Ghani and Suleiman, 2016).

This paper aims to understand the future student housing in Finland both from the supply and demand side. The questions asked are: what are the demands of students for future student housing and how the supply of student housing can or cannot response to these needs.

The overview of present studies of student housing is discussed in chapter two. The research perspective is widen by introducing diverse new student housing concepts from USA and Europe. The last chapters include the empirical data from Finland presenting the research design, results and conclusions.

2 STUDENT HOUSING

2.1 Definitions of student housing

Student housing is the housing unit for college students to live for the purpose of studies where many young students leave their homes and parents and is provides a different experience for new life style, learning how to live independently, which was regarded as a transitional phase towards adulthood, compromise with others, leadership and citizenship development and shared space and facilities (Amole, 2012; Khozaei et al 2010a; Zaransky, 2006).

Correspondingly student house should have some infrastructure facilities and services that are deem necessary for learning to be considered as student house. These infrastructure facilities are categorised into two: - basic (core) and supportive (supplementary) facilities and services. Basic or core facilities are regarded as those necessary facilities for a house to function such as bedroom, toilet, bathroom, etc. On the other hand, supportive (supplementary) facilities and services are those that are not compulsory, but are equally important in facilitating or enabling the attainment of the fulfilment of the house functions, such as common room, cafeteria, shopping area, parking, security, library, playground, transportation, cable TV, security, and laundry (Aluko, 2011; Garg et al 2014; Khozaei et al 2011; Mohit et al 2010; Nimako and Bondinuba, 2012).

There is lot of research connected to student housing in Eastern part of the world. One need to consider the cultural differences in terms of requirements for student housing. However, there are also similarities regarding to the basic equipment. Today, students mostly demanded furnished rooms with high speed internet connection, wireless broadband or Wi-Fi capability, cable TV, common room, entertainment hall, reading room, library, security, central air conditioner, ease of transportation to lectures, washers and dryers, microwave ovens, and garage are becoming more common of students requirements (Zaransky, 2006; Pace, 2007; Khozaei et al 2010b). Abramson (2009) finds that extra amenities such as parking lots, mini

markets, bookstores and cafeterias should also be provided in student housing. The inclusion of these sophisticated student housing features results in a higher level of residential satisfaction (Abramson, 2009). However, student housing requirements are depending on the cultural context including cultural norms, laws and regulations as well as the transformation of life styles including the new ways of living, working and learning.

Basically student housing, on the basis of their locations, can be categorised into two types of housing accommodation, these are living “on-campus” and living “off-campus”. Ghani and Suleiman (2016) refer earlier literature about four types of students housing models that were considered and practiced in many parts of the world. These include, traditional on campus accommodation, off- campuses leased, on-campus school managed and off-campus private. The traditional on campus accommodation is the conventional student housing build by universities or higher education institute in their premises; off-campuses leased is the private investors build students housing off-campus. While on-campus school managed are those types of student housing built in campus premises through partnership and managed by the institution under certain arrangement/conditions and lastly off-campus private refers to student housing built and manage by private investors outside the campus. They found also three descriptions of student housing models practice in worldwide. These models include: non-residential, residential and dual-residential. Non-residential is where higher education institute has no student housing programme therefore all students source for their accommodations; residential where the higher education institute house all students in their housing programme and the dual-residential the most popular model, where the higher education institute houses segment of its student population for a period of time only while during the remaining period of study, the students source for their housing accommodations in the private rental market. All in all, student housing location in-campus and off-campus provide a starting point also for wider discussion about student housing as a service. One cannot ignore the fact that the discussion is also depending on the size of the university cities: from capitals to medium-sized university cities (Ghani and Suleiman, 2016).

2.2 Resident satisfaction

Previous studies have identified characteristics that influence resident satisfaction with student housing. Kitchens, private bathrooms, study lounges and social spaces are considered basic necessities in student housing as well as Wi-Fi. A growing body of literature has underlined that usually students possibly will perform efficiently and perfectly in their studies and be more socially adjusted given that they received proper care of their welfare together with comfortable living condition in their student housing (Rinn, 2004; Amole, 2005; Radder and Han, 2009). Wilcox and Holahan (1976) investigated the influence of high- vs low-rise building design on the psychosocial climate of university residence hall environments. Their hypothesis that physical design features (building size and floor level) would differentially influence perception of social environments. Based on their results these features significantly affected degree of commitment students felt for one another, patterns of interaction and emotional support, and level of involvement in organizational functioning.

All in all student housing is currently going through dynamic shifts in design and functionality. For example in the last decade in Norway, there is a distinct need for new student housing due to rising student numbers. Thomsen and Eikemo (2010) investigated which aspects influence students’ housing satisfaction in Norway and found out that the most important variables for student residential satisfaction were, first, the type of tenancy/ownership; second, the quality of different housing characteristics; and third, the location. Where once a student dormitory merely required a bed, adequate kitchen facilities and (in recent years) a reliable WiFi

connection, student housing today is being refashioned around concepts of community which blend living, leisure, socializing and studying functions. Students are increasingly selective in their housing choices, and universities and developers alike have capitalized on this with contemporary design, strong brands and forward thinking uses of space. This reimagining of the traditionally compartmentalized lifestyle of a 21st-century student is built around a collaborative model intended to nurture entrepreneurial spirit and to build lasting social and professional networks. (Anon. 2016)

2.3 Student housing and campus development

Student housing in campus development is facing the changes in terms of new ways of living and learning. The larger context of campus in the city emphasizes phenomena like innovation and collaboration, sometimes at odds with an ever-changing political climate. Den Heijer (2011) has proposed that the future of the university campus is rooted within the spatiality of its host city. Student housing is part of discussion about universities as learning hubs and their significance for the cities of the future. Nevertheless student housing is also a matter of facilities management. Facilities management is in charge of providing flexible and collaborative spaces for innovative and interdisciplinary areas of study. In ensuring the students can feel a comfortable and pleasant campus and student lifestyle in their on-campus student housing, thus, the university governance besides government especially policy officials are accountable to provide high quality facilities and services to these people (Jiboye, 2011). Hence, regular assessment of the service quality performance of the on-campus student housing is expected and very important because it can affect individual's quality of life.

Student housing is not the only part of university life undergoing transformation. The design-based approach utilized in new student housing developments has also been applied to changing campus structures. Universities are increasingly shifting gear toward interdisciplinary and independent study programmes, as well as digital and open-source learning. At the same time, university campuses are being redeveloped, introducing a plethora of modern built forms and multifunctional facilities. Spaces are increasingly flexible, open and active, enhancing the potential for users to socialize, meet and work together (Anon. 2016).

3 CHANGING STUDENT HOUSING CONCEPTS

Next to literature review the interest was to conduct a market analysis and gather some concepts indicating the shift on the markets. The cases were chosen either from USA or Europe excluding other geographical areas.

Table 1 Examples of changing student housing concepts

Country	City	Student housing concept
USA	Diverse cities	WeLive is a new way of living built upon community, flexibility, and a fundamental belief that we are only as good as the people we surround ourselves with. From mailrooms and laundry rooms that double as bars and event spaces to communal kitchens, roof decks, and hot tubs, WeLive challenges traditional apartment living through physical spaces that foster meaningful relationships. ¹
USA	Katho in Courtrai	HUB 01 is a mobile housing terminal. The concept is based on three principles; 'mobility', 'personalized student rooms' and 'educational design'. A prototype of

¹ (www.welive.com)

		this terminal is built in Courtrai. This mobile terminal houses a central kitchen, a living room and a bathroom. The rooms all have different concepts. ²
USA	San Francisco	Starcity provides comfortable community homes in the heart of San Francisco. The mission is to make cities more accessible for everyone by creating comfortable, community homes that inspire people to live a more intentional life. ³
Denmark	Copenhagen	Student housing platform UrbanRigger offers unique modular living spaces that float in the city's harbour. The property is fully carbon-neutral and features a courtyard, a kayak landing point, a swimming area and a barbeque space, all of which support social interaction. ⁴
Denmark	Ørestad	Tietgenkollegiet (The Tietgen Residence Hall) in the Ørestad district represents the future of student residences. A type of residence that supports and develops an attractive housing and student area with a so far unheard of focus on prioritising of the community in combination with the individual. ⁵
The Netherlands	Amsterdam	Je m'appelle Company is a co-habited house on a tiny side street in Amsterdam, which houses 25 creatives under one roof. The goal of Je m'appelle is to create a 'village within a city' where young minds can cross-pollinate and share ideas while also sharing costs. ⁶
The Netherlands	Diverse Cities	Student hotel's all locations are built with the same general blueprint in mind: fully-equipped rooms and studios, kitchens (shared or private), flexible co-working space, chill out lounges, libraries, TedTalks booths, ping pong tables, gyms, all-day dining restaurants, designer bikes, laundry facilities, meeting rooms, auditoriums, calendar of events, swimming pools (select locations), shared common facilities and extensive ground floors where people can come together. ⁷

The identified common drivers of these new concepts were community building, freedom of choose and in some cases sustainability. These cases are platforms for tomorrow's vibrant community of students as well as new ways of providing student housing services.

4 RESEARCH DESIGN

4.1 Methods

The nature of the research is explorative. The sequential explanatory method is a two phase design where the quantitative data is collected first followed by qualitative data collection. The purpose is to use the qualitative results to further explain and interpret the findings from the quantitative phase (Creswell 2003). Student survey was used to collect quantitative data from a larger group. Members of that group were then later selected for interviews in order to explain and offer insights into survey answers.

Methods used were:

1. Survey for the students in one particular University in Finland.

² (www.archilovers.com/projects/73525/hub-01-student-housing-of-the-future.html#info)

³ (www.Starcity.com)

⁴ (www.urbanrigger.com)

⁵ (www.tietgenkollegiet.dk)

⁶ (<http://www.jemappelle.com>)

⁷ (www.thestudenthotel.com)

The aim of the survey was to map students' living preferences and opinions about two diverse concepts: mini apartment and community housing. The sample was student union students in one particular area and university in Finland (n=173).

2. Workshops for students in two universities in Finland

The aim of two workshops was to deepen the data gathered from the survey and get more precise information connected to two potential concepts as well as perspectives for future of student housing. This was achieved by discussing about the future city scenarios. The participants of workshops were from two different universities (n=97).

3. The interviews for the students (n=14) provided additional information about the themes which were not included to survey. The themes of semi-structured interviews were safety, multi-use of housing facilities, community and cultural diversity. The sample consisted on students from two different universities.

4. The interviews for student housing service providers (n=6) included six interviews representing the sample from different university cities in Finland. The semi structured interviews had the following topics: Student housing offering, laws and regulations of student housing and the drivers of future service provision.

4.2 Data analysis

The data surveys was analysed statistically in order to identify the quantity of different user preferences in student housing. The results were clustered based on preferences. The interviews were analysed by content analysis. The content analysis was based on identifying the similarities and differences between the topics discussed in the interviews. This provided comprehensive summary of the phenomena both based on students demands of student housing and provision of student housing in Finland. The workshop outcomes complemented the results by providing material for identification of scenarios of student housing.

5 RESULTS

5.1 Student housing in Finland

Approximately one third of all Finnish students live in student apartments. Student apartments are either within walking distance of universities, or easily reached by public transport. Student housing organisations are in 22 localities. Student apartment lease contracts fall under the act on residential leases, which governs all housing rental contracts in Finland.

Student housing is available in several forms: shared apartments, usually shared by 2-4 students, more expensive studio apartments, group apartments and family apartments. The shared apartments are typically furnished. The student housing product tends to be standardized.

5.2 Diverse student resident profiles

Based on results we identified four different types of student housing profiles. Students preferred either privacy or community but also the mobility profile differed. The first student profile was "Home sweet home"-type, who enjoyed the first own home, which was important for the new identity as a student living away from childhood home. The second profile was called "Hedonistic lifestyle", who appreciated both own home but also the shared facilities like e.g. kitchen which is not only a simple micro-wave oven but has high quality for cooking and spending time with the friends. The third profile was nominated as "Place to sleep"-profile: the apartment was a storage for stuff and a place to sleep – the life happened outside the

apartment and this profile typically both studied and worked all around the academic year. The time spent at home was limited. The fourth profile indicated the change of life style, the profile was called “Pop in – pop out”. These students had their regular home somewhere else and they came for their university town only occasionally using all possible ways to study e.g. by using technology. The requirements of all these profiles for the apartments differ: the first and third profile appreciated privacy and not shared facilities while the shared facilities were very important for the second profile. The fourth profile preferred the cost-effective and more concepts like “apartment as a service” for occasional use only.

5.3 Modular service offers and servicescape

The concepts discussed and developed in the workshops included modular solutions both as physical and service structure. The mini apartment with different kind of choices and service levels were preferred and it responded well to the fact that the situations of students change not only based on the number of study years but more based on choice students do during the academic year. The current student housing is not agile enough to response e.g. to internationalization of students while the options to study abroad vary in length.

The service providers pointed out that the different student profiles might prefer different services in different locations in the city. So far the on-campus housing is rare in Finland, but there are possibilities to rethink new living concepts located in the campus. Additionally the needs of different profiles could be tackled by using more co-creation and student centricity in designing the new concepts. It is time to give up the cohort-kind of service provision in student housing.

The new ways of studying and working require re-definition of student housing and the supply is not based on only providing place to live. Learning is taking place everywhere and “flipped classroom“ is changing the significance of campus as a learning environment. One should not develop or design learning and living places separately. If the student housing is providing places for co-working, group working and using digital technology fluently, it provides an alternative and sustainable solutions for study also in the housing facilities.

The student housing providers pointed out that new kind of space types have been developed already, e.g. club house is more than traditional living room or gathering place for students. It is a service and it can be used in various ways. However they pointed out that the use of different kind of third places (cafeterias, libraries, co-working places) might be the essential part of network of places for mobile students and one need to be sensitive for weak signals: what are the first, second and third places for students. In the student survey campus had a high priority as the second place and the city itself with the third places was not so important option to be chosen for e.g. groupworks.

The significance of developing the areal ecosystem in a systematic way is an important success factor for attractive housing for the students. Possibilities for outdoor sports in the neighbourhood of student housing were emphasised. The student house community can offer something for the neighbourhood and vice versa. If the student housing is shifted to on-campus locations, one need to consider the volume of users of services. Nevertheless, the topics dealing with sharing economy were identified as one driver of student housing. The business models based on “housing as service” are not yet in use in Finland, but there is a possibility to re-think the ecosystem of studying and living. However the student housing markets in smaller university towns in Finland are limited and the volume is not very large. This means that the trials need to be made in larger cities or in new kind of collaboration with the local ecosystem around student services. All in all, the students are looking for affordable solutions – the ways how to make the living affordable are the most important drivers for future services.

5.4 Summary of the results

The key findings for facilities management are summarised in the Table 2.

Table 2 Demand and supply – drivers for facilities management in campus

Demand	Supply
Modular spaces and services	Flexible alternatives
Any-time – any-where learning	Concepts for integrated co-learning and co-living
Services of neighbourhood	Service ecosystem and service platform based on sharing economy
Different student profiles	Co-creation with mixed lifestyles representatives
Campus as living room	Campus as service

Student housing as a service need to include flexible alternatives. It can be structural, built flexibility in space but it can be also flexibility in rental times (not only one month being the shortest time for the payment) or in the services included to the apartment. This can be important e.g. in providing facilities for international students and maybe also for their families.

The new concepts for co-learning and co-living are simultaneously partly design solutions but also service offerings. The co-working concepts include many times community manager services – could this be the case also in student housing services?

Service development need to be developed in service ecosystems by using service platforms. The service design need to be done by using “one-click-away”-approach. The sharing economy has risen up by using digital channels to share different things – the consumer behaviour of the future students is digital. There is a possibility to provide many services in terms digital delivery channels.

Student housing as a service is worth to co-create with different lifestyle representatives. One can identify also lifestyles, which are even traditional with their expectations to the student housing services. Additionally one can find new kind of lifestyles where the needs differ.

Finally, the development of campus as living room is not enough – campus as service include elements which make both studying and living easier, cosier and easy to access. Student housing as service is based on integration, hybrid solutions and ecosystems in urban, city and campus planning.

6 CONCLUSION

The study is limited to Finland and even there in limited sample. This is the weakness of the study. Additionally the rich data can suffer from too general summaries. However the results were able to indicate the diversity in the needs of students. The traditional standard solutions are not the answer when the questions is about diversity of student housing services.

The study adds to the knowledge on drivers that influence student housing development in the society, where the mobile life styles and sustainable choices play more and more important role. Further discussion on the student housing situation in medium-sized university cities in Finland is needed as well as further studies about the changing demands for living as part of the future campus and its management.

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FM services get digital: key prerequisites to integrate intelligent personal assistants in Swiss hospitals

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ABSTRACT

Purpose: The healthcare sector in general, and hospitals in particular, are being confronted with increasing financial pressure. FM – responsible for up to 30 percent of the total costs – is compelled to improve the service as well as to boost efficiency. At the same time, there have been major technological developments in artificial intelligence (AI). In our every-day life, so-called Intelligent Personal Assistants (IPAs) help us to control our homes or to communicate with others. These are practical examples of the use of AI technology, and consist of electronic user interfaces, enabling the system to use natural language, vision and contextual information to automate routine tasks, offer assistance, streamline and enhance repetitive activities. There are attempts to use them in healthcare environments to facilitate the patient and staff interactions, to perform processes more efficiently and to compensate staff shortages. However, systems implemented, focus primarily on medical tasks between patients and medical staff. Nevertheless, the non-medical field must be considered likewise, for this innovation. FM in the hospital context at present, is not too familiar with the field of AI. In general, one can observe a denial of AI applications in healthcare. The authors therefore stress that beyond the technological debate, key prerequisites on a strategic level are needed to integrate IPA-systems.

Methodology: In the case study, the key prerequisites on a strategic level for the implementation of IPA-systems in Swiss hospitals, is investigated. A qualitative Delphi method was applied and the data was validated by semi-structured expert interviews.

Findings: The paper summarizes key prerequisites to the implementation of IPA-systems within a hospital context. The authors stress that IPA-systems can be implemented as part of hospital management systems, for example, to assist in information retrieval, monitoring, assistance or advice, etc., or to interact between various applications, actors, institutions, departments, locations and services. The findings reveal a diverse range of possible IPA-based services, ranging from information management and registration, signage and navigation, transport and logistics, safety and security to hotel and bedside services. At the same time, there is a need for further research beyond the technological requirements.

Impact: There is evidence to support the notion that in the coming years AI is likely to rapidly spread. Given that, the future proliferation of IPA technology and its applications will undoubtedly continue. For FM this holds challenges and opportunities. On the one hand, IPA technology will improve the efficiency of non-medical support services; on the other hand, Facility Managers need to become familiar and knowledgeable with AI based technologies. This paper focuses on the strategic impact of the management of hospitals, as well as underlines the need for digital strategies, taking the four defined prerequisites into consideration.

Paper type: Research Paper

Keywords: FM in Healthcare, Artificial Intelligence, Intelligent Personal Assistant, Key Prerequisites

1 INTRODUCTION

Of all the 34 OECD countries, Switzerland is positioned third amongst the most expensive healthcare systems (OECD, 2015). With an 11 percent share of the national GDP, the healthcare sector accounts for roughly 70 billion Swiss Francs per year (BFS, 2016). 20-30 percent of hospital costs are not linked to primary processes or medical services, instead they fall within the scope of Facility Management (FM) (Honegger, Züger, & Betschart, 2016; Lennerts, Abel, Pfründer, & Sharma, 2003). In other words, medical as well as non-medical services are being forced to operate with fewer resources and are under more pressure (Hofer, Gerber, Honegger, & Züger, 2016a). Moreover, it is stated, that there is room for improvement to align and increase the effectivity of FM-services performed (Hofer, Honegger, Züger, & Gerber, 2016b). In the report of the European Union (2015), it is stressed that there is an increasing need to invest in ICT solutions in order to address the growing pressure on the healthcare system. When it comes to hospitals, significant technological developments in the medical and non-medical field are evident (Balmer, 2016; European Union Agency for Network and Information Security, 2016; Frisch, 2014; Holzinger, Röcker, & Ziefle, 2015; Sánchez, Tentori, & Favela, 2008). Markedly, major technology developments in the healthcare context are seen in cloud computing, data exchange platforms, wearable technologies, data analytics and artificial intelligence (AI) (Chouffani, 2017c). In particular, with technological developments in the field of AI, new digital, intelligent services are being developed (Hurwitz, Kaufman, & Bowles, 2015; Santos, Silva, Rodrigues, Casal, & Saleem, 2015).

There is a need for Swiss hospitals to perform their non-medical support processes more efficiently. Thereby, the authors of this paper stress that there is a potential in the field of applying Intelligent Personal Assistants (IPAs). The paper attempts to answer the research question: *What are the key prerequisites on a strategic level, in order to introduce and integrate IPA-system into the processes between patients, visitors and non-medical support services in Swiss hospitals?*

2 BACKGROUND

With the use of “sophisticated intelligent sensor networks” (Holzinger et al., 2015, p. 1) - also known as IoT - and Big Data, interoperable, digital, smart socio-technical systems are formed. Thereby, information is contextually provided to execute services and operations, resulting in highly interactive hospital environments (Sánchez et al., 2008). In literature, these are referred to as Smart Hospitals (European Union Agency for Network and Information Security, 2016; Holzinger et al., 2015; IBM, 2013). The major advantage of digitalising hospitals, is the possibility to exchange entire information flows between all care providers and other actors, within the hospital setting (Balmer, 2016). In this regard, technologies augment the access beyond the traditional hospital and to the tertiary healthcare locations (Kofler & Schmitter, 2017). Equally important to the interconnectedness of devices, sensors and actuators, is the underlying intelligence of the Smart Hospital environment. In order to establish such a system, it is necessary to incorporate AI (Ramos, Augusto, & Shapiro, 2008).

A prominent practical example of the use of AI - offering intelligent services - are so-called Intelligent Personal Assistants (IPAs) (Khanna et al., 2015). An IPA is understood as a digital, virtual, artificial intelligent entity. It runs on a diverse range of devices, which consist of one or more electronic user interfaces, enabling the system to use voice, vision and contextual information to offer digital services, thereby automating and assisting the user in his or her daily routine. As of yet, there is no single definition given for this technology. In certain hospitals, IPA-systems are already being deployed. These systems are able to collect information from a number of data banks and networked devices autonomously. For example, they can access databases with information (Liaqat, Athar, & Saqib, 2015; Wu, Lu, Zhang, & Gong, 2016) and are able to interconnect with wearable sensors to actively monitor patients or motion sensors to detect various activities (Chouffani, 2017a; Santos et al., 2015; Wu et al., 2016). The ability of IPAs to connect to various medical systems, allows them to act as an intelligent interface, simplifying the input of data. When it comes to information retrieval, IPAs can be deployed to quickly access reports and patient information (Divall, Camosso-Stefinovic, & Baker, 2013; Liaqat et al., 2015; Santos et al., 2015). Furthermore, the IPA is able to support and advise the patient (Liaqat et al., 2015) and acts as a single source of contact and gateway to various services (Zeng et al., 2016). Systems such as IBM Watson (Chouffani, 2017b) could be established as health advisors. Assistant robots are being used to welcome visitors and support patients with administrative and medical tasks, while waiting for their examination (The Guardian, 2016; Morgan, 2017). Also, after the patient is discharged, IPAs can be further used to assess their health condition at home, instruct and educate patients, log daily activities, and trigger specific tasks (Chouffani, 2017a). IPA-systems can also be implemented as part of hospital management systems, for example, to assist in information retrieval, monitoring, assistance or advice, etc., or to interact between various applications, actors, institutions, departments, locations and services (Liaqat et al., 2015).

Overall, IPAs need to be considered in a broader context, amalgamated with other digital systems, as an integral part of Smart Hospital environments. In addition, importantly, what IPA-systems are able to offer, is a natural digital interface and thereby could become a critical element to establish intelligent, context aware environments.

3 METHODOLOGY

The methods chosen facilitate a better understanding of the role of FM in healthcare, to examine in-depth how technology could be deployed in the future, and what the possible impacts could be. The data collection follows a multi-method design, based on a two-round qualitative Delphi (N=7) study and expert interviews (N=2) for validation. In order to develop both data collection tools, 61 technology blog articles, within a timeframe of 6 months (between 01 June to 20 November) were analysed. This was necessary to confront the experts with the most recent developments in the field of IPAs.

Delphi is a method based on anonymous judgment of expert opinions and seeks to forecast future situations and scenarios, or answer a research question where there is little or no knowledge available (Brown & Helmer-Hirschberg, 1964; Rowe & Wright, 1999; Skulmoski, Hartman, & Krahn, 2007). The Delphi method is an iterative process, in which the participants are shown the results of the previous round before they are asked the same questions in the proceeding round (Skulmoski et al., 2007). It is mostly used as a quantitative technique. However, there are also research references clearly promoting it for a qualitative approach (Habibi, Sarafrazi, & Izadyar, 2014; Skulmoski et al., 2007). For the research, a two-round Delphi process with seven experts from Switzerland was applied. These were FM experts, who have an overall overview of hospital processes, expertise with digital healthcare environments

and automation or expertise and experience in constructional processes of hospital facilities. Participants were given a two-week response time in both rounds. They were provided with a questionnaire with open-ended questions. One key question was: *As a facility manager, what would be the necessary prerequisites and framework conditions for successfully implementing an IPA-system for non-medical support services?* In the second Delphi round the participants were able to correct, complement and / or rewrite their answers from the first round (see also Skulmoski et al., 2007). Furthermore, each questionnaire included a summary of all the statements from the previous round made from all participants. The semi-standardized expert interviews following the Delphi process, aimed at validating and refining the collected data from the Delphi method. Two experts (software engineer at Microsoft Germany; head of data and advanced analytics at ABB, Switzerland) provided information specifically of IPA technology in the hospital context.

All the data generated from both data collection methods, and the technology blog articles, were analysed using data matrices. This is a process of interpreting data, by presenting it in a more readily form. The data analysis roughly followed the four steps defined by Nadin and Cassell (2011), starting with a synopsis, followed by a template with codes, which are transferred into matrices. These matrices are then analysed.

Although significant experts from the Swiss FM healthcare and AI technology sector were involved in this research, there is a need for further research in this area, with a larger sample, a more comprehensive Delphi method and additional expert interviews.

4 FINDINGS

The following findings summarize the preconditions and circumstances that are central to the development and integration of any future IPA-system in a hospital. The topics derived from the data collection are: (1) governance, (2) culture, (3) processes and (4) technology. The expert responses have proven that the introduction of IPA-systems in the first place depends on user acceptance, on hospital culture and readiness for ICT innovations. From a technological point of view, IPA-systems could be in use by now. The critical moment however is, that IPA-systems are to be considered as integrated solutions, which are aligned with an overall digital strategy.

4.1 Governance

At the outset of introducing IPAs in hospitals, it is necessary to outline a clear delineation of the framework requirements of the designated system. Moreover, a clearly defined scope of the IPA-system to be implemented can support the strategic decision-making process, which is irremissible with such an undertaking. Sometimes the management might need to decide between patient satisfaction and profitability. Markedly, the financial aspects are a crucial factor. The Delphi study participants thereby stressed investment security. Thereby, it is necessary to define the economic efficiency of an IPA-system, and the required financial resources for the investment and operation. The initial investments need to be compared to the added value, such as cost reduction (quantitative) and the impact of the system on the patient and / or visitor satisfaction (qualitative). The participants of the Delphi study argued, that the trade-off, due to a possible decrease in patient satisfaction, needs to be balanced with the reduction of costs. There was clearly the recommendation, that a small scale and logical use-case should be initiated beforehand. Based on the results of this pilot project, resources can be allocated to a full-scale project to implement IPA-systems in a broader manner.

From the point of view of FM, when implementing an IPA-system, a key prerequisite would be the design of the interfaces and services, the process integration, such as the transfer of tasks, and a good user experience and usability. Working alongside an IPA, prerequisites include good training, customer support during the implementation phase and project ambassadors from the (strategic) management. Lastly, a fundamental prerequisite that was raised by the interview experts concern the issue of data governance. In other words, who has access to the data and how to best secure the data?

4.2 Culture

Understanding the hospital organisation and its culture is paramount when introducing any new ICT system. In addition, the overall fit of the system with the hospital strategy is a key prerequisite when introducing IPAs in hospitals. These issues need to be clarified internally. This includes, when and where an IPA-system would be most useful and needed, as well as the patient's expectation. However, the participants of the Delphi study voiced their concern with the acceptance by patients or visitors of IPA-systems. In this case, the issue is raised, that an introduction of an IPA could cause dissatisfaction with patients. From the hospitals point of view, it must be remarked that it is difficult to assess the patients' and visitors' reactions towards an IPA-system before its applications and parameters are clearly defined, and they are able to experience it. Thereby, the issue of generation conflict was also highlighted by one of the interview experts. Here, FM could play a vital role, namely by identifying the determining drivers for implementing the system, openly communicating with all stakeholders and assigning 'ambassadors', to motivate and lead the change management. Notably, change management has been highlighted repeatedly as a critical factor. Any new technology that could likely cause a redundancy of human interaction could lead to a reluctance of the staff, when accepting the proposed idea.

4.4 Processes

The question is, how to shape interactions along the process steps between the IPA and the users – be it the patient, the FM personal, nurses or even visitors. It is envisioned by the experts that the IPA acts as an intermediary for certain non-medical support services. However, the design of the processes is crucial when it comes to successfully implementing the system. Likewise, the key prerequisites of the possible added value of an IPA-system also holds true, in terms of processes. The added value could be assessed with performance measurements. The mentioned performance indicators include waiting time, noticeable processes improvements, convenience and IPA availability. From the authors' perspective, certainly, other performance measurements should be acquired, in order to assess the overall system performance. This includes end-user satisfaction indicators. From the perspective of the FM experts, the concern is that at present, processes are not clearly defined. This is a requirement to successfully introduce IPA-systems into FM. If all the existing processes are running well, a step by step introduction of the IPA-system should be carried out. In addition to the task, a part of the skills and knowledge of the personnel will be taken over by the IPA-system. This step must be accompanied by a specialist.

4.5 Technology

From the identified and presented topics, technology was least described by the Delphi participants. Nevertheless, its importance cannot be neglected. Many of the insights here stem

from the interview experts. In principle, a technological key prerequisite, when introducing an IPA-system, is a clear and comprehensive overview of the state-of-the-art in IPA technology. Also, there are two main infrastructural premises necessary when integrating an IPA-system into the hospital infrastructure: I) The need of high speed Wi-Fi internet connection across the entire facility, which is II) properly secured. It is likely that critical user data will be handled by the network. In fact, data security and governance are a major prerequisite themselves. Another prerequisite identified, concerns the systems' flexibility. It would mean aligning the functionalities according to external circumstances and patient preferences.

5 CONCLUSION AND IMPLICATIONS

Besides the technical requirements, subject matters regarding organisation, culture and management, play a decisive role, and these considerations concern particularly FM. Overall, hospital culture could be a critical element preventing the proliferation of innovation and therefore also IPA-systems. Healthcare is deeply rooted in a humanistic viewpoint and any new technology that could challenge these set of values, could cause resistance. Understanding the attitudes of the patients, hospital personnel and management towards IPAs, and carefully approaching the dissemination, seems to be a key element. On a strategic level, the alignment of the system with the hospital strategy is important. The authors argue that more efforts in this regard are necessary and a digitalisation strategy would be advisable. FM could play a crucial role when it comes to redefining processes, interfaces and interoperability of the non-medical support services and the digital services provided by the IPA, in order to create an intelligent hospital service ecosystem. For this reason, FM could interact as a facilitator between the different stakeholders in the hospital organisation and, in addition, offer the developers clear specifications of the prerequisites of the system.

With this paper, the authors have summarized four crucial prerequisites beyond the pure technological debate. Hospitals in Switzerland, but also in other countries, will be faced, unequivocally with the digital transformation that is shaping the interactions between stakeholders, as well as the non-medical service provision. They have taken into consideration the drivers for this change – beyond efficiency reasons. They have acknowledged that there are IPA-systems in use; so far, however, there is a lack of use-cases in the hospital context. With respect to IPA-system advancements, various non-medical areas for further research are identified: patient and visitor registration, indoor navigation, translation services or room automation control. However, this asks for an ongoing research for clear ethical concerns, thereby dealing with accessibility, usability, control, privacy and trust. Within the healthcare context, the staff (including FM staff) and patient interaction consequently requires legal and ethical considerations.

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Sustainable and energy efficient real estate education: A survey and needs analysis

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ABSTRACT

Purpose: The purpose of this paper is to investigate the trends and developments regarding sustainability and energy efficiency among professionals working and students studying in the real estate sector in five European countries. The educational viability is approached by determining learning needs originating from these trends and developments.

Methodology: The key data were obtained by survey questionnaire which was translated to five different languages. The surveys were directed to real estate professionals working in a position of power or authority to make decisions concerning sustainability and low-energy residential buildings. Because we were also interested in training needs for the future, it was reasonable to invite also participants studying in the real estate sector. Altogether 378 questionnaires were completed and returned.

Findings: Findings indicate that new energy efficiency technology and digitalisation were regarded most important and impactful when considering the trends and developments regarding sustainability and energy efficiency. The biggest divergence between five countries arose when considering the role of policy makers. In Finland and in the Netherlands, their role was regarded as crucial whereas in Estonia, German and Slovakia, respondents seem to feel that legislation is one of the key tool among many other actors for making changes for energy efficient real estate.

Impact: This paper provides insights into education decisions and contributes to the understanding of the training needs in vocational and professional real estate education. The findings indicate that training requirements depend on the cultural and political circumstances and the curriculum development should therefore be adjusted to the local needs and conditions, thus pointing out the need for a comprehensive training approach.

Paper type: Research Paper

Keywords Energy Efficiency, Real Estate, Facilities Management, Vocational Further Education, Professional Education

1 BACKGROUND

The broader real estate sector is going through an immense period of change, sometimes labelled the “energy revolution”. It is currently experiencing various impactful and possibly disruptive developments. This includes many aspects, ranging from increasing demand for sustainability, the availability of new sources of renewable energy and developments in construction and facility management.

Buildings and construction projects consume 40% of all energy (European Commission, 2017; Thomas, 2017), upon which it is no wonder that more attention will be paid to them. The energy efficiency of a building is determined in its design and construction phases but the property manager plays an important role in keeping the energy consumption of the property during the life-cycle (Khazaii, 2014; Aaltonen et al., 2013). Further, through their advice to customers and actions in the built environment, property professions have a responsibility in the environmental impacts of the built environment (Wilkinson, 2016). As maintenance and upkeep of buildings do matter, this inevitably means that qualification demands for real estate professionals will increase.

Although the necessity of managing energy efficient and sustainable buildings and properties have increased, the skills of how to apply that awareness in their actual work has not yet changed to the entire group of professionals. Existing buildings are trapped in time, but at the same time the new building codes and standards are implemented. Buildings are also subject to changing community and business standards and advances in technology. Further, behavioral attitudes of users, their level of education, occupancy and other social influences affect the overall energy consumptions of a building and although some buildings may be deemed to require energy retrofit, they may consume less energy in their operation than others due to their occupants (Bardhan & Kroll 2011; Ahonen et al. 2014).

Increasing the rate and effectiveness of building renovation and retrofitting will further add the great challenge for the coming decades (Kerr et al., 2017). According to Thomas (2012) for renovation and operation of existing buildings, the goal is two-fold: pave the way for higher energy savings in each retrofit and in operation, and for increased rates of energy efficient retrofit. To achieve these goals, a well-combined set of policies reflecting the national circumstances are needed to correct market distortions and improve requirements to access the information about available technologies and solutions for energy efficiency.

To realise energy efficiency in real estate requires that all members of the complex value chain act in favour of energy efficient choices and work together for an optimal outcome (Thomas, 2012). The importance of continually improving knowledge and practice cannot be emphasized too much. From property and facility professionals' point of view this calls for anticipating the future learning needs to further ensure curriculum relevance in vocational education and training (see Hiim, 2017). In line with that we need to know more about the kind of new competence and training needs are emerging in real estate education, e.g., due to the introduction of renewable energy and energy efficiency technologies, digitalization and smart operating systems.

Although the demand on inclusion of training on intelligent energy efficiency and sustainability in real estate is common in many European countries, there is little comparative research available on that topic. How should national and European vocational and professional education and qualifications be developed to cope with these challenges? For this purpose, a transnational questionnaire was set up to identify the main trends and needs amongst five European countries regarding the energy challenges in the real estate sector. It aims to determine training needs originating from new energy solutions, national regulatory requirements, possible performance problems and to identify the training needs that make it possible to anticipate on future skills needed in the real estate sector.

2 METHODOLOGY

Questionnaire development

A survey goal was to know more about current and future focus regarding energy efficiency and sustainability in the real estate sector. A cross-national questionnaire was first developed in English with an eye toward comparability across five languages and cultures. For example, question wording and answer alternatives as well as when to ask open- vs. close-ended questions were carefully considered within a group of professionals. The development team consisted of 2-3 professionals from each country representing altogether 4 pedagogical experts and 7 energy experts in sustainable development working in educational organisations. The discussion between development team members were organized mainly by Skype meetings but e-mails was also used to collect further suggestions and comments. After the general agreement the English version survey questionnaire was then translated to Finnish, Dutch, German, Estonia and Slovakia.

The questionnaire consisted of 23 questions of which three were open ended, the rest questions being closed ended, typically the kind of asking the participants to choose from several alternatives the three most important factors. Altogether 8 questions asked about current and future focus regarding energy efficiency and sustainability in the real estate sector, and 8 were related to the trends, needs and challenges which will be most important to deal with through training and education. The last 6 questions were demographic questions including age, gender, education level, employment status and work experience. The questionnaire ended with question inquiring the participants whether they would be interested and willing to be involved in follow-up analysis on the topics of this survey.

Multiple-choice questions were used be more specific, and thus more likely to communicate similar meanings. Furthermore, to better anticipate on the future needs, we used open ended questions with which we seek to explore the qualitative, in-depth aspects of training needs on particular topics and issues, and with which we give participants the chance to respond and share their thoughts in more detail.

Data collection

Participants were selected according to the criteria of "purposive" or "convenience" sampling. This means that the main target group was defined to be real estate professionals working in a position of power or authority to make decisions concerning sustainability. Closely related to the purpose of determining training needs for the future, it was reasonable to include also educators, apprentices and students who are about to finish their studies in the real estate sector.

Data were gathered both by distributing invitations by name via email and by sending an open link to different companies with instructions for accessing the survey and reasons why it is important to complete it. Invitations were sent to real estate professionals who work at big as well as smaller companies in the real estate sector, and to those who had completed different training programmes during the past three years. The programmes include examples such as: Training for senior construction project manager certificate, Programme for real estate administration and project management, and Advanced training for technical property managers.

Respondents

Altogether 378 answers were received from five countries: 120 replies came from Estonia, 92 from Finland, 88 from Slovakia, 48 from German and 30 from the Netherlands. Among the target group samples for whom email invitations were sent, the answer rates varied from 9% to 35% but the total response rate could not be calculated because some countries gathered the data merely through the open link. It is worth noting that the topic of the questionnaire, however, raised a wider interest than the received 378 answers because the number of those who opened the questionnaire or started to answer it without completing all the questions was 1158.

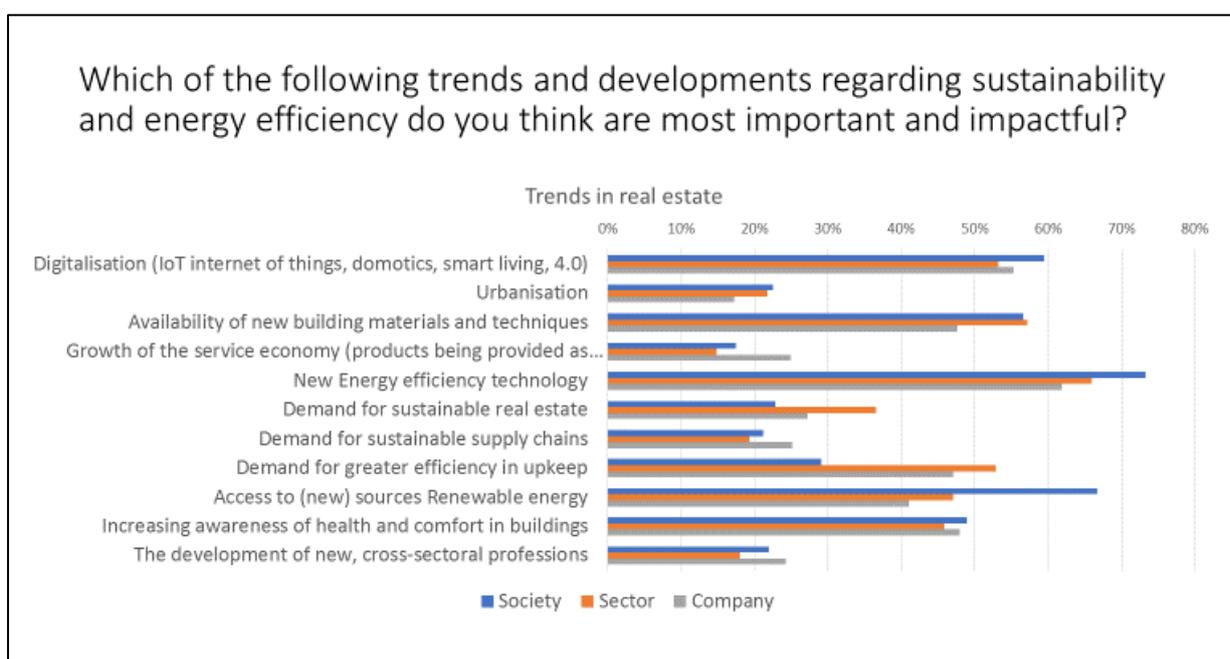
In general, there was a reasonable balance in responses from property managers (28%), facility managers (24%), property owners (23%), architect and engineers (11%), educators (10%) and others working or studying in the real estate sector (4%). Half of the respondents (54%) have over 10 years of work experience in the real estate sector whereas 14% have worked less than one year in the field. From all of those who answered the question of what is your gender, 66% were male. German respondents were the only ones whose majority was female (70%).

3 RESULTS AND ANALYSES

The results revealed that amongst the trends and developments regarding sustainability and energy efficiency, new energy efficiency technology was rated most important and impactful. The result was received when asking the respondents to choose the three most important topics from the list of several alternatives.

The second most impactful trend on society was considered access to (new) sources of renewable energy, while for real estate sector most beneficial was availability of new building materials and techniques. Digitalisation, including 4.0, Internet of things, domotics and smart living, was rated as third most important development at all levels.

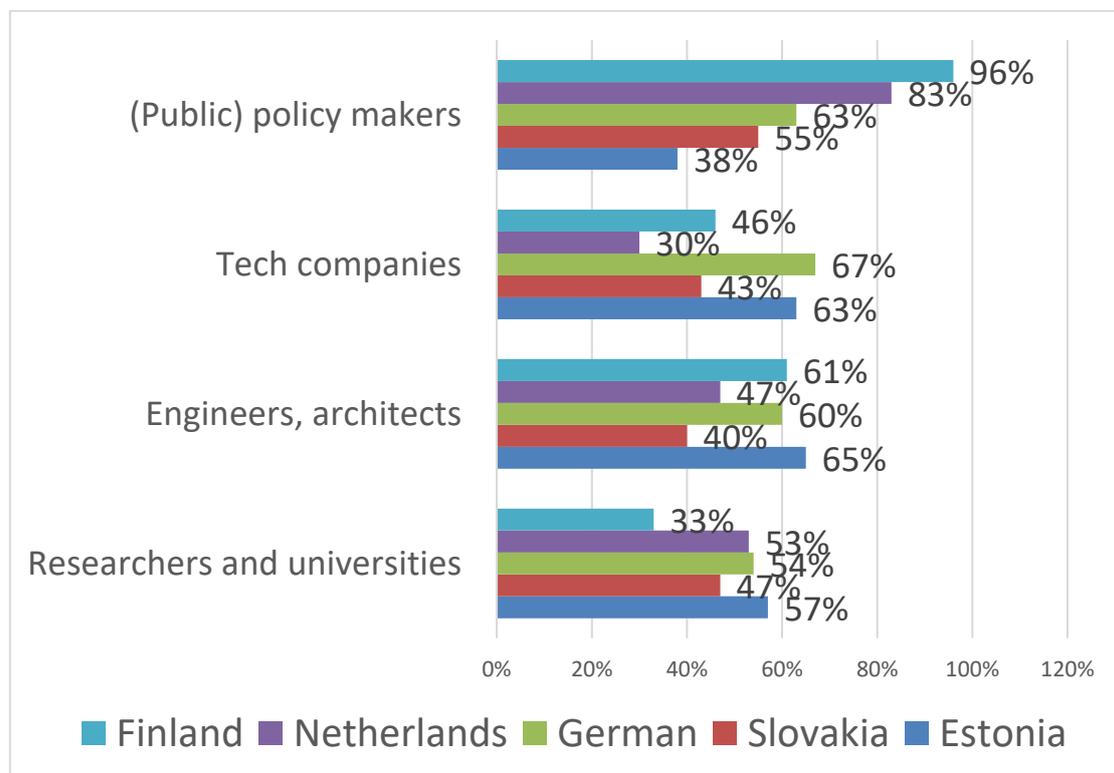
Figure 1. Trends in real estate



The result concerning new energy efficiency technology was parallel to considering the various levels. That is, 74% of respondents found new energy efficiency technology most relevant on society in general, 66% for the real estate sector and 62% for their own company. The biggest difference between the various levels was found when considering access to new sources of renewable energy. Two third of all respondents (67%) regarded the impact of renewable energy sources as important on society in general but less than half of respondents thought in the same way when considering both the real estate sector (48%) and the company they are working for (41%). This type of pattern was found more commonly as most developments were somewhat more important on society in general than for their company. Yet, demand for greater efficiency in upkeep was considered more often important in the real estate sector as well as at the company level than on society in general.

No considerable differences or patterns were found between the five countries except for one aspect. This concerned the opinion about the actors that have the most active effect on sustainability and energy efficiency. The biggest divergence arose when considering the role of policy makers. Practically all Finnish respondents (96%) regarded their role as crucial in sustainability and energy efficiency in real estate. The responses of Dutch (83%) were also very positive whereas far less than half of the Estonian respondents (38%) considered that policy makers play a big role.

Figure 2: Actors that have the biggest active (“shaping”) effect on sustainability and energy efficiency in real estate



In Estonia, the expertise in general was valued more than policy makers. That is, engineers and architects, as well as tech companies, universities and researchers were regarded as actors that

have the biggest active effect on sustainability and energy efficiency in real estate. In German and Slovakia, all the actors were considered almost equally important.

Figure 3: The areas of participants' interest to increase or improve their professional training.

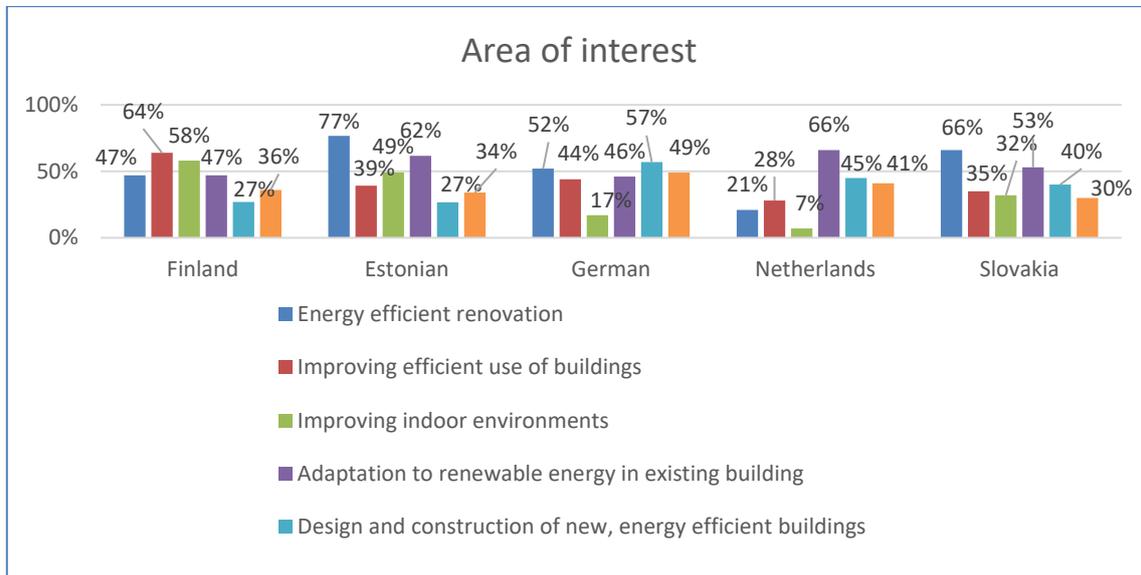


Figure 3 shows respondents' views about the areas of their interest to increase their professional training related to sustainable and energy efficient real estate. The results show that the different countries have different interests. In Finland, the major areas of interests were related to improving efficient use of buildings and indoor environments. These topics were unique to Finnish real estate professionals and they were not emphasized elsewhere, regardless of the need for knowing more about indoor quality in Estonia and somewhat in Slovakia

In Estonia and Slovakia, the future training needs were mostly related to energy efficient renovation and adaptation to renewable energy in existing buildings. Renewable energy was considered as being the most important training need in the Netherlands, and it was rated reasonable high in Finland and Germany too. Germany was the only country where respondents' major areas of interests were design and construction of new energy efficient buildings.

Respondents answers to the open-ended questions were consistent to the above mentioned findings and further show that there is still a lot to do in all countries in order to achieve apparent results in energy efficiency. This was expressed with answers like: "The situation is unclear and disoriented" and "It is in its infancy". The comments also revealed that to a large extent energy efficiency and sustainability are still unattended in vocational and professional education. It was mentioned that "there is barely no reaction to changing requirements regarding energy efficiency and sustainability in real estate sector."

4. CONCLUSIONS

This transnational survey collates the initial sentiment from over 350 real estate professionals on the outlook for energy efficiency and sustainability in the real estate sector. It was found that new energy efficiency technology was rated most important and impactful amongst all countries considered here. Although other trends and developments, such as digitalisation, new

building materials and techniques, and access to renewable energy sources were considered significant too, they were not seen as relevant as the new energy efficiency technology. The consistent results at all levels; on society in general, the real estate sector, and in one's own company, support the previous findings showing a positive association between adoption of the newest technologies and environmental performance measurement systems as well as to product and process innovation (Gerstlberger et. al. 2016). Yet, as Gerarden et al. (2017) concluded energy-efficient technologies appear not always to be used by consumers and business to the degree that would be justified for reasons that vary between different countries.

The biggest divergence arose here when considering the role of policy makers. Considerable more Finnish as well as Dutch respondents regarded policy makers role crucial whereas expertise of engineers, architects, tech companies or universities was seen to have less impact on energy efficient real estate. This does not, however, need to mean that the influence of experts would have been respected in these countries too. It is likely that respondents, especially in Finland but also in the Netherlands, consider that the expertise of all of the above mentioned parties have already been used in the preparation of real estate and property laws and regulations. Another explanation might derive from the notion that Finnish businesses are unusually law abiding (eg., Miller 2016), and for the general public in Finland, law is "strongly binding and unconditional or obligatory" (Nieminen, 2006).

What comes to sustainable and energy efficient building environment, the purpose of the law is to guarantee the minimum level of safety, health and energy efficiency in buildings throughout their life cycle. According to Kerr, Gouldon and Barret (2017) ultimately policy contexts are thoroughly unique, and recognitions of benefits is dependent on the political and cultural contexts. As the current findings showed, Estonian, German and Slovakian respondents seem to feel that legislation is only one of the key tool among other actors for making changes. Expertise, no doubt, plays an important role, as does economic rationale.

In their interesting analysis of rationale for energy efficient retrofit policy, Kerr and his colleagues (2017) found that the German example, which has the most consistently economic rationale, also had the most celebrated retrofit policy package. It included high levels of national funding, significant non-financial policy intervention and higher levels of leveraged private investment from a predominantly loan-based system. They concluded that a policy framed as offering some return on investment and funding, most presumably is more attractive to a wider range of policy makers and property professionals. The relationships between the role of policy maker, real estate and property policy mechanisms as well as benefit perceptions are not considered here but is something that could help shed light on determining future learning needs. For example, could a stronger policy obligation for energy savings in combination with a change in economic policies be the key to improve the energy efficiency performance of buildings?

Many studies have showed that the technologies and the design know-how to energy-efficient buildings are already available in many countries but what is still lacking is their wider dissemination (Thomas, 2013). According to the current results, a clear need to develop a better understanding of the various areas of sustainable and energy efficient real estate was found. Training qualifications of real estate and property professionals should keep pace with the technical complexity of buildings, and especially to energy efficient renovation and adaptation to renewable energy in existing buildings. This applies to all countries with varying topics. The topics that were highlighted in different countries evidently depend on cultural and political contexts and thus we cannot draw strong conclusions from our findings. The analysis presented in this paper should, otherwise too, be considered alongside some caveats. While descriptive

results have been received, several energy efficient policy evaluation studies and interviews with experts are needed to meet the challenges of energy efficient real estate education.

With the trends and developments regarding sustainability and energy efficiency among professionals, and the areas of participants' interest to increase or improve their professional training, this analysis seeks to draw attention to the related issues of the future learning needs. The findings thus provide insights into education decisions. This is especially the case when developing the curriculum for new degrees in sustainable and energy efficient real estate education, and the analysis here should have relevance to vocational and professional education organisations.

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Improving the implementation of sustainable facilities management: the role of end-users in realising energy efficient solutions

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ABSTRACT

Purpose: The focus on sustainability and circular economy is becoming increasingly important for the Facilities Management (FM) sector. In order to adapt to the recent national and EU-regulations and policies, the sector needs to adapt its practices and processes. Research has demonstrated that FM can play a central role in implementing sustainable solutions, but it appears that practitioners don't have sufficient access to knowledge and tools to develop their practice efficiently. It is not so much the implementation of technical solutions which are challenging the practices of sustainable FM, but rather the process of ensuring the adequate use of the buildings. In particular, methods to secure that the occupants of the various facilities act accordingly to the new buildings' prescriptions, indispensable to the success of these initiatives, seem to be missing.

Methodology: Building on a three years research project aiming at strengthening FM competences in the Nordic countries, our study identifies and documents the bottlenecks of sustainable FM implementation related to the participation of end-users as well as the type of tools or solutions that can help to obtain the expected benefits.

Findings: The paper presents the results of two complementary activities: A workshop with more than 40 practitioners and the realization of four in-depth case studies. Whereas the workshop has allowed us to map the different issues related to sustainable FM, the case studies enable a deeper understanding of these challenges. The cases, two renovation projects and two solutions for sustainable operation and maintenance, face similar problems when it comes to realise the energy potential of the implemented technical solutions. As apartment renters or offices workers, end-users tend to ignore the needed adequate compartments and jeopardise the measures taken by the FM practitioners.

Impact: The results of the project are beneficial for the FM sector and the education institutions as they summarise the principal challenges related to the implementation of sustainable FM and as they indicate solutions to successfully reach the sustainable targets.

Paper type: Research Paper

Keywords: Facilities Management, sustainability, challenges, users, energy

1 INTRODUCTION

It is now widely accepted that Facilities Management (FM) can contribute to reaching sustainability goals: there is potential to reduce energy and material consumption both during renovation and operation phases; the transformation of buildings can improve users' health and well-being, and FM can influence social surroundings and contribute to social coherence at the local level, (Elmualim et al. 2010). However, whereas there is a broad agreement on the need to implement sustainable solutions, the concept of sustainability, upon which theory policy and practice are developed is far from being well defined and often misses a shared understanding of its dimensions and applications (Sarpin et al. 2016) Moreover, the concept encompasses internal tensions and contradictions creating debate and uncertainty in its realisation (Buser and Koch 2014). Therefore, it can be difficult for FM practitioners to orient themselves in the complexity of sustainability and to make adequate decisions. In particular, the combination of environmental, economic and social ambitions requires multidisciplinary competences. Whereas professional guide lines, standards and regulations offer support to the practitioners, they are not always sufficient to define and implement concrete solutions to the local sustainability challenges (Sarpin et al. 2016). Besides, focusing on theoretical calculation of energy and other measurable features, they fail to address the questions related to the daily use of the facilities and the integrations of the users (Sezer, 2016, Gram Hansen et al. 2017). Researchers have underlined the need to include all the stakeholders and in particular the users already from the early planning and design phases to ensure the efficiency of the renovation (Kaatz 2004, Menassa and Bear 2014, Støre-Valen et al. 2016). Meehan and Bryde (2015) have emphasized a need for integrated and collaborative strategies adapted specially to the practitioners' context and stakeholders' needs rather than generic solutions. However, FM practitioners are not always equipped to handle user integration and may find it difficult to achieve (Støre-Valen and Buser 2017). Moreover, the participation of users in the early phase needed to achieve efficient solutions is not a guaranty for successful building operation on a longer sight. The measures taken to ensure the adequate use of the buildings once it is renovated may be challenged by the users anyway (Gram Hansen et al. 2018).

Building on a three years research project aiming at strengthening FM competences in the Nordic countries, the paper identifies and documents the bottlenecks of sustainable FM implementation related to the participation of users from design to operation. Here we use "users" to refer to both tenants and office workers, as the adaptation to the sustainable facilities by these two groups seems, according to our study, to share similar features in terms of attitude and practices.

2 METHOD

The present paper draws on a Nordic Built project aiming at strengthening Sustainable FM by developing new educational material for professional and university curricula in Scandinavia (Buser et al. 2017). The team includes two professional schools in Denmark: KEA and VIA;

and two universities: Chalmers University of Technology, Sweden and the Norwegian University of Science and Technology (NTNU), Norway under the management of the Danish Association of Building Experts, Managers and Surveyors (KF).

The framework of understanding is interpretive sociological approach and we use mix methods to gather data. The paper draws on different activities carried the three last years:

A one-day workshop with more than 40 Danish practitioners and Scandinavian academics during which the challenges of sustainable FM were discussed. The participants were distributed during in smaller work groups addressing five different topics, users being one. An observer was present in each group taking notes and some of the sessions were also recorded, besides each group had to fill up a matrix organising the identified issues. The workshop has enabled us to list the main challenges linked to Sustainable FM and identify the users as one of the bottlenecks of sustainable operations when implementing energy saving solutions. So, this paper discusses only the social aspects of solutions targeting environment sustainability and not social sustainability as such.

Four cases studies were conducted: two in Denmark, one in Norway and Sweden. The case studies enable a deeper understanding of the users' challenges identified during the workshop and serve as material for the education development. The cases studies, two renovation projects and two solutions for sustainable operation and maintenance have been chosen for their integration of users' concerns. Two of them have achieved a milieu certification. The cases are the following:

1. **University**, a Swedish project aiming at engaging the users of a retrofitted university building to act and use the building according to the new specification, besides the case study, the author was part of the user participation programme organised by the architects before the renovation.
2. **Social housing**, a Danish project of a social housing retrofit focusing on inner climate and on engaging the residents to act accordingly to new standards, the case was part of an action research project carried by Via Horsens
3. **Eco Housing**, the second Danish case a new built eco housing area which goal is to motivate the residents to take responsibility, to operate and maintain the buildings and their surroundings. The case was part of a PhD. thesis carried at KEA and Copenhagen architecture school.
4. **Hotel**, a 1.2 billion NOK renovation project in Norway, dealing with the luxury renovation of an hotel with certain protection status as it is built in 1870;

The cases material includes site visits, interviews with the different stakeholders and the project owners, in three cases observation of meetings between FM providers and the users, questionnaire to the users in two cases and the compilation of the projects' internal documents and blue prints. The use of multiple sources such as interviews, field observations, visits, and document analyses enabled triangulation and increase the trustworthiness of the results (Bryman and Bell, 2015).

3 FINDINGS

The table below is indicative and presents a summary of the fourth case studies' context, goals, and contents. As already mentioned, the workshop has enabled us to identify among the main challenges, the difficulty for both owners and FM providers to obtain during the operation phase the theoretically estimated results. The four cases had in common the integration of the

users at an early phase of the project and the ambition to gain the users' commitment for the operation phase, however in very different contexts. We present here their process and results.

Table 1. Short description of the four case studies

Case	1 University, Sweden	2 Social housing Denmark	3 Eco housing, Denmark	4 Hotel, Norway
Building category	Education and office building	Housing, cooperative apartments	Residential housing	Hotel
Owner	The university	Public housing company	Public housing company	Large property company
Management, operation and maintenance	The university property management	Public housing company	Residents' responsibility	Large property company
Context	Retrofit of a university building, the creation of small open offices and new meeting area	Designing retrofit for social housing targeting inner climate issues	New built of sustainable housing, users' participation in operation and maintenance	Large ambitious renovation of a hotel originally built in 1870
Goal	How to engage users (students and employees) to behave according to the sustainable goals integrated in the building	To solve inner climate issues and engage the residents to act accordingly to new standards	To motivate the residents' association to take responsibility, operate and maintain the buildings and surrounding	How to integrate sustainable solutions including the hotel's guests
Client	Facilities management company	Public housing company	Public housing company	Contractors
Challenges	To create an attractive environment that inspires and supports the interaction between researchers, students and companies.	To engage and motivate residents to take an active role	To motivate the residents to do self-management and operation of housing and common areas	To create a luxury hotel which builds on sustainable principles and engage clients to behave accordingly

3.1 University

The planning phase of the university building renovation took over 10 years, as the scope and the financing of the project were hard to balance. The building needed façade renovation as well as a new assignment of room as two departments were merged together. The final solution included open space offices distributed along the outside side of the building; the inner space looking down at a large atrium yard was dedicated to computer and meetings room as the light measurement of these spaces did not live up to the milieu standard expectation. A new heating and ventilation system was installed and the building earned a silver green certification. A long participation process including both employees and students of the university took place to adjust the new configuration to the users' needs. However, most of the proposition suggested by the users were rejected by the architects or the FM company as they were either too expensive or not fitting with the new concept. The situation created a gap between the employees favourable to the new design and the ones opposing it. The building has been operational for several months. The divide between the people in favour or against their new offices is very visible as the latter avoid in principle to be at work unless forced to do so. So, most of the office appears half empty even though the number of employees and students for the matter exceeds the one for which the renovation was conceived. The internal temperature is electronically controlled by a central system to a general temperature of 21 °C, but the particular situation of each office or meeting room is challenging this average. After numerous

calls to the building service, some of the employees unplugged the sensor controlling the room temperature, challenging the whole system! It is worth noticing that most of the researchers employed in this department work with sustainability and are therefore well informed about the efforts that sustainable challenges require. Besides, the distribution of activities in specific spaces is challenged as well: small silence offices dedicated to temporary work have been appropriated by employees unsatisfied by their desk in open office. So, the initial goal to create an environment favouring interaction is not yet realised.

3.2 Social housing

The social housing project concerns a large group of three-storey residential buildings in yellow brick, built in the period 1960-1968. The properties appeared generally well maintained. Kitchens were replaced in 1992. Bathrooms were partially renovated. And recently, a new mechanical extraction has been established from kitchens. The renovation was meant to improve the results of an already complete building renovations which took place in the period 2011-2014 and had focused on improving indoor climate and minimizing heat loss.

However, residents were generally dissatisfied with the work carried out, and claimed that their apartments were better before renovations. They identified difficulties to heat the place uniformly, draft between the rooms; condensation and cold fall on the windows. Measurement showed that a third of the apartments had an average temperature just above 20° C and that the amount of CO₂ was too high in the majority of them. Though the humidity measurement did not reveal problems, tenants' behaviours jeopardised the inner climate balance by misusing the premises for example when drying clothes on the radiators. Besides, the janitors noticed inappropriate and wrong ventilating occurring in large parts of the year. The concrete goal of the building renovation was to achieve concrete and measurable indoor climate improvements of at least 50 percent of residents after implementation: Humidity should be improved with min. 10%; CO₂ content must be improved with min. 10% and heat consumption must be reduced by 10%. To achieve this, they planned to carry a renovation of fall trunks and pipes, installation of extractor in kitchen and bathroom, installation of heat source (radiator) in kitchen but also a reduction of the energy consumption. Besides, saving energy and reducing the emission of CO₂ the housing company housing aimed as well at improving the health, wellbeing and happiness of residents by improving, among other things, indoor climate. However, it was considered not enough to insulate the buildings or to control the ventilation mechanically. The tenants should be helped to understand the new functioning of their apartments and learn how to use the new control tools.

The housing company opted for value-creating solution empowering the inhabitants. They started with a detailed questionnaire listing the habits and routines of the occupants to identify among people behaviours what needed to be changed or improved. They invested in a control tool enabling the tenants to manage and control indoor climate and heat consumption based on their own wishes and values. Through measurements of temperature, humidity and CO₂ content, for example, it is now possible to get a feedback for each apartment. The company aimed at including standardization in the process to increasing the individual's understanding of why it is important to focus on indoor climate and energy consumption.

3.3 Eco housing

The target group of this Eco housing new area was families who could and would make an extra effort and were prepared to adjust their homes themselves. The project builds on architect-designed houses but mass-produced, and therefore cheaper than traditional construction. Part

of the cheap price was a thorough joint planning, prefabricated modular construction and assembly line technology. The newly built homes were proposed to new residents for a rent of approximately DKK 8,000 per month for a family apartment of 130 m². The properties were listed as low-energy homes according to energy class 2020 with the expectation that energy consumption would be kept to a minimum. The intention was that the residents should jointly care for cleaning and maintenance of the surroundings such as hedge raising, snow removal, outdoor cleaning and participation in residents' meetings. The condition to be considered eligible to the project was that the residents were committed to day-to-day operations and that all communication with the administrative division of the housing company was to be digital. However, the self-driven aspects of the project have created unexpected problems: Instead of managing the surrounding themselves, the users have outsourced some of their tasks and accordingly increase the cost of maintenance. The residents managing the technical installations were not acquainted with the equipment and misunderstood their functioning resulting in an increased consumption of energy. The digital user information network which was supposed to allow the operating phase to be coordinated was not being maintained and operated properly creating disruption in the maintenance organization. Besides, the transfer of the management of maintenance tasks to a digital network created a void in the collaboration between users as there was no physical meeting point where people could meet or deliver papers or tools. The distribution and completion of tasks and workloads the users were self-managing was unfortunately challenged by some underperforming residents. The housing board, composed of residents and responsible for the economy of the premises, became the local police officers in charge of controlling the contribution of all the members, roles they had not planned to incarnate.

3.4 Hotel

The former goal of the hotel renovation was to achieve luxury accommodation with state of art sustainable solutions while preserving the history of an iconic building. In order to achieve this the hotel should be shaped to simultaneously offer the outstanding facilities and services expected of a 5 stars hotel but respecting sustainable principles. Parts of the existing building stock are protected. This means that state conservator had to be involved in any decision and approve of the solutions. New building stock had to be integrated with existing building stock. The hotel been situated in a dense city centre area, the space was limited and existing building materials provided significant challenges related accessibility for the technical installations especially for ventilation channels.

The premises were divided into 3 main areas. Building 1 is so-called the new building, which is listed in accordance with Passive House Standard. Building 2 is the oldest part and is protected. Building 3 is the rehabilitation of newer building that is according to the Norwegian regulation renovated to have low energy standard. The owner instated for the perceived quality to be very high. The climate and temperature in the hotel were interpreted by the contractor as a significant part of the quality. For example, one should quickly change the temperature in hotel rooms according to the customer's wishes increasing need for quick monitoring and control tools to be able to regulate the temperature instantaneously.

It is a challenge that the owner has high ambitions and focus on proper and efficient energy use, despite the fact that the clients' perceived quality is to be prioritized and ahead. However, the perceived quality is a subjective notion which happened to be difficult to understand and translate into a generic solution for the contractor. The possible contribution of the clients to the optimisation of the sustainable solutions was discussed extensively. However, the project ended up with a focus on technical solutions to optimise the building in particular when the

clients would not be in their rooms. It seems impossible to associate clients' luxury feel with an energy responsible behaviour.

5 DISCUSSION AND CONCLUSION

The examples above show the difficulty to implement sustainability not so much in terms of energy saving and technical solutions, but by failing to engage the users to actually understand, accept and support an efficient use of the renovated facilities. The hotel gave up focusing on users' behaviours as the team could not foresee how to compromise between a luxury feels for the customers and having the latter engaging in a milieu friendly attitude. The University renovation project did not succeed to secure the involvement and contribution of the employees in supporting the new milieu friendly features, ending up with a result opposed to the announced goal. The building became a resistance tool for some of the employees against the school employment and organisation strategy. The Eco housing though selecting an environmental friendly audience for his project fail to maintain the inhabitants active to contribute to the common chores. It seems that whereas people have made a conscious effort to support milieu friendly initiatives, their commitment tend to relax regarding new proposals as they feel they have already contributed to a better climate (Gram Hansen, 2017). The Social housing has focused for their second renovation on the roles of users and proposed some tools to avoid the frustrating results of their first attempt. It seems difficult though even for their second trail to encourage the collaboration of residents who expect the service they paid for to be delivered without other contribution form their side. Their solution involved training and analytical nudging. However, it is not certain that this solution will still be effective once gone the novelty of the tools.

Sustainability concerns have created new demands regarding the collaboration between FM providers and their customers. Whereas in the past service delivery could be described as "one way" distribution, it appears that in order to attain the realization of sustainable goals, users need to be actively participating to the operation of the building.

6 ACKNOWLEDGMENTS

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The maturity of facility management in South East Europe

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ABSTRACT

Purpose: In Europe, facilities management (FM) is generally seen as a mature market. However, this is largely the case because of the high level of sophistication of the FM market in central and northern Europe. South East Europe (SEE) however, is less developed and lacks the maturity of many of its European neighbours. To date, little research has been undertaken to really establish why this is the case, and why there are disparities with other parts of Europe. This study aims to gain a qualitative understanding of the complexities of developing a mature FM market across SEE.

Methodology: The purpose of the research is to take an inductive, constructivist approach to gaining knowledge about the maturity of the FM market in SEE. This is because, to date, there is no data that has investigated the state of FM from a qualitative perspective. There is only currently general statistics available to investigate this issue. Data is collected through in-depth, semi-structured interviews. The findings will critically analyse the perceptions of each country located in SEE, regarding their key challenges and opportunities of the business environment; FM organizations; FM supply market; Professional bodies; FM education; and FM research. The interviews enable the critical evaluation of the maturity of the FM market in SEE.

Findings: The qualitative findings provide an alternative perspective to previous studies that look at the FM market in Europe. The findings show that the FM market is very competitive in this region, but at the same time, the market is still undeveloped in some of the countries. The most recognisable and mature FM business is in Bulgaria, in which the maturity of all measured segments were highest.

Impact: FM is a global discipline, recognised in every sector, in every organisation. At a global level, this is a very pertinent topic, as FM is increasingly being standardised and globalised through the generation of a new suite of ISO standards (ISO41000 series), the first of its kind for FM. However, across the globe, especially in Europe, there are varying degrees of maturity of the discipline.

Paper type: Research Paper

Keywords: Facilities Management, Strategy, Maturity, South East Europe

1 INTRODUCTION

The global FM industry is moving at a fast pace, with an estimated market worth of approximately \$1.3 trillion (Hodge *et al*, 2014). This economic growth has been progressed through greater integration and sophistication of outsourced services, increased international and professional standards, and wider educational recognition of FM as a career of choice. However, with such growth can also come discrepancy, as it is not easy to simply calibrate all companies, sectors, industries, regions, and countries to the same standards and growth.

This paper makes an intriguing insight into one particular European region: South East Europe (SEE). For the purposes of this paper, SEE is defined as a region in the south eastern part of the European continent, consisting of the following nine countries: Albania, Bosna & Herzegovina, Bulgaria, Croatia, Macedonia, Montenegro, Romania, Serbia, and Turkey.

The critical question that this research pursued was “what are the current challenges and opportunities for the future, that determine the level of maturity of the FM market in South East Europe?”. This was achieved through undertaking a qualitative study of the perceptions from a selection of informed participants in the SEE region. The paper presents some expanded literature on the background and context to FM in SEE, followed by explanation and justification of the research methodology used, and concluded by presenting the key findings and observations from the qualitative data collection.

2 BACKGROUND AND CONTEXT

FM is about the integration and alignment of non-core services, including those relating to premises, required to operate and maintain a business to fully support the core objectives of the organisation (Pitt and Tucker, 2008). This cuts across all companies, industries and regions, as any commercial entity requires (non-core) support mechanisms in order to generate income and profits. As such, the reporting of trends and growth of the FM sector has been a common activity for many years, and there are reports published regularly, usually annually, that forecast and predict the growth and prominence of FM on a global scale. For example, an ISS commissioned report by Hodge *et al* (2014) claim that the growth of the FM outsourcing sector is evident across all markets, from North America and Europe to Latin America and Asia Pacific.

More recent reports on global FM growth include Global FM (2016), which provides quantitative economic data on 33 selected countries, 10 of which are from Europe. Generally, it could be argued that such reports show that the level of outsourced integrated services is a good barometer for understanding the maturity and sophistication of an industry. It is important to emphasise that this observation does not imply that the decision to outsource services is necessarily preferable over in-house provision; it is simply an observation that the extent to which an industry is outsourced is often used as a general economic barometer to the level of maturity of that market.

Such reports are extremely prominent as the global FM industry becomes more standardised. This has culminated recently in the development of international standards in FM, which have taken a major step with the introduction of the first global standards in FM (International Standardization Organisation (ISO) 41011 and 41012) being published 2017.

Reporting on trends and growth of the European FM sector was quite prominent around eight years ago where important studies have emerged to try and map the size and scope of the European industry. For example, reports by Redlein and Poglich (2010) and Teichmann (2009) published quantitative data on European trends and developments in FM, focusing mainly on the size and scope of the industry and the level of outsourcing that exists. Such data was consolidated and reported in 2011 by EuroFM in a market data report which attempted to collect and share European market data. However, more recent studies have been less common which some recognition coming from particular sources, such as the research from Vienna University of Technology who have maintained updates on the size and scope of the European FM sector (Stopajnik and Redlein, 2017).

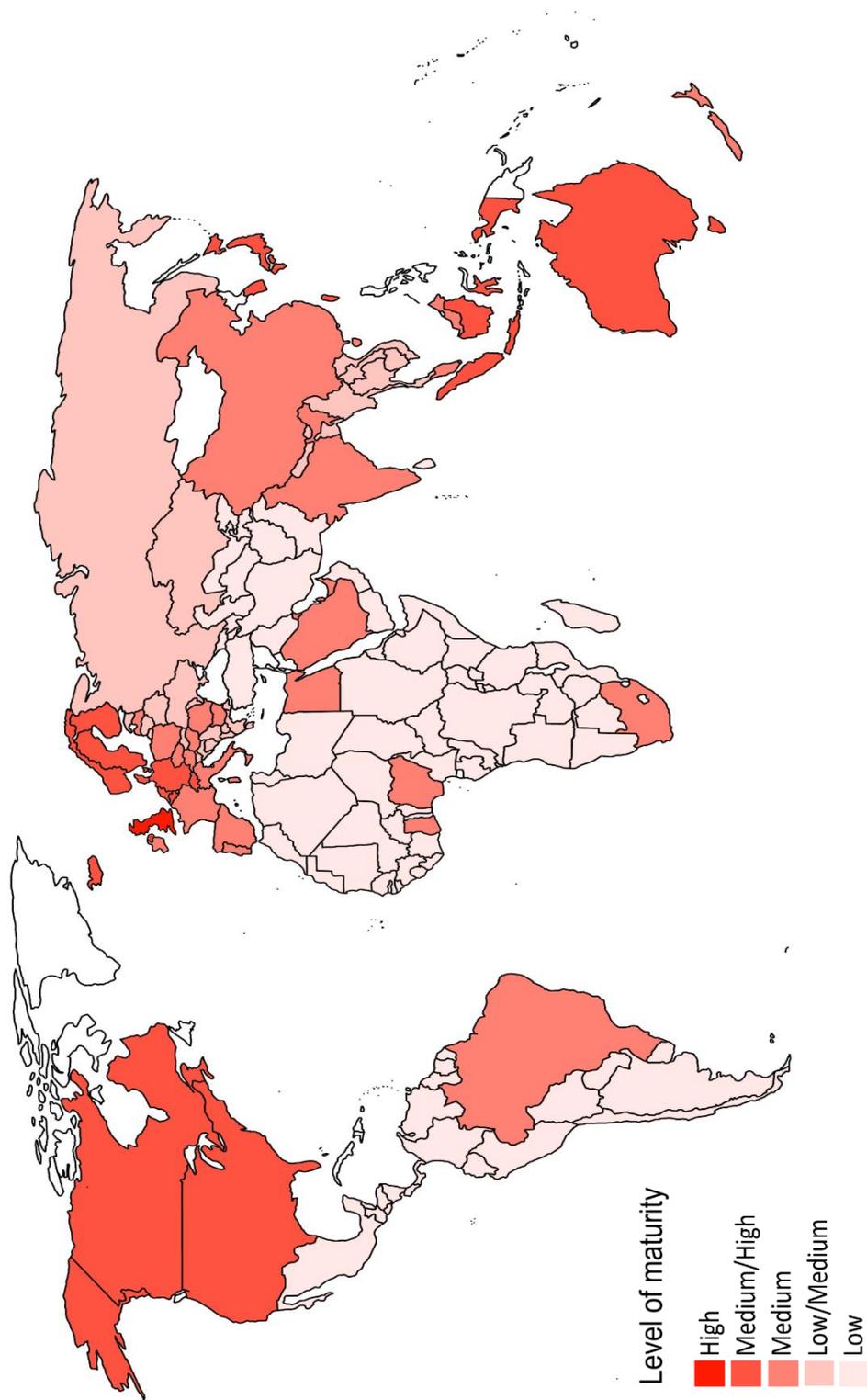
This study therefore makes a call that more research is needed that explore further dimensions and aspects of the European FM industry. Although previous reports offer interesting insight into the general economic status of FM, they are often difficult to qualitatively understand the reasons behind particular trends and patterns that exist. It could be argued that they allow us to generalise the general state of the FM industry, without fully appreciating the complexities that are really taking place within our global regions.

Tucker and Cannon (2017) attempted to critique some of these challenges by investigating the implications for the growth and standardisation of FM. Other studies, such as Tucker and Roper (2015) argued that there is disparity in educational pathways, practical application and the development of practice across continents and industry bodies. For example, a variety of FM associations and competency frameworks exist across the globe, which gives rise for potential disparity and a possible challenge to standardisation. Tucker and Roper (2015) undertook a qualitative assessment of competency frameworks produced by RICS, IFMA & BIFM. Although many of the competencies were similar in some aspects the weighting and frequency altered greatly at times.

Temeljotov and Ceric (2017) prepared a special edition of *Facilities* on the topic of 'FM Status in SEE', with the aim to highlight the situation in several countries in the region: Albania, Kosovo, Macedonia, Serbia, and Slovenia. They learned that some of the academics partly addresses the research topics from the field of FM, but in general, that FM as a field is recognized in Slovenia and Kosovo, that professional FM associations do not exist in SEE countries (except Slovenia), and that formal education programs are very rare.

The study by Tucker and Cannon (2017) presented a snapshot of the FM associations prevalent in Europe, and illustrated that are many diverse associations all attempting to provide good practice and standards to their FM communities. They emphasise that on a European scale, organisations like EuroFM play an important role in enabling FM associations to network and collaborate to ensure that standards can be communicated consistently. Tucker and Cannon (2017) subsequently mapped the majority of FM associations in Europe (figure 1), and it emphasises the challenges of standardising FM competences in a growing, yet diverse market.

Figure 2 Global FM maturity levels (Tucker and Cannon, 2017)



3 METHODOLOGY

From the above described research findings, 12 semi-structured in-depth interviews with key informants in member countries were collected, with a questionnaire based on the findings of Banyiani and Then (2016) and Shallah et al. (2017). Topics cover the key challenges and

opportunities of the business environment: FM business environment; FM organization progress; FM supply market; FM Professional bodies; FM education; and FM research. The definition of an informed participant in this instance is someone who would possess some or all of the following attributes, specific to their home country:

- Has expertise of the FM industry through education and/or research
- Has a senior practical industry role that relates to the FM industry
- Has a professional/governance role that relates to the FM industry

For each topic in the interview questionnaire, the main research goal, main question and assessment instruction were prepared. The goal for the Business environment topic was to understand how wealthy is the country for the FM business development, with the main research question: What are the driving factors for FM in the country? The interviewees here describe the current situation through a simple PEST evaluation (Political, Economic, Social, and Technological) and give an assessment of possible future prediction. In the Organisation progress section, the focus is on understanding how active FM business is in practice, on the macro level (country) and capabilities of benchmarking and performance (micro level). The main research questions were if FM business is present in the country and how active it is. In the Supply market topic, the interviews understood FM supply and demand activities in the country, so the description of the current situation with a possible future prediction is discussed. Within the Professional bodies section, information about FM supply and demand activities in the country were given. And from the FM education and FM research section the aim as to hear about the development of education and research in the country. Each of the topic was divided into subtopics, and a set of basic questions or key words are prepared as an interview guidance. This formed the basis to analyse the data thematically using this interview questionnaire structure.

The interviews were conducted via Skype to overcome geographical obstacles. It was planned that two informed participants will be interviewed from each of the nine countries in the SEE region, but so far interviews have been conducted with the following countries: Turkey, Bulgaria, Albania, Croatia, Serbia, and Macedonia (12 in total). So far, at least one informed participant from all the mentioned countries, except Romania have been conducted, but this paper reports on those with at least two participants from each county.

The qualitative methodology chosen for this study is to present an alternative viewpoint to previous quantitative studies on this subject matter. Nevertheless, it is important to identify the limitations with such an approach, mainly that the results are subjective in nature and based on the opinions on the informed participants. This should be taken into account when reviewing the findings.

4 KEY FINDINGS

The main results from the interviews with key findings are presented in tables from 1 to 6, followed by a critical discussion.

Table 1 - Business environment

Country	Political/ Economic/Social/ Technological motivations
Albania	Easy to start a business. FM is not recognized as a profession. No FM standards. Small economic growth, unemployment rate declining. Working environment: 40 hours per week, illegal labour force, working on Saturdays is usually required. Technological motivation is not so strong. Drone are used for promoting purposes.
Bulgaria	Easy to start a business. Shadow economy is present. FM is recognized. Implemented European FM standards. Economic growth, unemployment rate very low; migration out from the country. Working environment: 40 hours per week, form 9-5. It can be divided in 2 shifts 4 hours in the mornings (starting earlier) and 4 in the late afternoons. No flexibility. FM software are used – some international mostly national, custom made. BIM only for planning and design.
Croatia	Complicated to start business, due to the rigid regulation. FM is immature. Huge resistance to outsource. No FM standards Economic growth, unemployment rate declining, youth unemployment rate still high; migration out from the country. Working environment: 40 hours per week, normal to work more than 8 hours per day (not extra paid). Flexibility is not possible. FM software are used – some international mostly national, custom made.
Macedonia	Easy to start a business. FM is not recognized as a profession. No FM standards. Economic growth, unemployment rate declining, youth unemployment rate still very high; migration out from the country. Working environment: 40 hours per week, flexibility is only on the time of arrival and departure. Some FM software are used, not universal. BIM only for planning and design. Government initiates programs for increasing educational level and employment opportunities.
Serbia	Complicated to start business. FM is not enough recognized. Shadow economy is present. No FM standards. Economic growth, unemployment rate declining, youth unemployment rate still high; migration out from the country. Working environment: 40 hours per week, if necessary they work in 2 shifts (not later then 10pm). 24/7 for security workers. FM software are used – some international mostly national, custom made.
Turkey	Easy to start a business. FM is recognized. No FM standards. Economic growth, unemployment rate declining, youth unemployment rate still high; Syrian crisis affected the south part of the country. Working environment: 40 hours per week, if necessary they work in shifts (not later than 10pm). 24/7 for security workers. FM software are used – some international mostly national, custom made. Mobile apps are in use.

Table 2 - Organization progress

Country	Positioning of FM organisations in the country. What kind of services are offered. What kind of model is the most common. Performance measurements. FM competences.
Albania	Small ones. In big companies: different departments covering FM services, but not FM department. No international companies.
Bulgaria	App. 80 FM companies. Offering all kind of services. In-house management, single-contract service is popular. Integrated FM is also in use. Performance measurement: benchmarking and KPI. FM competences high.
Croatia	Different kind of FM companies: bigger, international, which use integrated FM to small single oriented providers (cleaning, security). All type of services. Performance measurement: post occupancy evaluation and KPI. FM competences undeveloped.
Macedonia	Different sectors covers different services. Big companies use in-house management. Few international companies. None of national companies offer total FM. All kind of services. Performance measurement: non info. FM competences: non info
Serbia	Many in-house FM in public sector, rarely outsourcing. Big FM professional companies- up to 7. Small FM companies, single or small scope service providers. Few international companies. In majority in-house management with service contracts; some managing agents; around 5 big companies offering everything (usually merged with international companies). The main model is a management

	staff and subcontractors. Some FM companies offer services for RE developers. No special performance indicators are required, only for some international companies (KPI). FM competences: no formal education so it is hard to measure. – in-house trainings, open for career development.
Turkey	10-20 big local FM companies, many small family business providers (cleaning, security). Around 10 international companies. Public sector uses in-house model. In residential buildings and shopping mall – integrated FM is used. Performance indicators: benchmarking, for international clients : balanced scores and KPI. FM competences: not known exactly.

Table 3 - Supply market

Country	How many and what kind of customers. Procurement options. FM market situation.
Albania	Some hospitals, hotels, residential buildings. Procurement still immature. No info about the FM market.
Bulgaria	Commercial buildings, industry, shopping malls, some condominiums. Started outsourcing in public buildings (cleaning, security). Procurement process average. SLA are in use. Not enough info.
Croatia	Commercial buildings, residential buildings. Large public sector - no outsourcing. Tourism is not using FM. Procurement process is very complicated and sometimes poor. SLA normal. Not enough info.
Macedonia	Not enough. FM is not recognized as a profession. Procurement average. SLA normal. Not many info.
Serbia	Not enough customers. Commercial, residential building, starting with industry. Public sector is rarely outsourcing. Complicated procurement and only cost orientation. SLA is ignored. Enough info.
Turkey	Not enough - big potential, but customers prefer to manage by themselves. Residential places, commercial buildings. A PPP city hospital project. Procurement average. SLA normal. Not enough info.

Table 4 - Professional bodies

Country	National / International associations. Members. Professional trainings.
Albania	No. Strong Chamber of Commerce - 'Economy and Industry'. Not many topics related to FM.
Bulgaria	Yes, BGFMA. EUROFM. 75 partners or individuals. Organizing courses, conferences, events – app 20 per year.
Croatia	No, under establishment IFMA Croatia. There is present 'Maintenance association', as a part of Croatia Engineering association.
Macedonia	No. Economic Chamber of Commerce.
Serbia	No, under establishment. Chamber of Commerce - 'Building managers for residential building'
Turkey	Yes, TRFMA, established in Dec. 2017. 15 founding partners.

Table 5 - Education

Country	Existence of education
Albania	No specific. It is partly taught on RE evaluation program.
Bulgaria	FM master program on 2 universities.
Croatia	No. FM subject will start in 2018/19, on Technical faculty (on maintenance program). Some FM topics are partly covered on University of applied Sciences (Business School)
Macedonia	No. Some topics related to FM are within different subjects on technical or business oriented faculties.
Serbia	No. Some topics related to FM are on faculty of Architecture and Faculty of Civil Engineering.

Turkey	Lessons or courses on University are organised, but not sufficient (Building and Residential Site Management lessons, Facility Management certificate courses)
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Table 6 - Research

Country	Existence of research centre. Do FM companies support the centre? Research orientation
Albania	No. Not really. Very rare publications from FM topics
Bulgaria	No special research centre for FM. Research in connection with FM programs. Very rare publications form FM topics.
Croatia	No. Rare publications from FM topics
Macedonia	No. Rare publications from FM topics
Serbia	No. Some publications related to FM from different faculties
Turkey	No special initiative for research.

From the PEST analysis, the political environment is stable in all countries and economic growth is remarkable. In some countries, like Albania, Macedonia and Turkey, it is easy to start new business. Unemployment rates are declining, but still appear high with the youth population (in Macedonia, Serbia, and Croatia), and creates migration between the young, educated population. In Turkey, they see the problems of immigration and fear among the investors to invest in business in regions, close to the Syrian border. The shadow economy has an impact on business in Albania and Serbia.

Regarding the recognition and maturity of FM, there are big differences among the countries. Facility management as a profession is regulated only in Bulgaria, but it is still not recognised in some countries, such as Albania or Macedonia. Even if the regulation in the countries is almost harmonised with EU directives, the FM European standards were implemented only in Bulgaria. Technology solutions are on very high level in all countries, so in FM companies it is usual to use custom-made software.

For interviewees they found it beneficial to implement certain facility management standards. The situation they experience now is a communication problem – there is not a common understanding of the level of services, so the expectations and realization are completely different. With standards, they can get clear overview of activities to satisfy both sides.

From the growth of the FM outsourcing sector, which as stated in the literature review is seen as a good barometer for understanding the maturity and sophistication of an industry, the public sector is unwilling to outsource services, and especially resistance from unions end employees in Croatia. A supply market exists more in the commercial sector, office buildings, some residential buildings (condominiums), partly in hospitals and as a new area in industry complexes (in Serbia and Bulgaria). In Turkey and Albania, there are cases that investment companies start FM businesses after the construction period. The most common outsourcing services are cleaning, security and technical services in Croatia and Serbia. Integrated facility management is find in Bulgaria, Turkey, Serbia and Croatia. Mostly, outsourced services are still not preferable over in-house provision. Only in Bulgaria it is normal to use SLA and performance indicators. In the other countries it depends more on client’s demand, what is recognized from the international companies and not from the local ones.

The interviewees see FM business as very new, which have an important potential to grow. A huge potential is seen in outsourcing FM services for the public buildings, but they hope for political changes. In Turkey they see a huge potential due to a highly motivated construction

sector and real estate development. In general they want to have a better procurement system and be more fit for FM services, with proper SLA's and quality control.

The competences in FM are not perceived as very high, except in Bulgaria. They are almost undeveloped in some countries, especially on the managerial level. The problems they see are not having enough knowledge, skills, responsibilities are not clear enough, facility manager's duties are not clear, competition is tough, fees are not high, salaries are low and employees are somehow squeezed to their limits young, so educated people try to find better working environment outside the country. There is no culture in flexibility regarding benefit for employees, they have to adapt to business needs. In bigger companies they organise some internal courses and take care for personal development. The lack of FM competences in some countries brings the discussion to the level of strengthening the facilities management to increase its quality.

The interviewees in Albania and Macedonia have not known if there are some professional international FM companies in their countries. In Serbia and Croatia they mentioned that some of them tried, but because of specific local markets, with a lack of transparent procurement procedures, rigid regulations, and in Serbia problems of a shadow economy, it was very hard to become competitive. In Bulgaria and Turkey they listed many international companies, some of them merged with local ones.

From a national association role in the countries, it should be mentioned that only in Bulgaria, the FM association is established for a longer period of time. In Turkey it was established late 2017, in Serbia and Croatia, there are imitative boards to establish, and in rest of the countries, there is nothing. The association in Bulgaria is very active and organizes training courses, conferences, events, working on standards, and are connected with companies, education and research institutions. In other countries, the experience with organized courses or conferences was very limited. Euro FM is present in Bulgaria.

The opportunity of establishing FM associations is seen to bring quality: to get standards; to get more professional knowledge and competences in FM; to improve management and management services; to provide solutions to problems related to FM; or, for Serbia to eliminate a 'black market'. In some perspective they miss a promotion of professional companies to do the proper business.

Formal education programs are very rare in the countries interviewed, only in Bulgaria has an FM masters program in two universities. In Turkey lessons or courses on University are organized, but it is not sufficient (Building and Residential Site Management lessons, Facility Management certificate courses). In Croatia, an FM subject will start in 2018/19 on Technical faculty. In Albania FM is mentioned in a real Estate Evaluation course.

5 CONCLUSION

In comparison with Teichmen's (2009) findings, it can be argued that the FM market is more developed, than in 2005. The FM market is very competitive and at the same time, the market is still undeveloped in some of the countries (e.g. FM is not commonly recognized in Albania and Macedonia). The most recognizable and mature FM business is in Bulgaria, in which the maturity of all measured segments were highest. In some countries the FM profession is even not recognized, with a lack of national and international FM associations or companies established or present (Albania, Macedonia). The outsourcing is much more intense from 2005,

for example new associations are established (Turkey) or are under establishment (Croatia, Serbia), more integrated FM companies appear (Turkey, Serbia, Croatia), and new education programs are arising. But, in some countries they struggle with unwillingness from the public side to outsource services, not enough defined services, not mature procurement processes and demands, lacking performance measurements, lack of standards, shadow market, cost orientation, low salaries, not understanding the FM competences, lacking knowledge etc. From the other side they see the growth in GDP, bigger real estate market, and more recognition on the local market. It is seen a great progress in some of the countries, and it is expected that FM business is beginning to realize the strategic importance of FM management. FM providers will increasingly adopt a greater role as strategic partners, investors and consultants since the demands of many organizations will further exceed their capacity to deliver in-house.

It is hoped that this study will assist in helping to grow the FM maturity across South East Europe, help establish FM associations and enable networking and collaboration to ensure that standards, knowledge and competences can be further developed.

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EuroFM exists to create a platform for opportunities for the facilities management (FM) community. Established for more than 30 years, EuroFM has over 80 members across more than 25 countries. EuroFM reaches around 60,000 professionals and 200,000 potential students, making it a truly integrated network of researchers, practitioners and educators.

The flagship event for EuroFM is the European Facilities Management Conference (EFMC) and the Research Symposium. This year, the EFMC conference organisation has taken a fresh approach by consolidating the EFMC with the EuroFM Research Symposium, creating one holistic platform for all FM researchers, practitioners and educators to share their work. This will mark the 26th Edition of the EFMC and the 17th Edition of the Research Symposium, all engaging together in one collective space, in the wonderful city of Sofia, Bulgaria.

A total of 15 papers were finally submitted and approved for publication in this year's proceedings. The papers embrace the theme for this year's conference which is titled "*Once upon a time in facilities management land*". The theme symbolises the impact that FM has on our daily lives, in which FM researchers, practitioners and educators will share their experiences on the impact of new technologies and other innovations in FM.

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