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FACILITIES MANAGEMENT RESEARCH AND PRACTICE

DOES FM CONTRIBUTE TO HAPPINESS IN NORDIC COUNTRIES?

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Technical University of Denmark

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PREFACE

Centre for Facilities Management – Realdania Research (CFM) in Denmark organized this conference about Facilities Management (FM) research and practice in the Nordic countries. The conference was arranged in collaboration with DFM – the Danish Facilities Management Association. The purpose was to create an exciting meeting place for people working with FM in the Nordic countries.

The conference presented and discussed recent research and best practices from CFM and our collaboration partners to and with interested professionals etc. We encourage dialogue between researchers and practitioners about the contribution of FM in the Nordics. CFM's arranged our first Nordic FM conference with success in August 2011. The ambition was also this time to create a meeting place, which the participants will remember for the intellectual challenge, its practical relevance and as a milestone in the development of an alliance around FM research and practice in the Nordic countries.

The conference included a combination of plenary sessions, parallel workshops and study tours at DTU Campus. Speakers were researchers and practitioners invited by the organizers. This publication includes the research papers presented at the conference. These papers were selected after invitation to our research partners in the Nordic countries through a double blind review of abstracts and full papers. The review was undertaken by the scientific committee listed on the next page.

All together 14 papers are grouped in 7 themes and they constitute the chapters in the publication. The first theme on "University Campuses of the Future" was also the theme of the opening keynote by professor Tore Haugen, NTNU. Chapter 1 includes a research paper related to the opening keynote. The other 6 themes correspond to the workshops organized as part of the conference. Each workshop included between 1 and 3 research based presentations and the related research papers are included in the respective chapters.

Besides this publication, all presentations from both researchers and practitioners at the conference can be found at the conference website at http://www.cfm.dtu.dk/english/CFM-SECOND-NORDIC-CONFERENCE-2016.

I thank all authors and the scientific and organizing committee for their great work. I wish the conference participants and readers of the papers in proceedings an enjoyable experience and a lot of inspirations for further research and the application into education and practice.

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Proceedings of CIB Facilities Management Conference 2014

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UNIVERSITY CAMPUS OF THE FUTURE

1.1

Campus Alive - Transformation and Integration of University Work and Campus Space

Tore Haugen and Tone Merethe Aasen

1.1 CAMPUS ALIVE - TRANSFORMATION AND INTEGRATION OF UNIVERSITY WORK AND CAMPUS SPACE

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ABSTRACT

Purpose: The purpose of this paper is to explore how strategic campus development can contribute to sustain and develop universities as attractive places for learning and knowledge development in a future of increased competition in higher education and research.

Background: Campus development is no longer about the construction of lecture halls, reading rooms and offices, but an important strategic tool to attract and keep excellent researchers, teachers and students. The paper reports from an ongoing campus development project, 'Vision 2060', at NTNU - Norwegian University of Science and Technology.

Approach: Our approach is that buildings are functional frameworks for human activity, and thus, that ideas about university space should be reconsidered as activities and demands on performance changes. The argument is driven by systematic trend analysis, scenario technique, and theoretical synthesis based on theory and research on Corporate Real Estate, learning environments, and innovation.

Results: Successfully meeting opportunities and challenges related to the development of campuses involve the need to understand the distinguishing characteristics and qualities of the university, and the premises these qualities establish for sustainable campus development. This understanding and knowledge is important for facilities managers, planners and designers managing university campuses.

Practical implications: The demand for space that supports the fundamental characteristics of experimentation, interdisciplinary work, education programs and collaboration with private and public organizations is urgent. Indoor and outdoor space are expected to support the ongoing activities for education and research, and they should encourage social life and recreation.

Keywords:

Campus development, University trends, Space management, Corporate Real Estate Management

1   INTRODUCTION

Changing ideas about education and the purpose of research are affecting universities worldwide (e.g. Annand 2007, Wissema 2009, Christensen & Eyring 2011, Waldrop 2013, Abbot 2014, Fishman 2014). More than ever, there is competition over students, staff and public funding (Ernst & Young 2012). This has resulted in a dialogue involving universities all over Europe about their place in society. The core of these discussions is to determine how to complete a successful transition from the more introvert academic traditions, towards more outward-oriented strategies based on a need to attract a heterogeneous group of students and academics (Christiaanse 2007, Torrance 2013).

In Europe, the increasing globalization of higher education together with the effect of the Bologna declaration, have led to the acknowledgement that opportunities beyond developing common programs of study and research have to be explored. Important in this is the European Union (EU), with its strong focus on 'the sustainable knowledge society' and the ambition to trigger synergies within the 'knowledge triangle' (EU 2011, 2013a-c, 2014). As an example, synergies between the university and city qualities are seen as important factors for attracting students (Hoeger & Christiaanse 2007) and campus development is gradually recognized as an important strategic tool (Corneil & Parsons 2007, den Heijer 2011). In line with these developments, our study leans upon the following research question: *How can strategic campus development contribute to sustain and develop universities as attractive places for learning and knowledge development in a future of increased competition in higher education and research*? The discussion is motivated by challenges created by new circumstances, like the need for more flexibility, a new digital reality for education, and increased internationalization of higher education.

2   TRENDS INFLUENCING THE FUTURE OF UNIVERSITY

Acknowledging that current ideas about the future will change and that new paradigms will emerge, we suggest that at the moment, there are five main trends being of particular interest to the dual theme of university and campus development seen from an international perspective. The trends are linked to new technologies for communication and transport making the world 'smaller' and leading to the rapid globalization of science, the economy and politics (Altbach et al. 2009). On the opportunity side of this, is the increased availability of higher education to more youths, increasing cultural and ethnical diversity, new economic growth areas and an improved standard of living for a larger part of the population. On the challenge side, is a fast growing population in many countries, as well as the massive migration of refugees, impacting on areas such as food, water, health and welfare, climate and energy, and education.

The essence of the first four trends, which we will not expand on in this paper, is that the global competition for students and researchers is increasing (trend 1: *attractive in a borderless world)*, that universities reach out to students in new ways (trend 2: *new education forms and learning environments*) and at the same time as students increase in numbers and mobility, representing a broader range of the population both regarding age and social situation (trend 3: *university in the society*). Moreover, focus on relevance of education and research, i.e. innovation and social development, is high up on the political agenda, emphasizing the necessity of interdisciplinary work (trend 4: *integration of education, research and innovation into a 'knowledge triangle'*).

We refer to the fifth and last trend as *strategic campus development*. This is based on a view that buildings can be seen as functional frameworks for human activity, and thus, that ideas about university space should be reconsidered as activities and demands on performance changes (Bygningsstyrelsen 2009, Den Heijer 2011, Beckers et al., 2015). The landscape of learning, teaching and knowledge development is currently moving into new forms difficult to foresee. What appears clear, however, is that these changes involve altering needs for working spaces such as classrooms, offices, laboratories, workshops and for social spaces. The tendency is that traditional solutions developed during the 1960s are substituted by more generalized areas adapted for cooperation and dialogue between the student and teacher, between disciplines, and between the university and the rest of the world. Generality, flexibility, and elasticity become key principles for both work and social space development (Blakstad 2001).

Today, a modern and effective infrastructure for education, research and on-campus social life, integrated with attractive cities or having urban qualities, are perceived as important factors for the recruitment of 'the best brains', whether they belong to students or to academics (Corneil and Parsons 2007). Furthermore, the opening up of the university campus towards the general public is seen as an essential component of the knowledge society, where expectations about value creation and welfare are closely related to new knowledge and innovation (Abbot 2014). According to the EU: *'global competitiveness and global cooperativeness are core aims for teaching and learning which aim to equip students for peaceful and healthy lives in the 21st century'* (EU 2013b:50). In sum, the modern campus should be an 'urban marketplace for knowledge' (Hoeger and Christiansee 2007).

3   CAN STRATEGIC CAMPUS DEVELOPMENT CHANGE UNIVERSITIES?

Corporate Real Estate (CRE), and thus the physical aspects of campus, is frequently referred to as 'the fifth resource for production' (Joroff et al. 1993). In line with this, den Heijer (2011:91) claims that '*if real estate had no effect on performance, no society, organization or individual would spend resources on it'*. 'Performance' includes economic results, social achievements and the aesthetic environment for wellbeing and happiness. However, the resource of CRE cannot be evaluated as independent of four additional resources, these being capital, people, information, and technology (Joroff et al. 1993). Adding to this is the increasing interest for the campus as a place not only to learn but also to live, implying the emergence of new kinds of on-campus services (Den Heijer 2011). Strategically approaching the physical environments implies opening the opportunity to define the expected contribution of spaces to university performance. According to Haynes and Nunnington (2010) this demands strategic alignment between university vision and strategy, and its architecture.

It is claimed that physical changes will affect organizational performance (Becker 2004, Gjersvik and Blakstad 2004, Vischer 2005, Appel-Meulenbroek 2010, Blakstad and Andersen 2013, De Paoli et al. 2013). Regarding university as the interplay between organization, technology and infrastructure, and physical surroundings (Gjersvik and Blakstad 2004, Nenonen 2005), means however that redesigning rooms or buildings is not enough for creating new work practices. With reference to the previous section, development should also be guided by visionary conceptions; what is it we want to achieve? New forms of work processes are impelled by technological innovations, meaning that education and research can happen 'anytime' and 'anywhere', in many different ways. At the same time, strategic workplace development is used to signal how people should work and collaborate in

physical spaces. Currently, a lot of interest has been developed in 'spaces between', or natural meeting places at campus, serving different defined functions and activities. When people move from one activity to another, there is a potential for planned and unplanned meetings. Conscious planning of the internal 'spaces between' represents a possibility to develop a living infrastructure for linking space and organization at the university campus (Kornberger and Clegg 2003).

4   APPROACHING THE CASE OF NTNU

From 2016, the Norwegian University of Science and Technology (NTNU) will be the largest university in Norway, specializing in technology and natural sciences, but also offering a range of bachelor's, master's and doctoral programs in humanities, social sciences, economics, public and business administration, and aesthetic disciplines, as well as professional degree programs in medicine, psychology, architecture, the fine arts, music, and teacher education.

Currently, plans have been made to merge the two main campuses of NTNU into one, implying the need to develop and rebuild as much as 100.000 square meters within the next 10-15 years, and to relocate 12,000 students and employees. Evaluation of the need for new and upgraded university areas is being carried out within the framework of a formal planning process for major public investments adopted by the Norwegian government. The process is accomplished by external consultants according to a fixed procedure, with NTNU in the role as information supplier. It adds to the complexity that NTNU is in the process of a merger with three university colleges. A major reorganization of the university is therefore in preparation. From 2016, NTNU is a place of work and studies for 5,500 employees and 35,000 students, for whom the campus represents an important frame for the quality of life and for job satisfaction. In consequence, NTNU are making comprehensive efforts to ensure the consistency between current and future work processes and campus development.

One of the actions taken is the campus development project 'Vision 2060', which was initiated in 2013 by the Rector (Haugen et al. 2014). The ambition is to develop the future NTNU campus into an attractive place with urban qualities, forming a vibrant environment for learning and the development of new knowledge. The work is founded in NTNU's strategy for 2011–2020, 'Knowledge for a better world' and in NTNUs vision document 'NTNU 2060'. It is also aligned with ideas of 'the knowledge city' developed by the local authorities, which are collaborating closely with the campus development project. Thus, conditions are suited for strategic campus development as a means to support sustainable university change.

Input to the project 'Vision 2060' is among other sources from more than 80 meetings and workshops with key persons in and connected to NTNU, including the Ministry of Education and Research, the NTNU Board, headmastership, deanery, institute directors, scientific and administrative employees and employee representatives and the local governments. As part of the work, four scenarios for the future NTNU were developed. These will be further discussed in the next section. In addition, comprehensive literature studies were made to map trends affecting university and campus development, the impact of space on education and research, and the significance of co-location and proximity for transdisciplinary knowledge development. Finally, examples of modern campus development worldwide were documented (Havenstrøm et al. 2014).

5   THE SIGNIFICANCE OF UNIVERSITY CHARACTERISTICS FOR CAMPUS DEVELOPMENT

Even if all countries are affected by the same global trends, responses will differ depending among other things on culture, regulations and conditions, and political choices. In Norway, which is the context within which we are interpreting trends and ideas, values like equality, involvement and sustainability are strong. There are few private schools, and education on all levels is financed by the public authorities.

NTNU is by far the largest technological university in Norway, situated in the city of Trondheim with 185.000 inhabitants. Compared to the population, the number of students is high, making the university a very visible actor in the townscape. There is a tradition for strong identity building at NTNU, connected to both the educational and the social parts of student life. The university is characterized by comprehensive, experimental activity, a strong focus on interdisciplinary programs for research and education, and widespread interaction with the business and public sectors and the society in general. An important part of the picture is the university's buildings, representing a large strategic resource. NTNU owns and rents more than 520,000 square meters and has an annual maintenance, operation and development budget of NOK 500 mill. Today, NTNU's campus is a mix of new and old premises, with predominantly traditional offices, lecture rooms, long corridors and few meeting places. This largely contrasts modern ideas of interdisciplinary work as being dependent on an active infrastructure that ties the campus together, with spaces that accommodate conversation, team interaction and supervision. Nevertheless, the organization, education programs, teaching methods and the technology used is constantly changing. Also worth mentioning is that NTNU aims at being a pioneer university when it comes to 'green' solutions in all areas. Consequently, effective adaptation and use of the areas are important to enable the university to return as much teaching, research and innovation as possible in exchange for the investments made by the society.

The project 'Vision 2060' develops a basis for strategic choices about possible campus models that will uphold and develop the distinguishing characteristics of NTNU. As an example, the experimental character of NTNU signifies that the identity of the campus will also be important in the future. Furthermore, the extensive use of specialized laboratories as well as other dedicated areas for education, research, innovation and communication, suggests that the NTNU campus should continue to accommodate a diverse range of space for experimental activities. In line with the view that solutions to the complex social challenges facing us globally can only be found in the borderland between traditional disciplines, proximity between different specialist fields is seen as an important means to stimulate professional development and innovation (Blakstad et al. 2014). The understanding of this mutual dependence is reflected in the NTNU strategy, and is also emerging from the 'sharp end' of different disciplines. We observe that in spite of physical limitations, new collaborative work forms are emerging, not only across scientific boundaries, but also crossing geographical and cultural borders. This development is supported by collaborative technologies, and fueled by public financial schemes. Thus, the general demand for space and for places that support and stimulate cooperation, physical and virtual, is increasing.

Another crucial factor in supporting interdisciplinary work and an open, living campus is the availability of areas for formal and informal meetings. Such meeting places, or the 'spaces between', play an important role not just for identity building, but also to stimulate the experience of identity sometimes needed for innovation (Taylor and Van Every 2000).

Conscious planning of a living infrastructure connecting on-campus meeting places means aiming at weaving communication arteries, 'spaces between', accessory spaces, and other meeting points into a 'social web' spanning the campus. By making the 'web' available not only for students and university employees, but also for private and public organizations, as well as for the general public, it could be a mediator for innovative meetings and new activities.

Figure 1: Alternatives for future campus development
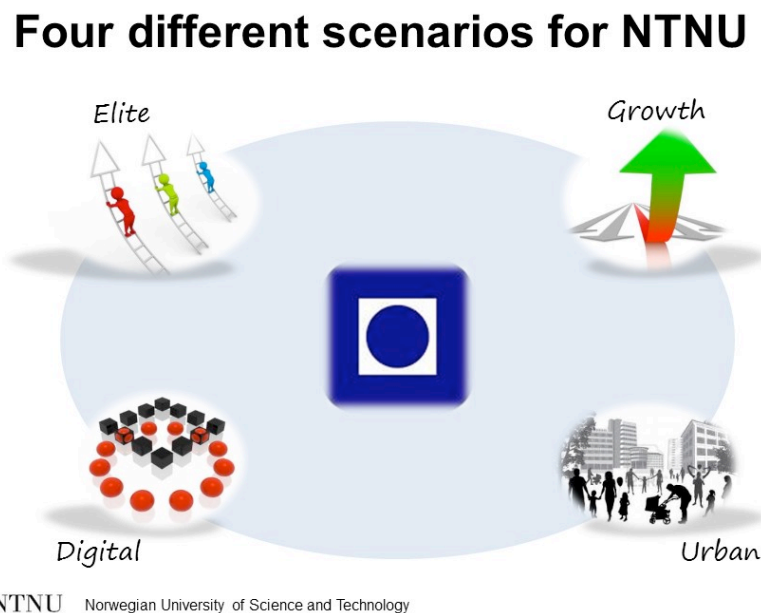
To construct a platform as basis for making strategic choices about campus development at NTNU, we used a scenario technique as one of several approaches. Based on historic developments and the identified trends and development drivers, we generated four alternative descriptions of possible future situations; referred to as 'Growth', 'Elite', 'Digital' and 'Urban'. The four scenarios constitute opportunities, but should not be seen neither as prognoses nor probability estimates pointing at a specific strategic direction. Our intention was to analyze the possible impact of different future situations on NTNU campus development. A basic assumption is that NTNU both in the near and distant future will need a physical campus which is attractive now and in the future for both students and researchers. From our perspective, the sustainable development of NTNU implies the need for a flexible and 'green' campus, adaptable to future changes and leaving only limited environmental footprints. There is also a need to develop sufficient area for experimental activities, including modern forms for learning and teaching, supported by effective means of communication. Finally, it is essential to ensure a positive environment for studying, working and socializing.

7   FINAL REMARKS

Until now, our attention has been towards the general development of areas for education, research, innovation, communication and social life, and how such changes affect the needs

and demands for physical campus development. We have also brought into focus three distinctive characters of NTNU seen as particularly relevant in connection with strategic campus development. However, we believe that the needs for space should be analyzed in more detail, and seen in the light of the different scientific traditions. We think in particular of the differing needs for specialized versus generalized areas, and for individual versus collaborative work. Another, still open question, is how one should approach the balance between physical and virtual campus development. Technology enables a variety of place-independent work forms, and online education is a fast-growing segment. This means, for example, that even if students choose to stay on campus, they may well attend lectures at a different university, in another part of the world. In a more mobile everyday life, the distinctions between study, work and leisure time will become blurred. We also believe that the selection and quality of services available on campus will become increasingly more important.

Campus development is no longer about the construction of lecture halls, reading rooms and offices. For NTNU, campus development is an important strategic tool to attract and keep excellent researchers, teachers and students. The demand for a space that supports the fundamental characteristics of experimentation, interdisciplinary work, education programs and collaboration with private and public organizations is urgent; Indoor and outdoor space and places are expected to support the ongoing activities, such as learning and teaching, research, innovation and communication, and they should encourage social life and recreation.

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2

WHAT DO WORKPLACES OF TODAY AND TOMORROW LOOK LIKE

2.1

Third Places and User Preferences – Affordances in the Cities

Suvi Nenonen, Riikka Rahtola and Inka Kojo

2.2

Alternative Learning Environments by Alternative Retrofitting Processes

Suvi Nenonen, Robert Eriksson, Olli Niemi, Antje Junghans,
Susanne Balslev Nielsen and Göran Lindahl

2.1 THIRD PLACES AND USER PREFERENCES – AFFORDANCES IN THE CITIES

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ABSTRACT

Purpose: This paper aims to identify the user requirements for third places by investigating the mobile workers in cafeterias as a traditional place to work within the city.

Background: The whole city can be seen as an office. The places where knowledge work is conducted are scattered to multiple spaces from traditional offices and business park complexes, to hubs, co-working spaces and home offices. The third place as a place between home and work is in transformation to diverse service offers for different user segments.

Approach: Data is gathered by survey (n=78) from the individuals who use cafeterias as places to work in capital area, Finland. Additionally the thematic interviews were conducted with a sample of 8 interviewees.

Results: The integrative model of requirements of third places was developed based on analyzed data. The results indicate that the user needs are connected to the accessibility, social activities, cozy facilities and well-being. The results shed light to transformation of traditional space segments and their development in the city.

Practical implications: The paper discusses how transformation in the work life widens the concept of workplace to the city as an office and provides user-centric data both to the practice of co-working service provision and design.

Keywords:
Third places, Working, Transformation

1　　INTRODUCTION

The organization no longer defines the location of the work; the work is disseminated all over the city structure. The places where knowledge work is accomplished are scattered across multiple spaces, from traditional offices and business park complexes, to hubs, co-working spaces, and home offices (Waber et al., 2014). What we used to know as the "third place" that supports the infrastructure created by offices and homes are remodelled to diverse service offers in a more conscious way (Termaat et al., 2014). The role of cities as the most effective environments in which the exchange of knowledge has actually increased in significance

even as technology allows so many forms of communication to be virtual. In fact, virtual interactions and face-to-face interactions reinforce each other. Information technology creates a more relationship-intensive world and reinforces the fundamental purpose and logic of the city as a dynamo of intellectual growth (Glaeser, 2011).

According to Laing (2013) the future of work and place is a shift towards an urban scale. The starting point is no longer the office but the city at large - a bricks and mortar urbanism imbued with digital information and connectivity: a powerful combination of the physical and digital. It is within cities that a nomadic way of working can be most successful, supporting individual users with a choice of places and settings in which interactive and solo work can happen.

The whole city can be seen as an office. The individual user is in the main role in deciding where to work. Self-employed people such as freelancers and the mobile employees of larger organizations are the main user groups of co-working places (Van Meel and Brinkø, 2014). The phenomenon of co-working has been expanding rapidly. It involves shared environments in which individuals and small groups gather together to work in a community, usually paid for on a membership basis and invoiced either monthly or daily. These spaces provide a community workspace with shared services that let individuals and small groups share ideas and mutually support each other's work. Corporate organizations are encouraging their own employees to work in co-working spaces as an alternative to their regular workspace, not to save on costs primarily, but to facilitate their interaction and knowledge sharing with others and to inspire creativity (Laing, 2013).

This paper aims to identify the user requirements for third places by investigating the mobile workers in cafeterias as a traditional place to work within the city. Typically third place "host the regular, voluntary, informal, and happily anticipated gatherings of individuals beyond the realms of home and work" (Oldenburg, 1999). Hotel lobbies, cafés, congress venues, parks and other open public spaces are examples of third places that can be used for working (see, e.g., Harrison et al., 2002; Hislop and Axtell, 2009). This paper focuses on cafeterias as third places and what kind of affordance city can provide for mobile workers in that context. Affordances are the functionally significant properties of the environment that are perceived through the active detection of information. Affordances include properties from both the environment and the acting individual. Affordances are always unique and different for each individual and each specific group of people (Greeno, 1994). Therefore, the concept is well suited for describing the characteristics cafeterias as third places. The user experience of third places in the context of work needs to be understood as a part of affordance of workplaces.

2   STATE OF THE ART

Throughout history, people have actively gathered in social spaces. Some societies are even known for the success of certain types of social spaces, such as cafés and pubs in Europe. The first coffee houses in 16th century London actually functioned as offices. They were places where business people gathered to find information, make deals and build their networks. In 1688, Edward Lloyd's coffee house in London earned a reputation as the place to go for marine insurance. It later evolved into world-famous insurance market, Lloyd's of London. In 1698, the owner of Jonathan's coffee house began to issue a list of stock and commodity prices called "The Course of the Exchange and other things": so starting of the London Stock Exchange. Auction houses Sotherby's and Christie's have their origins in coffee houses.

These vital social hubs offer a place where people can come alone or in groups to gather for conversation (Anon., 2013).

Long after these spaces found their place in societies, Oldenburg (1999) named and explained this social phenomenon, calling these active social spaces "third places" (the "first place" being home, and the "second place" being work). Third places are a specific type of public space that is separate from home and office. They host the regular, voluntary and informal social gatherings of individuals and are easy to access in terms of location and time. Moreover, they do not set formal criteria of membership and exclusion. Hominess, playful mood and regular users characterize third places (Oldenburg, 1999).

Third places host rich social interaction and can enhance the sense of community. Oldenburg´s (1999) research on third places built a strong case for the advantages of appropriate amounts of social interaction and, consequently, the importance of third places. Wellman (20012) describes how place-to-place to person-to-person communication can be seen nowadays as Networked Individualism, in which micro-communication with our 'tribe' replaces casual social interaction with our community. These urban tribes, via new communication methods and evolving social practices, are supplementing or replacing the socialization that once took place in 'third places'. Through friend-of-friend associations and the overlapping of different social groups, people are exposed to wide range of people similar to community gatherings in public space. This new phenomena could be called a symptom of the modern community, or of modern communication tools (i.e. it is now possible to maintain contact with a select group of friend and to spurn all contact with the community). Any solution to improve community interaction should address not only the lack of third places in our communities, but should also leverage the interactions and relationships within our urban tribes (*Chatfield and Hexel, 2007*). Some independents try working in cafes because of the liveliness and the atmosphere, but the trouble is that cafes can be noisy and impractical (think for example of going to the loo, wondering whether you take your laptop with you or not). So, cafes are fine for quick tasks, but not as a structural solution (Van Meel and Brikkø, 2014). So-called Coffice-work seems pretty much to be solo activity with the laptop so the social characteristics of Oldenburg´s perceptions have been changed. Initially, as it has been claimed, that flexible worker used to locate them selves at home or in a cafeteria nearby (see, e.g., Huwart et al., 2012). Social isolation or distractions are the downsides of using these locations (Spinuzzi, 2012). Diversity, novelty, perspective and knowledge of people are claimed to be the benefits of third place utilization (Oldenburg and Bisset, 1982; Oldenburg, 1999).

The research including interviews of mobile workers about third places was conducted in Sterlitz (2011) and it was found out that by far the majority of interviewees did not want to work at home. They wanted to work amongst other people who are working, motivated by the synergy and common purpose of other people working around them, with no distractions, benefitting from access to technology and facilities not available at home, and the freedom to focus on their work in a non-domestic, professional environment. Being able to work in a place close to home radically improves people's work-life balance, job satisfaction and productivity. Convenient location was cited by 73% of respondents as the top benefit of third place working. These third places encompass business centers, clubs, libraries and informal areas such as coffee shops. This demonstrates that working in third places - neither office nor home - is the new normal (Sterlitz, 2011)

Next to the social aspect of third places, one can approach the issue from perspective of privacy. Individuals want to have strategic anonymity – this means being unknown, being "invisible". The ability to make one anonymous is a key aspect of privacy, in that it frees an individual from the restraints incurred through normal social surveillance. Being unknown allows people to avoid interruptions, as well as express themselves in new ways and experiment with new behaviors. The key is that it is strategic—individuals choosing when and why to make themselves anonymous. For instance, when people go to a café to get focused work done, they are often seeking to block the social distractions of the workplace. The low-level vibe of strangers can be just right to stimulate thinking without attention becoming diverted. (Anon., 2014) Another type of privacy is separating oneself purposefully to solitude. Isolation is a state of mind and it is possible to feel isolated from a group while that group surrounds one. But solitude is physical: intentionally separating from a group to concentrate, recharge, express emotions or engage in personal activities (Anon., 2014)

People look for the right blend of privacy and isolation that's needed to get work done, but at the same time we want to feel connected to the greater whole. Third places are places to work together alone. People interact with places in their everyday lives: they are constantly moving in places, working in them, and, making decisions in and about places. Places provide a context for everyday action and a means for identification with the surrounding environment. They help inform our own sense of personal identity - such as national, regional, cultural identity, socioeconomic identity, or religious identity (Entrikin 1991) - and they make us identifiable to others. Therefore, the meanings given to places are fundamental components of social interaction (Goffman 1959). Places such as towns, offices, or restaurants, can be defined by agents according to the activities, which happen there. Rasmussen and Pejtersen (1995) suggest that these types of places are "loosely coupled" systems. As such the affordances available rely more heavily on the intentions and profiles of the actors involved. That is, other people are an important part of the functional landscape for a given actor.

3   APPROACH

The research approach in this paper is based on mixed methods. The term "mixed methods" refers to an emergent methodology of research that advances the systematic integration, or "mixing" of quantitative and qualitative data within a single investigation. The basic premise of this methodology is that such integration permits a more complete and synergistic utilization of data than does separate quantitative and qualitative data collection and analysis.

Sequential mixed methods data collection strategies involve collecting data in an iterative process whereby the data collected in one phase contribute to the data collected in the next. Data were collected in these designs to provide more data about results from the earlier phase of data collection and analysis, to select participants who can best provide that data, or to generalize findings by verifying and augmenting study results from members of a defined population (Creswell & Plano Clark 2007).

The quantitative data was collected in the first phase of the research. The survey was conducted in order to find out information about people working in the third places: how and by whom the third places are used for working. The survey included also questions about preferences of the users of the third places. The Internet survey with randomly picked sample was conducts. The participants were invited to the survey by flyers in cafeterias and hubs as well as by using Facebook community as a source of information. The survey questions included sections background factors, the use of third places, processes conducted in the third places and the open-ended questions.

The qualitative data was gathered in the second phase of the research. It consists on semi-structured qualitative interviews using an interview guideline with about 25-30 questions divided into three themes: (1) atmosphere of third places (2) people, (3) services. Questions were framed as open as possible. The interviews aimed to get more insights to the supply side of third places: the supplier's opinion of the customer's experiences. The sample included the people running the cafeterias and hubs, which were typically filled with people working in them. All interviewees were asked the same questions, but ordering the questions was flexible and followed the progression of the conversation. Additional questions were asked dependent on what interviewees brought into question. Each interview lasted about one hour and was recorded. One can ask why the users were not interviewed in the same manner. In the end of the data gathering there was a workshop with users to discuss about the model created based on the user survey and supplier interviews and that produced again new data from user perspective.

Both the quantitative and the qualitative data were analyzed in different phases of the study. The quantitative data was analyzed according to frequencies. The thematic analysis frame of Braun and Clark (2006) was used in data analysis of qualitative material. The data was analyzed step-by-step consisting of three interactive sub processes. The first, data reduction phase consisted of generating initial codes where the process of systematic coding was applied. The second phase of the analysis was searching for themes and all the codes were collated into potential themes. Also the comprised themes were reviewed against the first phase initial codes' themes. Finally, defining and naming themes and the drawing of conclusions were implemented. The codes were used as the units of organizing the qualitative data in a way that the initial codes were formed through the re-reading of the data.

The first version of integrative model of requirements of third places was developed based on the data. It was validated in the focus group workshop. The holistic model frames the affordance of the third place in the city.

4   RESULTS

4.1   Survey results
The amount of responses to the survey was 78, including 45 women and 33 men. The diversity between age groups was the following, 7 participants representing the generation Y (born in 1977-1994), 61 representing generation X (born in 1966-1976) and 10 persons from the age group baby boomers (born before 1966). The most commonly used third places were cafeterias (73 %) public transport, stations (e.g. railway, bus, and airports 13 %), virtual third places (e.g. project platforms, (4 %) and restaurants (10 %).

52 % of respondents were weekly using third places, 27 % once a month and percentage of daily users was 19. Typical length of stay for working was mostly 1-2 hours a day for 46 % of respondents. Less than that was reported by 18 %. The rest of the group was staying longer in the third place. The longer stays in general were more typical for women – 24 % of women stayed 2-3 hours at a time in the third place while only 6 % of the men preferred such a long stay. The most important reason for choosing the third place was location (65 %). The second reason was the atmosphere of the place and third preference was services of the place. The third places were used mostly to creative work: producing ideas and content (63 %). Writing and e-mailing were the second largest group or activities. Third places were also used for meetings.

The ideal third place for 60 % of the respondents was a place, which is open for everyone. There is no entrance fee and it is easy to get there. The use of space is substituted by a cup of coffee or other service. 23 % were ready to pay about services, which support the work in the third place, which could be open for everybody. 12 % were ready to use the third place where the employee has bought a licence to use it. Pure co-working place was interest only for 5 % of the respondents.

The open-ended responses were coded and categorized and the preferences concerning the third places included the following perspectives: atmosphere, place, interior design, usability and services. People made the place and the atmosphere. The half-social spirit was mentioned to be important. Additionally the services and the service attitude of the staff were highlighted.

4.2   Interview results
The service providers found that the atmosphere is the most important attractor factor in the third places. The half-social spirit was mentioned also in the interviews. One can see other people, who work in the similar way. The feeling of working is something one can sense and it does not matter if the people around are unknown. The social clue is in sensing the similarity in the ways of work.

The typical characteristic of place preferred was relaxed place. Third place reminds more lounge than typical office setting. It is good to have diversity of places: corners and "hiding places". The space can be high so that there is enough space to think. The windows and natural light were appreciated.

The customers are seeking for possibility to be effective and to get rid of daily routines. The service providers state that people working there got a better support for the concentration to the work itself in the third places. The feeling of managing own time and place is important as well as the control of time and place for working.

People appreciate also the diversity and variety of working positions and places. The physical surrounding needs not to remind oneself of office environment. The users come to have a different perspective to they work.

People are seeking the work community and networking also from the third places. The network possibility is important. In terms of interior design the informal and relaxed choices were preferred. Coaches and diverse possibilities for sitting were important. The colours make you have better ideas, stated one respondent. Next to the comfort people preferred clear and usable, compact concept. It can be trendy but it is not the only priority. Lightning should be warm, non-direct and sensual. The message by furniture should repeat the atmosphere: now we are out of the office.

The service attitude of staff was important. The aesthetics and healthiness in services was emphasized. The functional network, easy connectivity as well as easy access by public transportation was mentioned. The motive to use the third place is in many cases the need to use time in an effective way: one wants to spend the time in a lean manner and according to the service providers the location is has a critical role.

4.3   Summary
Based on the results one can summarize four main themes which are important for the demand and supply of the third places. They are as presented also in Table 1:

1. Accessibility
2. Social activities
3. Well-being
4. Facilities and services

Table 1: Third place

Accessibility	Community
Facilities	Well-being

Each theme has three subthemes. Accessibility includes the following perspectives: location, opening hours, publicity. Location is most likely to be successful when it is near the place where the daily routes take place. It needs to be in the natural crossroads in the city. Opening hours are connected to the routines of daily office hours: if the third place is open outside the office hours it is more likely to be used more frequently. Thirdly the accessibility to the third place in general is important. How one can feel to be welcomed to the third place: is it open for anyone and there are no limitations in the access.

Community is the seed for the social activities in the third places. This includes social activities, working together alone and social interaction. Social interaction is based on processes taking place in the third place. Working together alone provides a possibility to balance between solo works within social group of people. Interaction between users provides possibilities to strengthen the network and significance of the third place.

Well-being includes the experience of the control over the work, time and place of user. The relaxed atmosphere is supporting the work processes and well-being of the user. The service providers can add value by providing the services in connection with well-being.

Facilities providing the platform for the third place have three aspects. The diversity of different places is one factor of third places. The significant question is who is maintaining and organizing the place in genera. Next to the physical platform facilities include also the digital platforms.

The following Table 2 includes the themes and subthemes and also the checklist kind of questions, which can support the service provision of third places in the future. This integrative model of requirements of third places provide also material for the evaluation and development of not only third places but also other places and concepts which are valid for the mobile worker.

The validity of the study can be improved by increasing the qualitative data from users. The interview data is now the interpretation of supplier and their opinion of the customers experiences. The study could be more valid by also interviewing customers of the same cafeterias to see possible match or mismatch between those two viewpoints – this would fit better also for the concept of affordance. The reliability can be discussed in terms of data got by using different methods. The content was aligned and completed each other. The developed integrative model of requirements of third places based on the data needs to be tested more in other studies in order to uncover possible weaknesses.

Table 2: An integrative model of requirements of third places

Accessibility		Community	
How easy it is to access the place?		What makes the place to be a community?	
	Openness	**Social activities**	
	Who can use the place?	What kind of social activities takes place?	
	Opening hours	**Alone together**	
	When the place is used?	What kind of privacy is possible within the community	
	Location	**Interaction**	
	Where is the place?	What kind of interaction takes place?	
	Maintenance	**Services**	
	Who is providing the place?	What kind of different services are included to the place?	
	Diversity of places	**Relaxation**	
	How the places require diverse settings for diverse needs?	What makes users relaxed in the place?	
	Digital platforms	**Experience**	
	What kind of digital services are provided?	What kind of user experiences is provided?	
Facilities		**Well-being**	
What kind of physical and digital platform is offered?		How third place support work-life balance?	

5　　PRACTICAL IMPLICATIONS

The results of this study can be applied to third places, hubs and collaboration arenas as a part of city development and workplace development. The third places are needed to ad hoc meetings and visits. They are a good resource for unplanned meetings, if they are located in the appropriate place. The third place can be an important areal meeting place with the identity of surroundings. One can feel that one belongs there.

The affordance of third place in the city is based on easily accessible and profitable place, where you can easily attract people to visit the place. However the business logic might be more sensible if it is based on the cash flow of the cafeteria. But there is a need to provide diverse way for users to commit themselves to alternative work environments. The service incentives can be the reason to join to the place.

The services connected to the third places need to support daily work and life in the way that it is not causing any extra harm. The network structure could be useful in order to provide services within the network.

The role of third place is in transformation. One can identify the scalable ways to develop alternative places for mobile workers. The practices, which are typical for the digital platforms, provide us more possibilities to redefine the significance of meeting places in the future. Nevertheless the user-driven third places need to be co-created by lead users of co-working places.

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2.2 ALTERNATIVE LEARNING ENVIRONMENTS BY ALTERNATIVE RETROFITTING PROCESSES

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ABSTRACT

Purpose: This paper presents the Campus retrofit framework (CARE-FRAME), which is an outcome of research, development and innovation project among Nordic university campuses. The Nordic campus retrofitting case studies (demonstrations) were analyzed during the process from different perspectives. CARE-FRAME integrates the different perspectives to one holistic model.

Background: The transformation of learning environments in university campus is often about retrofitting the parts of campus, which are not functional anymore. They do not provide any value for the users and the new ways of learning and working. Traditionally the retrofitting approach is about adding new technology, features or services to the existing built environment systems. However campus-retrofitting process needs to be much more aligned with organizational goals, visions and strategies.

Approach: The analysis of different campus retrofitting demonstrations as well as literature review and participatory workshops are the foundation of the CARE-FRAME.

Results: CARE-FRAME characterizes perspectives of the activity-based retrofitting as systemic context, co-operative processes and integrative, blended environments.

Practical implications: CARE-FRAME and its three perspectives provide a tool which can be used in updating and developing alternative learning and working environments to campus. It emphasizes that core of the retrofitting is in practices, co-creation and social dimension of places. Core is supported by more tangible elements like economical and technical solutions.

Keywords:
University campus, Retrofitting, Framework, Learning environment

1   INTRODUCTION

Nordic universities have been investigating and analyzing campus retrofitting case-studies, which include a wide spectrum of methods how interaction and co-creation between students, teachers, researchers, real estate and FM staff as well as industry can take place in campus retrofitting processes. The wide user group represents a broad cross section of perspectives and experiences and provides a platform for fruitful discussions of the studied demonstration projects. The transformation of learning environments in university campus is often about retrofitting the parts of campus, which are not functional anymore. They do not provide any value for the users and the new ways of learning and working. Traditionally the retrofitting approach is about adding new technology, features or services to the existing built environment systems. However campus-retrofitting process needs to be much more aligned with organizational goals, visions and strategies (Eriksson et al. 2015). The retrofitting solution as a technical and spatial solutions covers only part of the process. The activity based retrofitting consists of multidisciplinary collaboration where the diverse users have different roles during the retrofitting process. One can claim that the process and the product are equally important for successful retrofitting concept (Nenonen et al. 2016).

This paper presents the Campus retrofit framework (CARE-FRAME), which is an outcome of research, development and innovation project among Nordic university campuses. The Nordic campus retrofitting case studies (demonstrations) were analyzed during the process from different perspectives. CARE-FRAME integrates the different perspectives to one holistic model. In joint conversations and research projects with Nordic partners the new insights for developing Nordic campuses by using small scale demonstrations as pilots were shared. The foundation of this paper includes analysis of different campus retrofitting demonstrations as well as literature review and participatory workshops. The framework is described by using three Finnish campus retrofitting cases as examples. The paper is concluded with the final recommendations.

2   CAMPUS RETROFITTING FRAME

Three perspectives to campus retrofitting cases were identified during the research project. The first perspective is about systemic context of campus retrofitting. It focuses on levels of campus retrofitting. The second perspective is about co-operation in campus retrofitting processes. The third perspective is about environment: campus retrofitting of digital, social and physical learning and working environments were included in analyzed case-studies.

2.1   Systemic context of campus retrofitting: landscape, regime, niche
University campuses can be seen as constantly evolving complex socio-technical systems (Rytkönen 2016). According to a multi-layer perspective theory developed by Geels and his peers

(Geels 2002; Geels 2004; Geels and Kemp 2007; Schot and Geels 2007; Nieminen et al. 2011), socio-technical changes are not solely explainable by single causal relationships but rather by a result of a set of constant, complex interactions on three systemic levels: landscape, regime and niche innovations. In a campus management context, landscape refers to the social, political, economic and technological forces that create pressure on current university practices. The regime level describes the current dominant internal practices of universities. The niche innovations level describes the approaches and experiments that are challenging the dominant regime in an attempt to fulfill the needs of the modern university communities despite the regime level boundaries (Eriksson et al. 2014). The core is in regional changes, tactical systems within university community and organization. The strategic processes are based on drivers, motives and values: new ways of researching, collaborating and learning as well as ecological drivers e.g. lowering the environmental impact. The tactical level includes co-design, co-use and continuous testing and improvement. In operational level realizing the campus retrofitting actions is made by different stakeholders. (Eriksson et al. 2014). The campus retrofitting processes are part of this complex system and classification of landscape, regime and niche is the first dimension of the CARE-FRAME.

2.2   Co-operational processes: co-financing, co-creation, co-evaluating
The Nordic case studies were chosen because they represented new and actual on-going, experimental co-creation strategies at the universities. They are called demonstrations. They provided new insights to innovative processes, where the universities deviated from their standard practice, e.g. use of new methods of user participation. Traditionally campus retrofitting can be seen as a technical process, which is linear and different phases follow each other (technology based retrofitting). Based on the Nordic studies the term "activity based campus retrofitting" was taken into use. It is the ongoing process and not limited to the certain phase of the retrofitting as a financial or technical process. Activity based retrofitting includes three aspects: co-financing, co-creation and co-evaluating. (Eriksson et al. 2015).

Commitment and engagement to sharing costs among stakeholders (co-financing) is a foundation of activity based campus retrofitting. For example property owners or facility managers are sharing the goal of providing good university facilities. Simultaneously they need to achieve goals set to sustainable and energy efficient buildings, sufficient usage rate of university facilities and efficient use of spaces. The financial investments need to be designed with users.

It is important to understand users and their needs as well as diverse activities, which set requirements for future learning environments. The users need to be challenged to provide insights about their activities and they can be in the active role also in designing the solutions. This activity based approach and co-creation are the basis of retrofitting solutions.

Evaluation of co-created solutions together can also be done with users and owners. Diverse methods like user surveys, sensors, interval cameras, user feedback and user interface testing provide evidence about effectiveness of the retrofit solutions. The collected data is a relevant material for continuous improvement (Nenonen et al. 2016). The campus retrofitting processes include co-operative activities in terms of co-financing, co-creation and co-evaluation: this is the second dimension of the CARE-FRAME.

2.3   Integrated environments: digital, social, physical environment
Significant changes in higher education the past decades, such as increased information and communication technology (ICT) and new learning theories have resulted in the dilemma whether higher education institutions can facilitate tomorrow's learning and teaching in

today's or even yesterday's school buildings (Beckers, 2016). Harrison and Les Hutton (2014) refer to Temple (2007), who stated that physical manifestation of universities is a thing of the past as learning will increasingly take advantage of ICT becoming independent of specific spaces, and to Drucker (Forbes, 1997), who predicted that university campuses will turn into relics as they won't survive the next thirty years. Even though a large part of university campus designs still mainly support learning in the traditional sense by providing massive auditoriums focused on teacher-centered pedagogies, and assigned individual offices with low utilization rates, there is also an increasing amount of examples across all five continents of how spatial transformation is changing university campus design principles, actions and processes (Den Heijer and Zovlas (2014).

In order to effectively manage the built environment and foresee the demands of the future, the management focus needs to shift from managing quantifiable empty facilities walls, roofs and floors towards facilitating the user communities that act inside the facilities. As the users act increasingly in both virtual and physical environments and have greater decision power over the ways in which they learn and work the best, effective campus management becomes increasingly complex and tailored (Rytkönen 2016). The third dimension of CARE-FRAME is about places: the digital, social and physical learning and working environment.

2.4   Campus retrofitting, CARE-frame

CARE-FRAME integrates three perspectives, which were identified during the research project. The first context perspective includes the levels of campus retrofitting from landscape level to niche level – having the regime level in between. The second co-operative process perspective includes the co-financing, co-creation and co-evaluating processes. The third learning and working environment perspective includes digital, social and physical places. Integration of three dimensions creates the Campus Retrofitting, CARE-FRAME, which characterizes perspectives of the activity-based retrofitting as systemic context, co-operative processes and integrative, blended environments.   The criteria to set the perspectives in a certain manner are based on the identified activity based retrofitting approach. The intention is to visualize the core of campus retrofitting, which is based on understanding the regime practices, potential for co-creation and importance of the way how places are understood from social aspect. This provides a core of activities, which then can be supported by surrounding aspects including e.g. landscape level drivers and niche level trials, co-operative processes of finance and evaluation and digital and physical places.   The CARE-FRAME is illustrated in Figure 1.

Figure 1: Campus Retrofitting frame

The core of the CARE-FRAME is about the behavior and use of space, which can be co-created within the university community. This perspective is lacking from the technically orientated retrofitting. Integration of different perspectives provides a model, which can be used for more holistic approach to motives, processes and outcome of retrofitting.

These three perspectives frame the retrofitting in the holistic manner including the perspectives of users, property owners and the way how they can combine their resources to develop updated and alternative learning and working environments to campus. The following section provides examples of the use of CARE-FRAME as a practical analysis tool of campus retrofitting.

3   CAMPUS RETROFITTING FRAME IN USE

The cases described in this section are all conducted by University Properties of Finland. They are not large campus development projects but demonstrations within different regimes, departments in three universities in Finland. The departments where the demonstrations took place are Teacher Training School in University of Oulu, department of Music in University of Jyväskylä and School of Information Sciences in University of Tampere. All of them had co-creation processes as a part of campus retrofitting demonstration. The focus in all three demonstrations was in new use of the existing place, the social practices and needs for the physical and digital environment.

The reason to focus only on Finnish cases is due to the fact that the selection of campus retrofitting cases was the most versatile in Finland. While Nordic cases are described and analyzed in the former publications (Eriksson et al. 2014; Eriksson et al. 2015; Nenonen et al. 2016), this paper has a national approach. University Properties of Finland has developed their campus with joint demonstrations that has been used to test and develop scalable solutions. The experimental and explorative approach of the demonstrations enables rapid and impressive changes that develop along with user needs. The decision to begin a larger retrofitting project is a significant physical, digital and social investment and can be a difficult decision to make. To help move this step forward, the changes can be tested beforehand in campus retrofitting demonstrations.

Demonstrations are about identifying the change in the requirements of the space during its entire life span in campus regime. During the process, users and experts co-create, build and test the new space and the concepts of operating it concepts by adapting to the social environment in physical or digital platform. The implementation of the change is followed; co-evaluated and problematic items are developed further as soon as they are detected. Demonstrations are projects in which prototypes of future facilities and culture are created. New ideas and experiments require user participation, making observations and learning from the process. Methods used in co-creation, as well as usage and circumstance measurements, have been utilized to help the development. Performing demonstrations and a culture of experimentation offer opportunities to utilize a renovation budget in a new way: instead of updating the facilities to their original form, as is traditionally done, the facilities are renovated to correspond to modern and future functional needs. For this, the strategic, tactical and operational needs of the activities have been identified and agreed in co-operation with the users.

4   CASE DESCRIPTIONS

4.1   Case Ubiko
The core of case Ubiko was to enhance social place of various learning needs and teamwork between teachers. The driver was a regime level principle of Oulu University, Finland in Teacher Training School to guarantee students' versatile human growth and learning. The co-

creation of a new kind of teaching unit with teachers, pupils and an architect was made in a dialogue. Because Ubiko's design process was led by the users, it was different from normal processes. Deviating from normal practice, the architect did not take part in the design from the first steps of the project; they only joined the team after the teachers had formed the key goals of the change. In addition, the budget was formed during the project. The role of the architect was to draw up the designs based on the goal, through discussions with the core group.

The project created spaces for active learning between classrooms and corridors that formed a rich learning environment together with the classrooms. New space solutions help teachers provide rhythm to and organize their lessons. For example, the lesson can begin in the classroom of their own, where instructions are given, and then the students can spread out to work in small groups in the lobby. In addition with that the technology (e.g. use of IPad´s) was an essential part of designing the activities and physical space. In the case of team teaching, sliding doors that divide the classrooms from the lobby enable the formation of larger space entities. Teachers have their own working space in the classrooms where they can prepare for the next lessons while the students work independently. Landscape drivers included the implication of new method of active learning that involves the student to play a key role in making sure the learning objectives in the curriculum are reached. This was not possible in the old facilities.

Usability of the physical place is supported through acoustics, furniture and lighting solutions. Several groups can work in the lobby simultaneously, thanks to wall-to-wall carpeting and ceiling sound insulators that dampen noise from conversations, people moving and furniture being shifted. At the same time, the carpet offers a soft base to sit on and its color zones can be used to limit the space in teaching situations. Lighting can be adjusted to support the activities: a cold tone refreshes while a warm tone is calming.

The development work of the project that was started in the autumn of 2011 was implemented in co-operation with the teachers working in the cell, teaching researchers and design experts. The process was underlined by the subsidy granted by the Finnish National Board of Education to develop the space as a pedagogical cell solution that inspires learning. The co-investing included the input from the property owner in addition to the grant.

After the space was adopted, Ubiko's impact and development needs have been monitored by comparing it to traditional teaching cells. Use experiences gathered from students and teachers reveal that the key goals set for Ubiko have been achieved. During the first year, the use of the spaces was clearly more multivariate and collaborative at Ubiko than in the traditional teaching cells used in the comparison. Acoustic solutions had a notable impact on the usability of the facilities and well-being of the users.

4.2   Case Musica

A core of the campus retrofitting process aimed to increase the use of unused space in regime level. The overhaul aimed to create a place where informal learning takes place as a consequence of multidisciplinary, experience-rich and international interaction. Strengthening the role of music with space solutions that enabled playing music both acoustically and electronically was crucial. It was also important to enable the listening of the music of the club also outside the building. The digital environment in the music production and performance required also technical retrofitting. Students' spontaneous culture activities were also added to the space use needs.

The co-creation was conducted by using Charette-method. A Charrette is a multi-day negotiation and planning process that harnesses different kinds of experts. A Charrette gives all affected parties the possibility to state their opinions about the plan and also to change the new plan. Careful selection of stakeholders and development at the site are important to a successful Charrette. The process varies from a three to a seven day event depending, for

example, on the size of the project and the design process. In Musica the co-creation process lasted five days. Parties included students, university staff, researchers, professors, an architect, a representative of the National Board of Antiquities, the developer, upper secondary school students and other interested parties.

Musica is a building in the department of Music in University of Jyväskylä, Finland and lobby of this building was selected as a change target because there was a desire to turn empty facilities in the building that used to house a restaurant into a facility that supported learning, teaching and research. A new kind of space concept that served the study of music, performance, event use and spending time was created during the five-day Charrette workshop. Plans were illustrated with three-dimensional floor plan sketches made of play-dough. Then plans were illustrated using a scale model made by the participants, based on which the architect drew the proposal regarding the space solution. In the last joint section of the Charrette, the scale model and floor plans were introduced and the feedback on them was processed and applied to the designs.

User participation in the development of Musica was crucial, because the space needs of the students were revealed to be completely different to what the designers had envisioned. Students wanted a free performance arena with acoustic solutions that would allow the performance of both acoustic and electronic music in the premises. The performance methods require different solutions, and the use of a fog machine had to be made possible by changing fire alarms from smoke detectors into temperature detectors. Because the ground floor did not have any toilets, the stairway joining the entire building would have had to kept open day and night, but this was not possible due to security reasons. As a consequence of realizing this problem, moving around was limited to the ground floor by turning a cleaning cupboard in the lobby into a toilet.

Without the expertise of the users during the design phase, the existing facilities could not have been used in their current form. Joint design also had an impact on the costs of the project. Traditional construction planning would have been more expensive than the measures taken as a consequence of precise mapping of needs to provide value for the users. This was an important saving to the property owner. The change was co-funded, also university joined to the costs.

During the first year, various events, seminars, workshops and parties have been arranged in the facilities. Catering during the events is possible, with a bar kitchen created in the old kitchen. An electronic environment was created to serve meeting and studying requirements, as well as the electronic performance of music. The idea has been to create different uses for the spaces as a consequence of users' creative solutions and needs, in which case the users make the space personal. The end result enables the networking of music professionals, experts and students and also opens the campus to other city residents. A new kind of club concept and the excellent acoustics in the space attract performers from all over Finland. The space plays a notable role as an implementer of the joint music campus vision of the University of Jyväskylä and University of Applied Sciences, which indicates that the process had also landscape effects.

4.3   Case Oasis

There was a desire to have a modern version of a library that was aligned to its subject, information science, where learning takes place by combining science and playing, via the industry literature and users' interaction, games and media in University of Tampere, Finland. The design process was started two years before Oasis was completed by using a survey to map the students' experiences of the student facilities on the campus. Responses from nearly 500 students proved that there was extensive dissatisfaction regarding the accessibility and characteristics of the workspaces on the campus. A group of students from various fields who responded to the survey enrolled in the next phase of the process.

The participants were invited to the future facilities of Oasis for group interviews in which the key themes related to the creation of the new concept were reviewed. The process continued by arranging several joint workshops for students and researchers in which the participants were free to come up with ideas for new concepts to achieve a better operating environment. The concepts have been introduced in the 'Making of Oasis' book, which was published on the Oasis website. The architect drew up designs for the space based on the wishes and concepts created by the participants. A user representative took part in the construction process to ensure that the implementation of the new kind of space and exceptional space solutions and needs were successful. After the change work, the information science students tested the facilities for a month to enable the final development work to be carried out before the official opening.

A strong influence behind the change has been the 'Oasis philosophy' that was developed during the process. This emphasizes the opportunistic use of the space and communal and experiential goals. In practice, opportunistic use refers to the user friendliness of the space and the use possibilities it offers, especially in the field of technology. The community spirit and experimental nature of the space are created as students and staffs meets outside lectures and create a close community that supports learning and commitment when you feel you belong to it.

The space had to enable the seamless mixing of studying and free time. To realise the goals, both the students and staff took part in the creation process of the space. The funding was shared between university property owner and the university. Since its completion, concept Oasis has been in active use, especially for spontaneous studying, event activities, and just spending time. The project was funded together.

Now OASIS is a social learning and research space at the University of Tampere. The key characteristic of the space is its playful, elevated auditorium like floor plan with bookshelves and four group stations with TV screens on the sides of the room. In addition to the big room, there is a small tube-like space underneath the highest step and a more conventional meeting room with open windows to the corridor and peek-windows to the OASIS. OASIS is a research-driven space: the design of the space was informed by design research conducted at the Tampere Research Center for Information and Media (TRIM), and ongoing follow up study of OASIS works as a basis for the future development. The space is open to everyone and it is not restricted to users during the opening hours of the building at all. There was a desire to ensure that the purpose of use of the space was not defined in advance, but that it was allowed to form itself through general use. Only the weekly events, such as games nights and hours reserved for quiet working, set temporary limits to the use.

Activities and furniture are revamped each semester: The fourth season that began in the autumn of 2015 introduced a 'meeting tub' filled with plastic balls, and a knitting corner. Some of the activities in the space take place via social media, which is utilized not only for communications but also for interaction between users. Operations at Oasis are the responsibility of Key Master persons who work on a volunteer basis. These people help users, arrange events and develop the facilities. Changing, playful elements are tried out at Oasis: pillows that make angry and happy sounds created an atmosphere and attracted new visitors. Relaxed meetings and working is possible in the 'meeting tub'. The walls at the floor level have been equipped with sliding glass doors to emphasize the experience of openness. Wall-to-wall carpeting improves acoustics and comfort through its vibrant color range, while it offers a soft seat in the platforms in addition to beanbag chairs.

4.4   Summary of the cases

The campus retrofitting cases presented are summarized in the following Table 1 by using CARE-FRAME.

Perspective		Case Ubiko	Case Musica	Case Oasis
CARE CORE	**Regime**	Teacher Training School´s aim to guarantee students' versatile human growth and learning	Department of Music aim to increase informal learning by enhancing multidisciplinary, experience-rich and international interaction	School of Information sciences aim to enhance learning by combining science and playing, via the industry literature and users' interaction, games and media
	Social	New ways of teaching in more collaborative way: various learning needs and teamwork between teachers	Informal learning by providing a platform for pending time, performing, learning and organizing events	Communal and experiential processes for learning and encouraging the opportunistic use of the space
	Co-creation	Co-creation with teachers, an architect joined after the teachers had defined the goals of the change which is achieved by retrofitting process	Co-creations with diverse users by using Charette-method	Ethnographic study and co-creation with students and staff – two years orientation and background investigation for design brief and co-design with architect
Landscape		New method of active learning that involves the student to play a key role in making sure the learning objectives in the curriculum are reached	New ways of performing music in collaboration with local stakeholders, e.g. university of applied science and providing a possibility for the town to use the place	New ways of providing open learning environment which is easy to access in the university campus
Digital		Digital tools were part of the learning environment use and design	Using the digital technology both in music production and performance	Interfaces and accessibility with diverse devices, social media as one platform
Co-financing		National Grant for the University and investment of property owner	Property owner and University	Property owner and University
Physical		The old, unsuitable classroom was replaced with the new learning environment which is not according to the traditional space typology of school	The empty, neutral lobby with closed cantina changed to the active culture hub and a meeting place in the campus	The traditional meeting room area changed to a social learning and research space, which is open to everyone
Niche		From six classrooms to one multifunctional area for different learning activities with good indoor environment	From empty lobby to towns best stage and club kind of environment – music hub	From neutral meeting room to multifunctional learning Living lab
Co-evaluating		Feedback and learning outcomes, monitoring the use of space	User surveys, sensors	User feedback, observations – ongoing development based on conducted playful experiments research

Table 1: Analysis of cases by Campus Retrofitting frame

CARE-FRAME indicates that the core is always about the change in user processes (social perspective in regime (school, department) level. The understanding of changing needs happened in co-creation process and architects joint to the co-creation activities. The agreements of co-financing provided to develop new physical and digital platform. In all cases the university took the financing responsibility of digital environment and the refurbishment costs were shared. The cases provide niche solutions like multifunctional classroom, music hub and living lab and they had also landscape effect: in the first case it was in curriculum level, in the second case in town level and in the third case in campus level. The co-evaluation in the cases took place by users and by property owner. The evaluation agenda was set in the early phase of the process because all parties were interested in the effectiveness of retrofitting changes. This provides data for further development.

The CARE-FRAME provides a holistic approach to the campus retrofitting cases. It makes it easier to identify the intangible but important perspective of user processes in the retrofitting process. The process is based on user activities not only to technical changes in the physical environments. If the starting point had been in physical environment more the activities in the space would not have been leading the solutions, but most likely the technology-based solutions would have been there. CARE-core captures the non-measurable and not explicit perspectives which then can be supported by more quantified perspectives of retrofitting, e.g. money, square meters, sensory data etc. The larger campus retrofitting projects can be analyzed by using CARE-FRAME in the similar way as it is now tested in the smaller cases.

5   CONCLUSIONS AND DISCUSSION

Joint development, joint funding and joint assessments are perspectives of campus retrofitting, which includes the update of activities and facilities. Conducted experimental demonstrations are scalable. The concepts, processes, services and technical solutions in future learning and working environments need to be developed together with users based on their visions and experiences how the processes will change.

Today's universities largely embrace a model of higher education developed over 100 years ago. Campus development is no longer about the construction of lecture halls, reading rooms and offices. Campus development is an important strategic tool to attract and keep excellent researchers, teachers and students. Campus retrofitting is part of this development.

The demand for space that supports the fundamental characteristics of experimentation, interdisciplinary work, education programs and collaboration with private and public organizations is urgent. Campus retrofitting is not only updating the existing premises, it is a co-operative process to develop together solutions, which are sustainable also in the future.

CARE-FRAME characterizes perspectives of the activity-based retrofitting as systemic context, co-operative processes and integrative, blended environments. It needs further development and validation. It has been developed based on experiences of retrofitting in Nordic campuses. It is one tool to involve different stakeholders around the same table in the development of built environment as a platform for future activities.

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3

HOW CAN IMPLEMENTATION OF IT IN FM BE IMPROVED

3.1

Information System Strategies in Facilities Management – Based on Five Process Studies

Poul Ebbesen, Jan Karlshøj, Sten Bonke and Per Anker Jensen

3.2

Housing Organizations Using Social Media in Sustainable Building Operation – A Review of Eighteen Danish Cases

Helene Hjort Knudsen and Susanne Balslev Nielsen

3.3

KPI Visualization Supporting the Involvement of Facility Managers in Early Design

Francisco Forns-Samso and Tuomas Laine

3.1 INFORMATION SYSTEM STRATEGIES IN FACILITIES MANAGEMENT – BASED ON FIVE PROCESS STUDIES

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ABSTRACT

Purpose: To present observed Information System (IS) strategies in Facilities Management (FM).

Background and Relevance: It is generally recognised that IS implementation and use should support the business strategy of an organisation. To gain more insight into this issue in the FM domain, this paper presents an analysis of how business strategies are supported by IS implementation and use in five cases.

Approach (Theory/Methodology): This paper applies the view of IS strategy as the use of IS to support business strategy. Based on chronological event maps concerning implementation and use of IS, the use of IS to support business strategies is studied and illustrated in an Information System – Business Process (IS-BP) framework.

Results and practical implication: It is found that IS strategy dictating use of IS with a high degree of uniformity, interoperability and data reliability can support more advanced and externally oriented business strategies.

Research limitations: This study is based on two interviews in each of the cases. More insights could be obtained if complete longitudinal studies and more cases were included.

Originality/value: This paper is the first research based contribution to development of an overview of IS strategies in FM. The purpose is to suggest a methodology for establishing such strategies based on studies of events during the past 25 years and using an IS-BP framework.

Keywords
Information Systems, Implementation, Facilities Management, Process Research, IS Strategy

1   INTRODUCTION

Information Systems (IS) based on different Information Technologies (IT) are increasingly being used and implemented in FM departments.

It is generally recognised that IS implementation and use should support the business strategy of an organisation. To gain more insight into this issue in the FM domain, this paper presents an analysis of how business strategy is supported by IS implementation and use in five cases. Basic characteristics of the five cases are presented in Table 1.

Table 1: Characteristics of the five cases

Case	Letter.	A	B	C	D	E
Organ.	Ownership	Public	Private	Public	Private	Private
	Business Area	Public Services	Transport.	Entertainment and Events	Real Estate Investment	Transport.
	Region	Denmark	Denmark	Australia	Sweden	Germany
	Employed	600	2200	750	350	6000
Facilities	Square Meters	2,200,000	700,000	55,000	2,500,000	2,300,000
FM Dept.	White Collar Employees	234	16	8	225	216
IS Project supports Mgmt. of	Information	●	●	●	●	●
	Workflow	●	-	-	-	●
	Construction.	-	-	●	-	-
	Maintenance.	●	-	-	-	●
	Way finding	-	-	●	-	-
	Building Auto.	-	-	-	●	-
Core IT in IS Project	Core IT in the IS:	Database, BIM, GIS	BIM, Database	BIM, Database, Laser scan, field location	Fiber Net, Sensors, Database	CAD, GIS, Workflow, Database

Because of space constraints only the most necessary references are included in this paper. Additional relevant literature can be found in the forthcoming PhD dissertation (Ebbesen 2016b) and in the comprehensive review on literature related to IT in FM (Ebbesen 2015) which this paper is based on.

The structure of the paper is as follows: In the next section basic concepts are explained and relevant literature is presented. Section 3 explains the overall approach applied to this paper. Section 4 presents the analysis of each of the cases giving an insight into the IS strategies used. Section 5 delivers results from the analysis in a condensed form. In section 6 the results are discussed and conclusions related to IS strategies in FM are proposed. Finally section 6 provides guidelines to practice in relation to IS strategy.

2   STRATEGY AND IS STRATEGY

There is no fixed definition of strategy. Strategy in warfare is "the science or art of employing all the military, economic, political, and other resources of a country to achieve the objects of war" (Cohen 2016). General strategy is about how objectives are achieved. This paper treats strategy as a change process which can be observed over time. The process includes incremental changes, and more radical changes such as changes taking place during IS projects.

This paper applied the business centric view of *IS strategy as the use of IS to support business strategy* as described in Chen et al. (2010). The questions answered by this position for a chosen business strategy is how IS can be used to support business strategy to gain and sustain the targeted competitive advantage? This view implies that the IS strategy is developed as an inherent part of the business strategy, and that the IS strategy is not a strategy on its own (Chen et al. 2010). In the literature other views of IS strategy can be found, e.g. a view of IS strategy being the master plan of the IS and a view of IS strategy being the shared view of the IS role within the organisation (Chen et al. 2010). These two alternative views on IS strategy are not applied in this paper.

A realized strategy can be based both on a deliberate strategy and on emergent strategy. Emergent strategy indicates that the strategy has emerged over time. Deliberate strategy can be based on intended strategy, e.g. a strategy defined by top management. Intended strategy can become unrealized strategy or deliberate strategy (Mintzberg 1987). In this paper the realized IS strategy is studied.

The approach applied in this paper complies to some degree with what is suggested by Waema & Walsham (1990) who state "*that it is imperative to treat strategy formulation as a continuous process in a constantly changing context. We therefore see the need for a broad and sound theoretical basis for the understanding of both context and process and believe that longitudinal interpretive case studies provide essential empirical evidence to test the validity of that approach*".

3   METHODOLOGY

In each of the five cases listed in Table 1 two interviews have been conducted with managers and employees responsible for implementation and use of IS for FM purposes.

The condensed event process maps in the appendices are based on more detailed event chronologies, which contain all events mentioned by interview respondents as relevant for understanding the IS and organisational change history and plans. The detailed event chronologies will be published in the forthcoming PhD dissertation (Ebbesen 2016b). The condensed event maps in the appendices contain important events in the IS implementation and use history of the cases. The events shown in the condensed event maps comply with the following two criteria: (1) Events related to specific business processes and (2) Events concerning IS change. These criteria imply leaving out events concerning e.g. organisational changes from the condensed event maps. Information about such events used in this paper is represented in the detailed event chronologies and in the interview data. In the condensed event maps the scope of current IS projects are shown with dashed rectangles. Each condensed event map is incomplete as it does not contain all FM business processes and IS in

the FM department, however it contains enough information to understand central aspects of the IS implementation and use process and the IS strategy.

The condensed event process maps are based on empirical data collected from IS implementation and use cases in FM departments in Denmark, Sweden, Australis and Germany. The five cases included in this paper, which are listed in Table 1, are selected from a broad survey of 16 cases.

In section 4 the use of IS to support business strategies is analysed, based on the condensed event maps, and illustrated using an Information System and Business Process (IS-BP) framework proposed by Ebbesen (2016). The IS-BP framework demonstrates that ideally IS should support BP which should be aligned with business strategy (BS). The framework thereby also illustrates how use of IS can support BS. The IS-BP framework contains four layers; computer network (CN), Information System (IS), Business Process (BP) and Business Strategy BS).

In section 5 the main uses of IS to support business strategy (IS strategy) in the five cases are presented in a condensed form. Likewise the business strategies which are supported by the use of IS are presented. These results are based on the analysis in section 4.

The qualitative approach applied to this study includes events during the last 25 years and reveals patterns and diversities in the unfolding of IS implementation and use in the scope of IS projects in FM.

4   ANALYSIS OF IS STRATEGIES IN THE FIVE CASES

In this section the IS strategy in each of the cases is analysed and illustrated using the IS-BP framework. As part of the analysis this section furthermore describes the IS strategies in both the current and the future state of the business strategy (BS), business process (BP), Information System (IS) and Computer Network (CN) layers in the IS-BP framework, and finally it describes the objectives and scope of current change projects including IS projects. See e.g. Figure 1 below. Some central strategies found in the analysis in this section are listed and explained in Table 2.

Table 2: Some of the strategy types found in the analysis

Strategy type name	Strategy type explained
Business Process Autonomy	A FM business process can be executed in different ways. Each facilities manager decides autonomously how to do things.
IS Autonomy	Each FM business process can be supported by any IS. It is decided autonomously by each facilities manager.
Business Process Uniformity	A FM business process can only be executed in one way and only supported by a specific IS. There may be standard FM business procedures.
Asset Business Process Uniformity	A FM business procedure relates to a specific set of assets, can only be executed in one way, and only be supported by a specific IS. There may be standard FM business procedures.

4.1   Case A

In case A, a variety of IS, each supporting specific FM business processes, have been implemented during the years in the FM department. Appendix A shows the event chronology of the IS supporting the business processes maintenance management, help desk and error handling, facilities registration and inspection, space management and lease management. The IS/IT supporting these business processes include a Computer Added Maintenance Management System (CMMS), Spreadsheets, a Help Desk / Error Handling System and a Tablet based Space Management (SM) System.

These IS are not internally connected and do not interact. Furthermore there are no standard procedures for exchange of data between the IS and no common exchange formats. In other words these *IS have a low degree of interoperability*. With no automated data exchange or sharing possibilities, the IS now contain redundant and inaccurate data about the facilities. This is seen as a major challenge in the execution of the different business processes.

The concept of interoperability is a basic concept and used several times in this paper. Interoperability is the ability to exchange data between applications, which smoothes workflows and sometimes facilitates their automation (Eastman et al. 2011).

During years the facilities managers responsible for the FM business processes have been allowed to implement special IS only supporting their specific FM business process. The facilities managers have not been required to choose solutions complying with overall organisational requirements. So far this "*IS autonomy*" has been a more or less deliberate strategy, which was found as implicit information in the empirical data of this study, e.g. by analysing the condensed event process map. This aspect was not directly addressed by the interview respondents and is not included in an overall well defined IS strategy of the organisation.

For each FM business process differences in work procedures have developed over the years. Whether the use of different IS for the same business process, e.g. the use of both spreadsheets and a SM system in the execution of the business processes facilities registration and inspection, have had an influence on this is unclear, but it is seen as a problem by the management of the FM department. In short this business process issue can be defined as a *lack of standard business procedures*.

In all the execution of FM business processes had an autonomous character and "*business process autonomy*" had become the norm within the FM organisation. It was decided to change this so that business processes in the future would be executed in a uniform manner, which implies that facilities managers in the future will be forced to follow standard business procedures. As a tool to change to "*business process uniformity*" it was decided to replace the different IS, hitherto supporting the FM business processes maintenance management, help desk and error handling, facilities registration and inspection, space management and lease management, with a new Integrated Workplace Management System (IWMS). The IS project set up to handle this only included the IS change, and the objective of the IS project was to *reduce the number of IS* used within the organisation. It is expected that implementing the new IS will lead to a *high degree of interoperability* because all processes will be supported by only one system.

When the IS has been implemented the facilities managers, no matter which business processes they are responsible for, will be instructed to use the new common IS (the IWMS)

and thereby work in a uniform way. This part of the process of *implementing business process uniformity* is expected to happen more or less by itself and is not part of the IS project.

The change process in case A is illustrated below in Figure 1. The figure is based on the Information System and Business Process Framework (IS-BP Framework) proposed by Ebbesen (2016). The figure illustrates how the change to a new common IS supports the implementation of business process uniformity.

Figure 1: IS strategies in the current and future state of the implementation process. Case A.

Current (left side) and future state (right side) of IS strategy in the business strategy, business process, information system and computer network layers. Change process objectives and scope of IS project (middle).
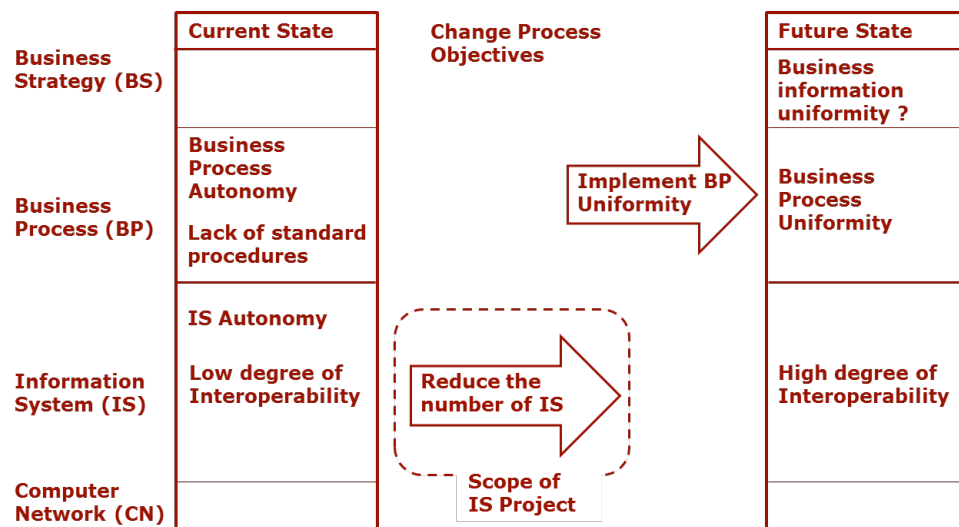
As described in the previous section, this paper applies the view of IS strategy as the strategy of the use of IS to support business strategy. However the empirical data in case A reveals no support of a specific business strategy by the future higher degree of interoperability and future business process uniformity. The dominant intention could be to support a business strategy of *business information uniformity*. The aim of such a business strategy may be to speed up access to business information.

4.2 Case B

In case B there are two current IS projects: IS project 1 and IS project 2. See appendix B.

For more than a decade the business process space management has been supported by a CAD based Space Management (SM) System, which now needs to be upgraded to comply with current standards. The main aim of IS project 1 is therefore *upgrade of the IS*. See Figure 2.

Figure 2: IS strategies in the current and future state of the implementation process. Case B.

Current (left side) and future state (right side) of IS strategy in the business strategy, business process, information system and computer network layers. Change process objectives and scope of IS project (middle).
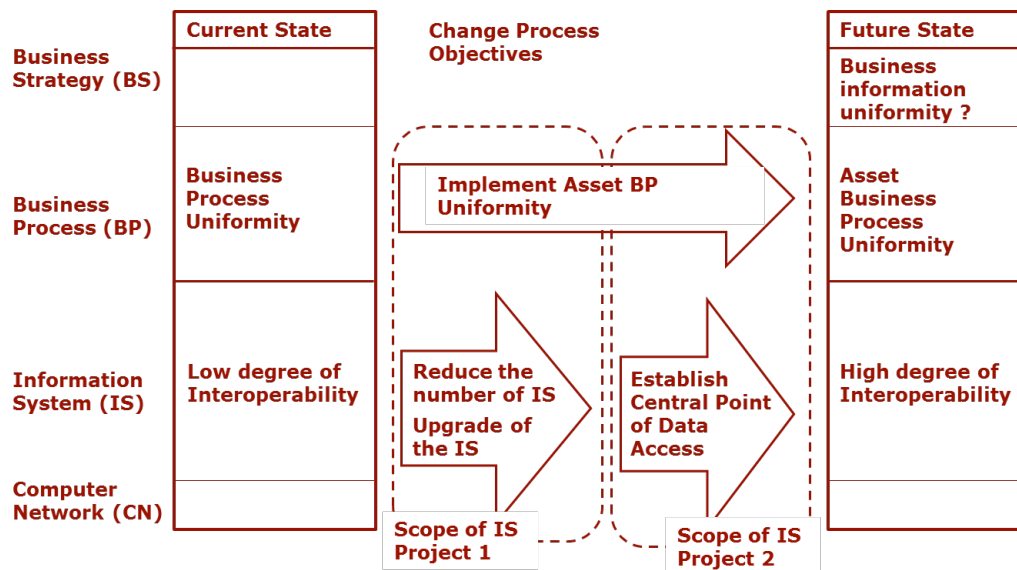
The IS strategy applied before the reorganisation was similar to the new IS strategy in case A. For each business process in case B there was only one right way of doing things. The former IS strategy can therefore be expressed as *business process uniformity*.

The reorganisation has created a need for easier access to facilities related data. Data currently stored in repositories such as Databases Systems and Spreadsheets placed in various parts of the organisation are difficult to access. Just as in case A, these systems are not connected and there are no standard procedures for exchange of data between the systems. *Low degree of interoperability* therefore applies to case B as it did in case A. To deal with this issue facilities related data, supporting the business processes facilities registration and inspection, were therefore, as a part of IS project 1, transferred from the Spreadsheets (where the data had been stored until now) into the upgraded SM System. This additional objective of IS project 1 is to *reduce the number of IS* in use. Reducing the number of IS is expected to lead to a *high degree of interoperability* because these business processes in the future will be supported only by the upgraded SM System.

The additional IS project (IS project 2) is initiated to deal once and for all with the *low degree of interoperability*. IS project 2 is based on an analysis of the many different repositories in the organisation for storing data related to the facilities. In IS project 2 a central database point will be established with links to all existing data repositories. The objective of IS project 2 is thus to *establish a central point of data access*.

Figure 2 illustrates how the change process of reducing the number of IS and establishing a central point of data access support the implementation of asset business process uniformity.

As in case A it is presumed that the objectives of the change process intended to lead to asset BP uniformity and a high degree of interoperability is to support a business strategy of *business information uniformity*. The aim of such a business strategy may be to speed up access to business information.

4.3   Case C

In case C, a strategic decision had been made to establish a digital basis, which can help *speed up the construction management business process*. A main time consuming obstacle in construction management was the necessary surveys, to establish the geometrical data needed, before each construction project could start. This situation can be expressed as *low degree of updated data*. See Figure 3.

Figure 3: IS strategies in the current and future state of the implementation process. Case C.

Current (left side) and future state (right side) of IS strategy in the business strategy, business process, information system and computer network layers. Change process objectives and scope of IS project (middle).
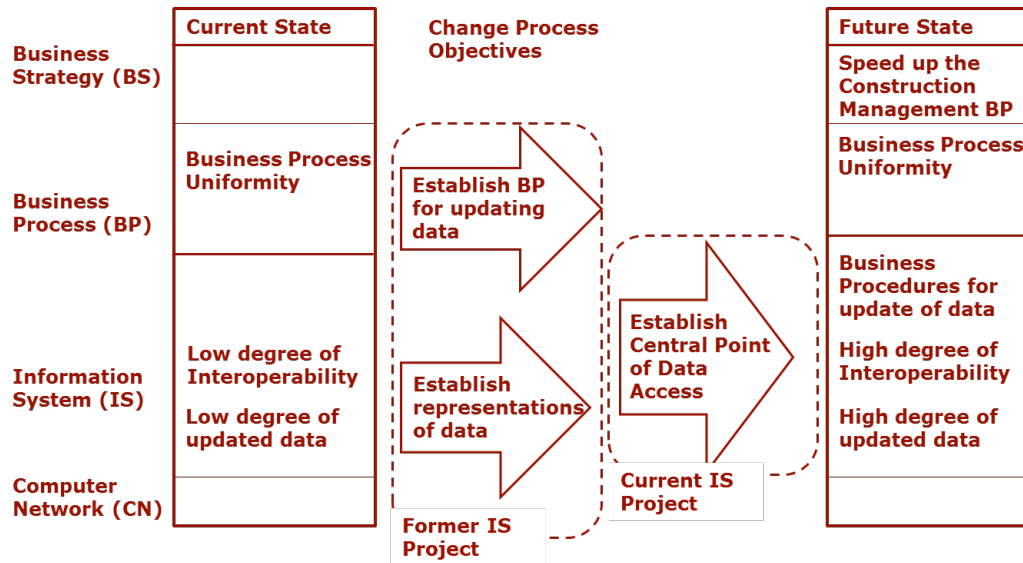
In a former IS project geometrical data representation of the facilities had been established and staff had been hired to keep these data constantly updated according to agreed procedures. In appendix C this is seen as the Point Cloud technology used for scanning the facilities and BIM used to store the geometry based on the point clouds. The aims of this former IS Project can be expressed as follows; to *establish representations of data* and to *establish business process for updating data*. The situation for the future state of the former IS project therefore will be a *high degree of updated data* and *business procedures for update of data*.

In this paper the concept of "data representation" is understood as representations of one type of data, e.g. alphanumeric (A/N) data, with another type of data, e.g. code. An example of this is geometrical data which can be expressed as A/N data, e.g. 100 square meters of floor in a room, which can be represented in a CAD or BIM file as code only with the coordinates of the corners of the room.

In general retrieving existing data, needed for the constructions projects, was characterised as time consuming because data were spread in multiple repositories, e.g. in Spreadsheets, thereby being yet another example of *low degree of interoperability*. To deal with this a current IS project has been initiated to *establish a central point of data access*. The central point will be the overall BIM model of the facilities, which will point to the different data repositories. Data in existing Spreadsheets will be transferred into the central point or to some of the other data repositories. The future state will therefore be a *high degree interoperability*.

In case C facilities managers must comply to some degree of business process uniformity; each FM business process is operated in a certain way and specific IS supports each of the FM business processes. This *business process uniformity* will continue, also in the future state.

4.4   Case D

In a current IS project in case D a fibre based network is being installed in all facilities owed by the organisation. The aim is to *establish a central system for monitoring and control of the facilities* so that different services, such as signage, broad band and electronic access control etc. can be offered to the tenants. Also building automation will be attached to the new central monitoring system. See Figure 4.

The IS project complies with the overall business strategy of keeping tenants satisfied with the conditions of the facilities, so that they stay in the facilities owned by this organisation. The business strategy is in other words it to *keep customers content*. The new services offered are expected to make the tenants choose to stay in the facilities.

The new services available through the central monitoring system have created changes in existing business processes. Control of access the facilities, as an example, will no longer be operated "manually" at the location, but will mainly be operated from one location in a remote monitoring centre. Consequently *changes in business procedures* becomes part of the IS project.

During the years the FM department has established a high degree of accessibility to updated FM related data; there is a *high degree of interoperability* and there are *procedures for keeping data updated*. This is expected to be the case also in the future state. Each FM business process is operated according to standard business procedures and is supported with specific IS: there is *business process uniformity*. As part of the IS project standard business procedures will be updated, but the strategy will still be to obtain business process uniformity.

Figure 4: IS strategies in the current and future state of the implementation process. Case D.

Current (left side) and future state (right side) of IS strategy in the business strategy, business process, information system and computer network layers. Change process objectives and scope of IS project (middle).
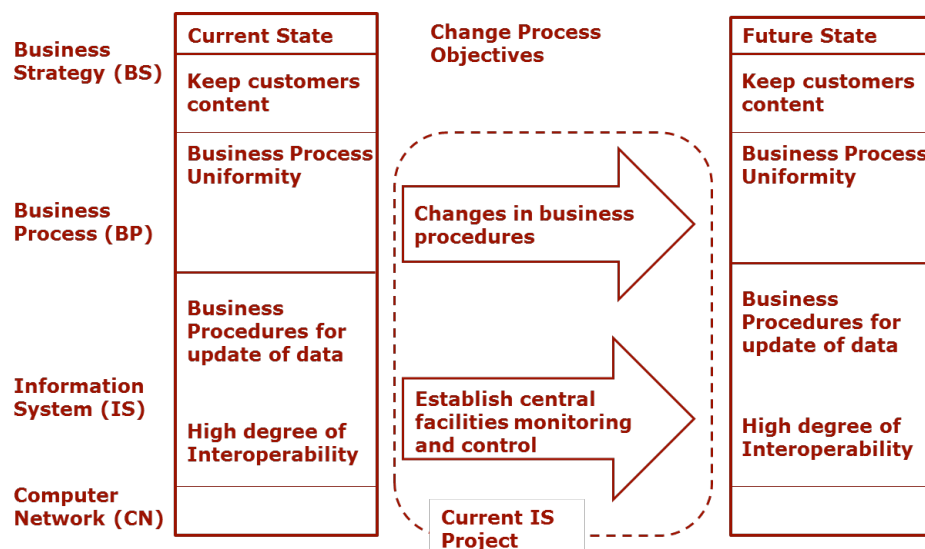
4.5   Case E

In case E each type of asset, e.g. doors or keys/locks, is operated in a specific way and is supported by specific IS, in other words there is *asset business process uniformity*. The facilities managers responsible for a specific type of asset can choose which type of IS they will use to operate this asset, but the selected IS must be capable of retrieving and transferring data of common interest from/to a central database. This model makes data highly accessible. All in all there is a *high degree of interoperability* and there are *procedures for keeping data updated*. See Figure 5.

The aim of a current IS project in case E is to upgrade an existing CAD and GIS based visualisation and data retrieval system used by all facilities managers in the organisation. This *upgrade of the IS* will make the functionality of the system more modern.

The general IS strategy in case E aims at supporting the business strategy of *keeping customers highly content* so that the strategic goal of *being the best supplier* can be achieved. Furthermore it supports the business strategy of *complying with official regulations* which applies to this type of transportation business. See Figure 5. This is not only done with business process uniformity and a high degree of interoperability, but also achieved by *constantly developing the use of IS in each of the business processes to support business strategy*. One example of this is described in Ebbesen & Jensen (2016) where the added value of a user frequency and response system supporting cleaning management within this organisation is presented. This specific IS depends on a high degree of interoperability and on standard business procedures for the FM business process.

Figure 5: IS strategies in the current and future state of the implementation process. Case E.

Current (left side) and future state (right side) of IS strategy in the business strategy, business process, information system and computer network layers. Change process objectives and scope of IS project (middle).
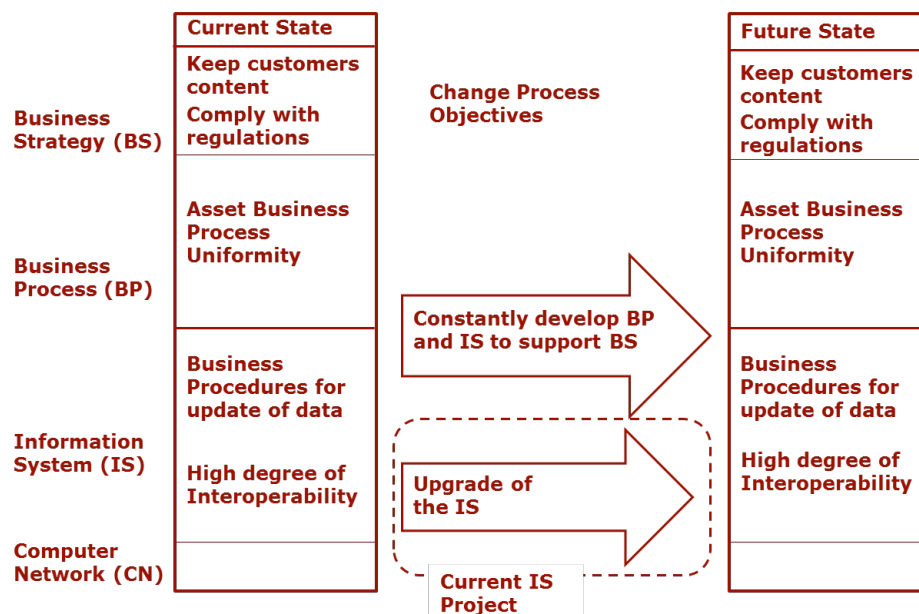
5   RESULTS

Based on condensed representation (Table 3-5) of the analysis made in the previous section, this section presents firstly the main uses of IS to support business strategy (IS strategy) and secondly the business strategies which are supported by the uses of IS in the five cases.

The observed current state IS strategies are listed in Table 3, and Table 4 shows the future state IS strategies. Table 5 shows the observed objectives of the changes taking place between the current and the future state. Table 6 shows the observed business strategies being supported by the IS strategies. All tables have a column for each of the cases A-E.

By comparing Table 3 and Table 4 it becomes clear that there is a move from autonomy towards uniformity, a move from a low degree of interoperability towards a high degree of interoperability and finally a move toward procedures for keeping data updated. This move is illustrated with the two arrows pointing downwards in Table 4. There seems to be a tendency toward more control in the use of IS to support business strategies. IS strategy is intended to control and direct facilities managers to do things the same way (uniformity) to retrieve and store information from a single source of truth (requires interoperability) and to keep information in this single source of truth updated (data reliability).

Table 3: Observed Current state IS Strategies.

Current IS strategies (use of IS to support business strategy) in each of the cases A-E. Bullet (●) indicates use of strategy. Left column indicates to which IS-BP framework layer the strategy belongs.

Layer	Current state IS strategies	Cases				
		A	B	C	D	E
BP	Business Process Autonomy	●	●			
	Lac of standard procedures	●				
	Business Process Uniformity			●	●	
	Asset Business Process Uniformity					●
BP/IS	Business Procedures for Data Update				●	●
IS	IS Autonomy	●				
	Low degree of Interoperability	●	●	●		
	Low degree of data update			●		
	High degree of Update of Data					
IS/CN	High degree of Interoperability				●	●

Table 4: Observed Future state IS Strategies

Future IS strategies (use of IS to support business strategy) in each of the cases A-E.
Bullet (●) indicates use of strategy. Left column indicates to which IS-BP framework layer the strategy belongs.

Layer	Future state IS strategies	Cases				
		A	B	C	D	E
BP	Business Process Autonomy					
	Lac of standard procedures					
	Business Process Uniformity	●		●	●	
	Asset Business Process Uniformity		●			●
BP/IS	Business Procedures for Data Update			●	●	●
IS	IS Autonomy					
	Low degree of Interoperability					
	Low degree of data update					
	High degree of Update of Data			●		
IS/CN	High degree of Interoperability	●	●	●	●	●

Table 5 gives us insight in the way the IS strategy is being implemented. A high degree of interoperability is implemented by reducing the number of IS and by establishing a central points of data access. Uniformity is achieved by requiring a uniform execution of each business process or by requiring a uniform execution of each business process for each type of asset. Data reliability is achieved by requiring data updated according to standard procedures.

Table 5: Observed Change Process Objectives.

Change objectives in current IS projects in each of the cases A-E. Bullet (●) indicates objective is included in the IS project. Left column indicates to which IS-BP framework layer the strategy belongs.

Layer	Change Process Objectives	Cases				
		A	B	C	D	E
BP	Implement BP Uniformity	●				
	Implement Asset BP Uniformity		●			
	Establish BP for update of data			●		
	Change in Business Procedures				●	
BP/IS	Constantly develop BP and IS to support BS					●
IS	Reduce the number of IS	●	●			
	Upgrade IS			●		●
	Establish Representations of data			●		
IS/CN	Establish Central Point of Data Access		●	●		
	Establish Central Facilities Monitoring and Control				●	

Table 6 shows that the business strategy *business information uniformity* is supported by the IS strategy in two of the cases (A and B). In the three other cases (C, D and E) the business strategies supported by the IS strategy *speed up the business process construction management*, *make clients content* and *comply with regulations*, are all business strategies pointing out of the organisation, and thus more ambitious. In these three cases (C, D and E) the IS strategy was in a sense more mature already in the current state compared to the IS strategy in the two first cases (A and B). See Table 3. Apparently more mature IS strategies, meaning IS use with a high degree of uniformity, interoperability and data reliability, can support more advanced and externally oriented business strategies.

Table 6: Observed Future Business Strategies "supported" by IS strategies

Future business strategies "supported" by IS strategies in each of the cases A-E.
Bullet (●) indicates use of strategy.

Layer	Future state Business Strategies	Cases				
		A	B	C	D	E
BS	Business Information Uniformity (?)	●	●			
	Speed up BP Construction Management			●		
	Keep customers content				●	●
	Comply with regulations					●

6   DISCUSSION, CONCLUSIONS AND PRACTICAL IMPLICATIONS

This paper aims at presenting an analysis of IS strategy (the use of IS to support business strategies). Based on data from the five cases it is concluded that:

- IS strategy is intended to control and direct facilities managers to do things the same way (uniformity) to retrieve and store information from a single source of truth (interoperability) and to keep information in this single source of truth updated (data reliability).
- Apparently more mature IS strategies, i.e. IS use with a high degree of uniformity, interoperability and data reliability, can support more advanced and externally oriented business strategies.
- Interoperability is implemented by reducing the number of IS and by establishing a central point of data access. Uniformity is achieved by requiring a uniform execution of each business process or by requiring a uniform execution of each business process for each type of asset. Data reliability is achieved by requiring data updated according to standard procedures.

This study demonstrates that IS implementation processes in FM, constituted by constant incremental changes and by more radical changes during IS projects, continuously improves the use of IS to support business strategy. An interesting aspect is whether we implement IS or implement IS strategy or both?

This study is based on observed realised IS strategies, which can be both deliberate and/or emergent. Each IS strategy may have emerged over time as a result of many events and decisions, and may not have been deliberate.

The methodology applied in this paper can be used to establish IS strategies in practice. Using the IS-BP framework the current state, the future states and the change process, e.g. the IS project, can be mapped. Thereby illustrating how the change in the use of IS can lead to more support of the business strategy.

This study demonstrates that IS implementation projects in FM are not delimited and isolated projects. Rather they appear to be interwoven and linked to past and concurrent IS implementation. Recognising this when planning and executing IS projects in FM is anticipated to strengthen the IS implementation process.

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Appendices

Appendices A-E below contains the condensed event process maps from the five cases A to E. Appendices A-E can also be found in Ebbesen (2016b) together with the detailed event chronologies they are based on.

APPENDIX A. Condensed Event Process maps Case A
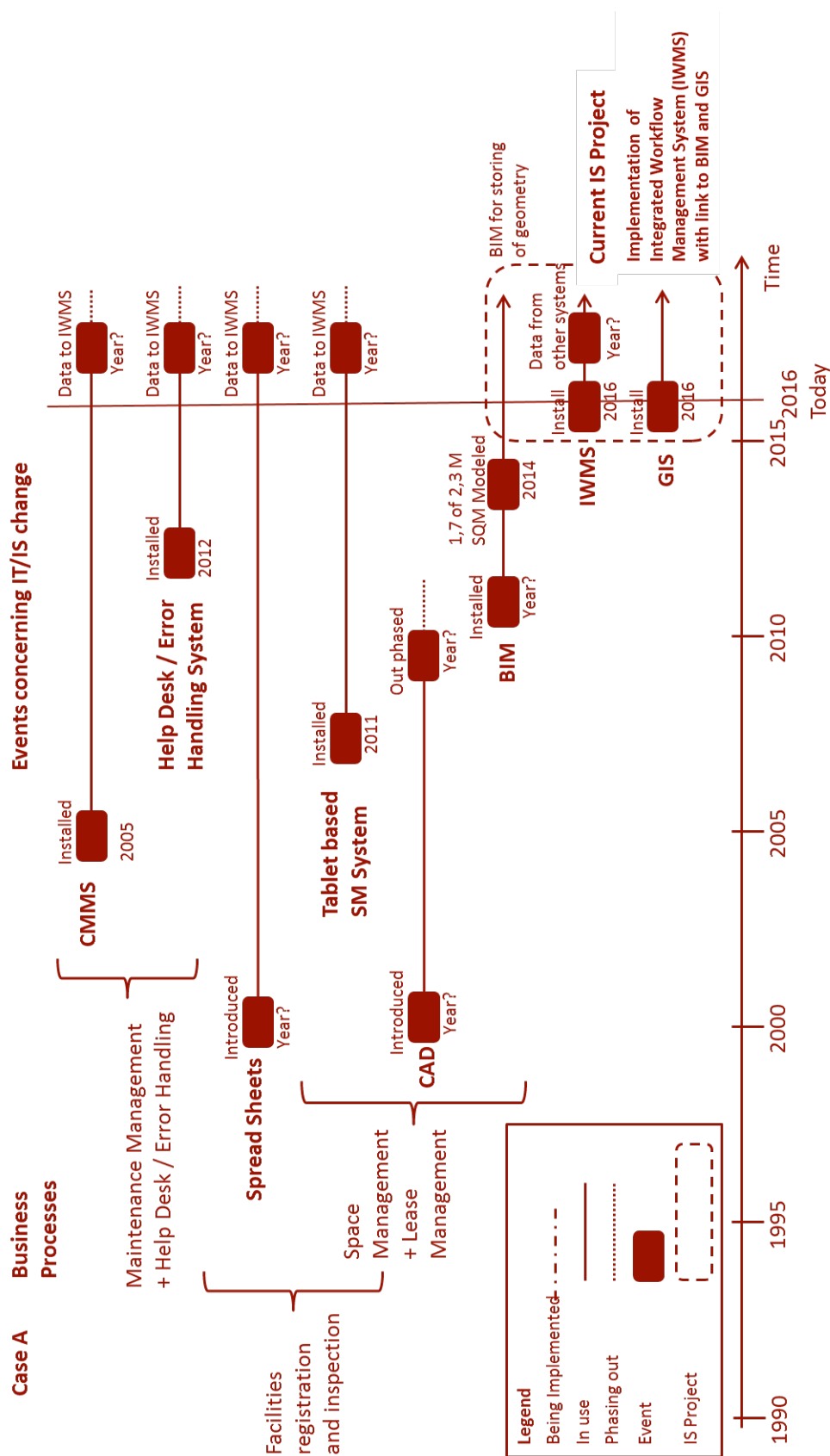
APPENDIX B. Condensed Event Process maps Case B
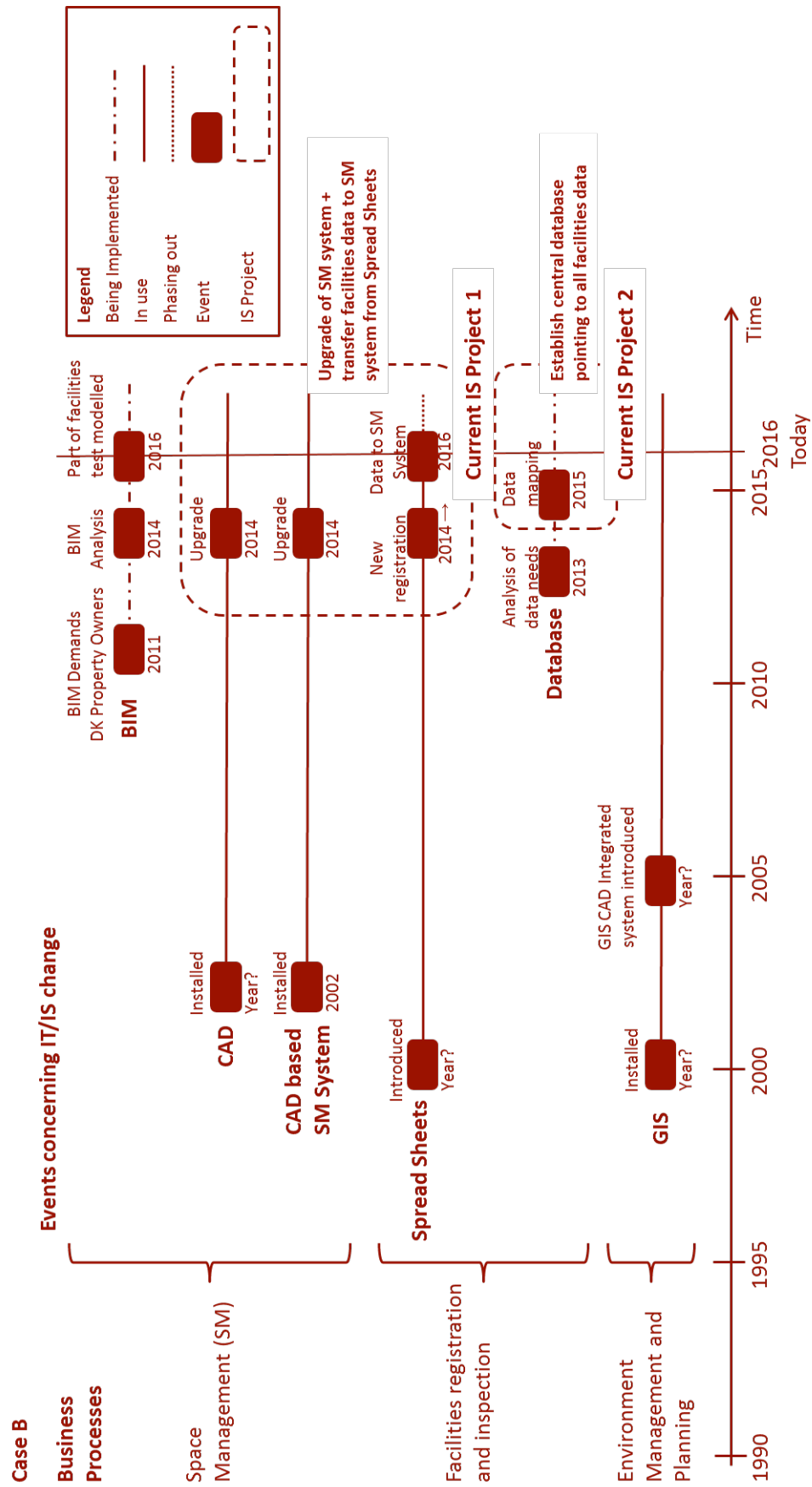
APPENDIX C. Condensed Event Process maps Case C
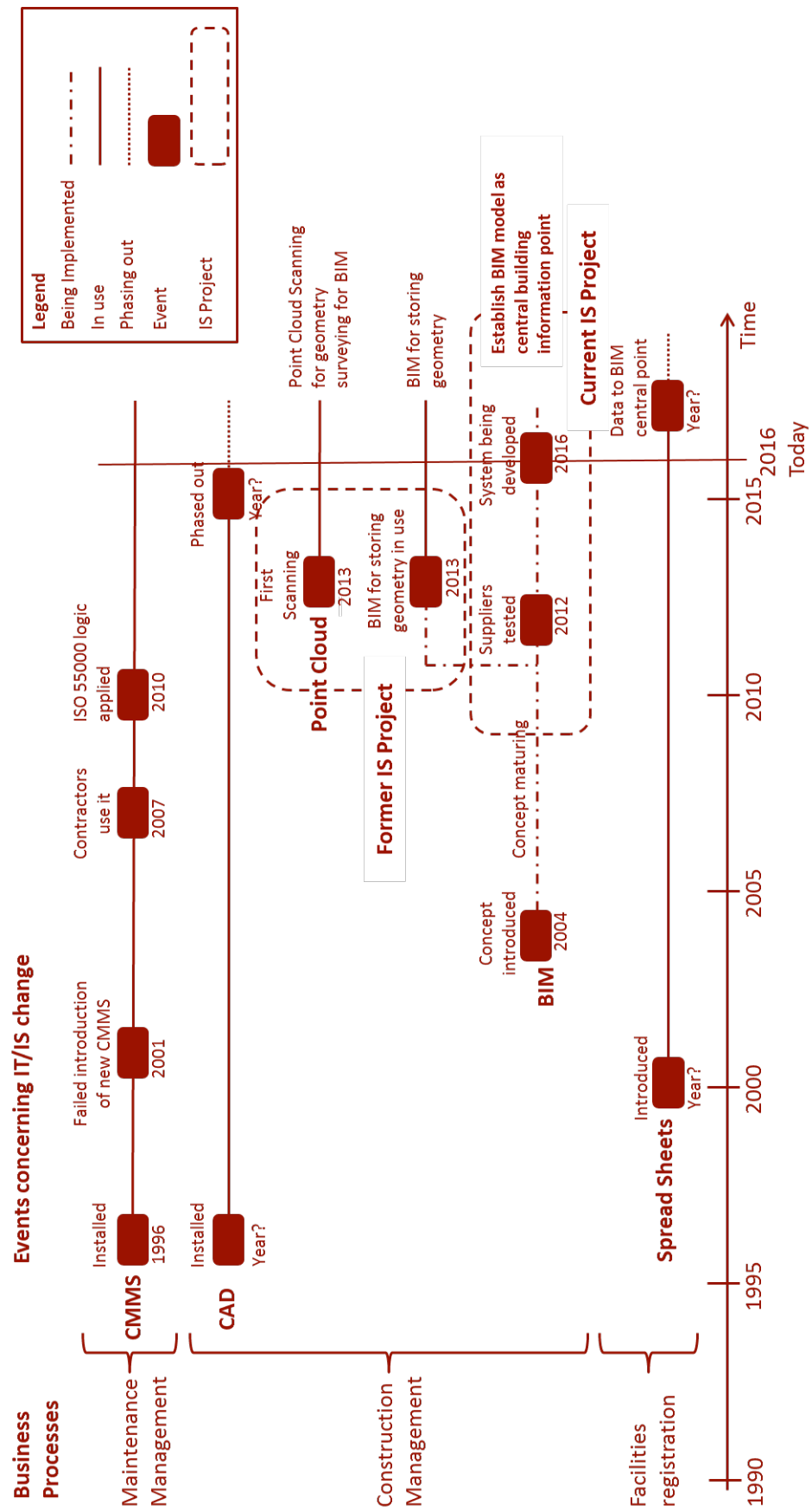
APPENDIX d. Condensed Event Process maps Case D

Case D

Business Processes

Maintenance Management + Help Desk / Error Handling

Facilities registration

Building Automation Management

Events concerning IT/IS change

CMMS — Installed 2011

Database — Installed Year?

Central facilities database

Analysis of Broad Band in all facilities — 2012

Sign system — 2015

Broad Band — 2015

Access Control — 2015

Installation of fibre cable based centralised building automation system in all facilities

Current IS Project

2015 2016 Today

Time

1990   1995   2000   2005   2010

Legend
Being Implemented
In use
Phasing out
Event
IS Project

APPENDIX E. Condensed Event Process maps Case E
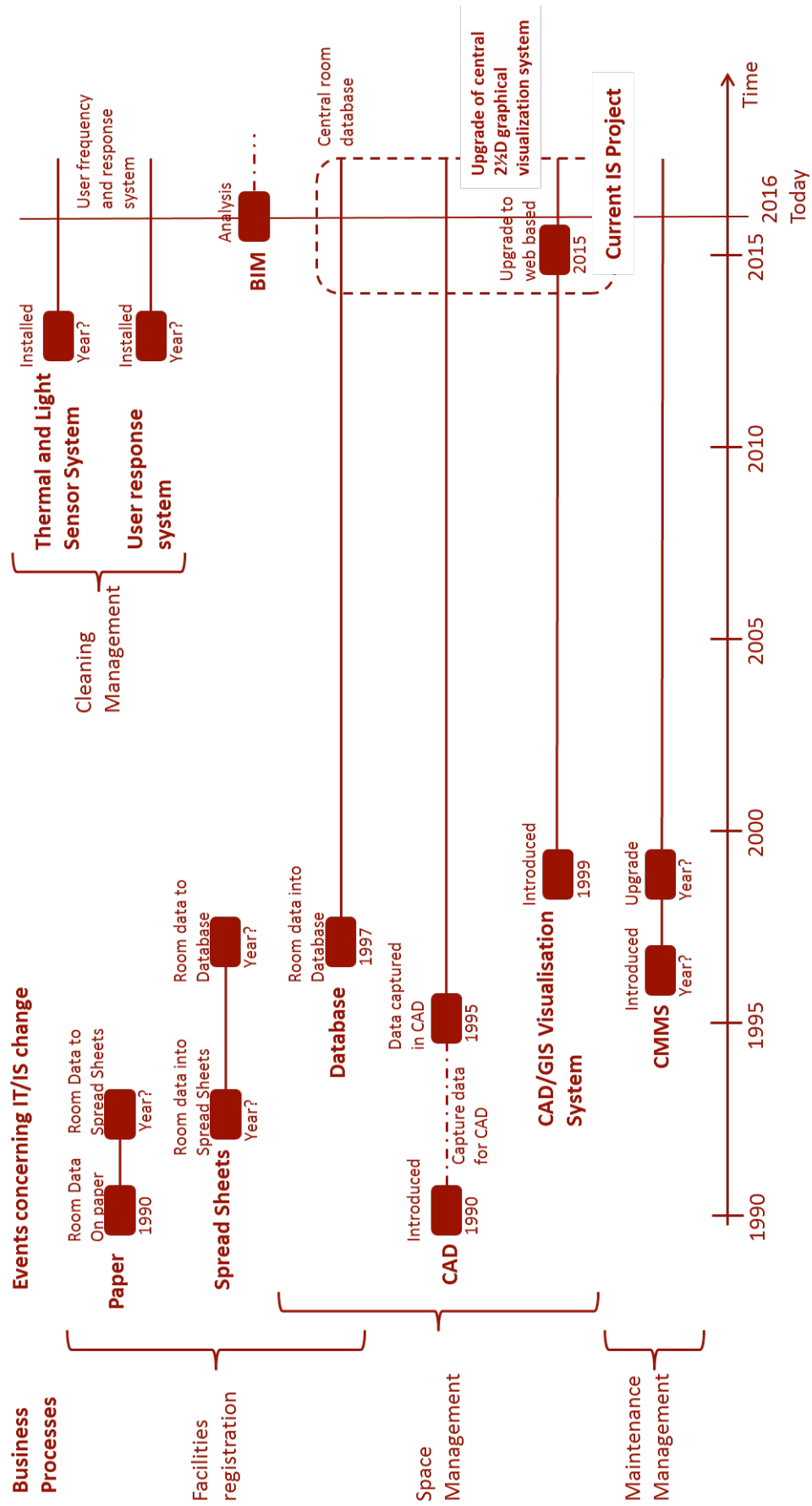
3.2 HOUSING ORGANIZATIONS USING SOCIAL MEDIA IN SUSTAINABLE BUILDING OPERATION – A REVIEW OF EIGHTEEN DANISH CASES

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ABSTRACT

Purpose: This paper investigates whether and how housing organizations use social media in sustainable building operations. This paper is based on a study of the current use of social and interactive media in Danish housing operations.

Background: Social and interactive media represent new ways of communicating that could be a promising step towards sustainability on the societal level.

Approach; Theory/Methodology: The study is a hermeneutic qualitative mixed method study consisting of 3 parts: (1) qualitative interviews, (2) an internet survey to verify the findings and (3) a case study of 18 examples of current use of social and interactive media.

Results: The paper concludes that the use of social media for facilities management purposes is still limited; the cases vary in their strategic focus on top-down or bottom-up communications and possibilities of self-presentation. Virtual communities can give the residents a new chance to share knowledge, ideas, experiences, attitudes and opinions and could become learning environments that lead to more sustainable practices in a neighbourhood.

Practical Implications: This paper shows that social media have overlooked potential for involving residents in sustainable operations and maintenance in housing organizations. The results are not limited to a Danish context and are likely to be of use in other countries as well.

Keywords:
Sustainable Building Operation, Social Media, Residents' Behaviour, Participation

1　　INTRODUCTION

The use of social media in facilities management is currently an understudied topic that is not yet found in current facilities management (FM) research articles. The idea that social media can support communication between facilities management organizations and the residents of local neighbourhoods regarding sustainable behaviour is also new. In the following, we argue why this subject is interesting for municipalities and facilities managers of residential areas. The state of the art is related to social media theory and facilities management theory of sustainable building operation. This section also describes the definitions of social media,

housing organizations, and the stakeholders in charge of sustainable change processes. Readers who want further informa-tion are recommended to study the full report (Knudsen and Nielsen, 2015), which is in Danish.

Recent research states that the energy consumption in newly energy-renovated homes varies by a factor of 2-3 due to residents' behaviour. (Gram-Hanssen, 2014) This means that energy-optimized buildings and renovations seldom achieve the calculated energy consumption or energy savings. One of the problems is that the Danish energy-calculation program BE10 operates with assumptions about indoor air quality and room temperature that do not correspond to the actual behaviour. Another issue is that residents' comfort needs and behaviours change when their flats or houses are easier to heat. With this in mind, it becomes essential to influence resident behaviour when the overall goal is to reduce energy consumption and CO_2 emissions for the housing stock. Resident behaviour also affects the supply and use of resources such as electricity, heating and water, the indoor climate, waste disposal and green areas. For the residents, sustainable building operation in residential areas has a significant impact on their everyday life, wellbeing and happiness, as it involves the management of their home.

In Denmark, there are 528,000 apartments or homes in the social housing sector, and there are 531,000 private rental apartments and approximately 1,500,000 privately owned apartments or homes (Statistics Denmark, 2015). The Nordic social housing organization, NBO, represents 2,500,000 homes in Denmark, Norway, Sweden and Iceland (Nordic Council of Ministers, 2013). Our investigation covers both the social housing organizations and the private property administrations. We have not covered homeowners' associations; because they are generally smaller with limited building administrations, we assume that they also might benefit from using social media. The focus of our study is housing organizations and their need to communicate with residents. What is the current use of social media? For housing organizations, what are the benefits and barriers to using social media? Is there a difference in the communication strategies among the identified cases?

2   STATE OF THE ART

Nielsen, Jensen and Jensen (2012) describe how various forms of ownership are connected with different strategic facilities management organizations (SFMOs), in this case, as social or private housing organizations. They argue that "facilities managers and building operators are key actors in implementation of sustainable measures in building operation" and that "the organization of housing companies has great importance for their environmental performance" (Nielsen et al. 2012). The facilities management organization of social housing consists of operation managers, who have responsibility for the operation of several housing departments, and local janitors, who take care of the housing areas (boiler room, building monitoring system, building information management system, gardening, waste disposal, cleaning etc.) Larger private administrations have the same organization or are structured so that the janitors refer directly to the owner of the housing estate.

Sustainable facilities management (SFM) is facilities management that aims to reduce the consumption of electricity, heating and water and to improve the management of waste collection for the benefit of the planet. In Denmark, SFM is related to the sustainability standard explained by the DGNB standard (Deutsche Gesellschaft für Nachhaltiges Bauen) which was adopted from the German standard and customized to a Danish context.

According to the United Nations' three pillars of sustainability, the DGNB standard addresses the social, economic and environmental values required for a building or urban area to be sustainable. According to Nielsen, Junghans and Jones (2016), "sustainability in the meaning of environmental impact is addressed in FM standard EN15221-7 on Performance Benchmarking (CEN, 2012), using the indicators for primary environmental ratios (e.g., total CO_2 emissions), primary energy, water and waste ratios and other environmental scores".

2.1　Stakeholders and different ownership

There is a significant difference between the primary stakeholder roles in social housing, owner-occupied or private co-ops and privately owned properties for private rental.

Social housing is administered by social housing organizations and is characterized by the residents' collective ownership organized by the local housing department. Therefore, it "is the type of ownership which provides the most integrated frame for common decision making" (Nielsen et al. 2012). In the case of private rental homes, the tenants have limited formal rights; the administrator and the owner represent two different organizations, and the local operation can be carried out by a third party, such as an external operator, caretaker or janitor. Private co-ops and owner-occupied dwellings are administered by self-administration or private administrators, which can vary from very small administrations to bigger private housing organizations. "The incentives and barriers to implementing sustainable facilities management are very dependent on the ownership" according to Nielsen et al. (2012). Their model of SFMOs in social housing and privately administered housing describes certain important actors': residents or tenants, admini-strators, owners and operators, who each have different roles. That study concluded that in social housing companies, administrators have a stronger commitment to sustainable issues, whereas the residents often feel little ownership of the housing department and have a short time horizon and no incentives for long-term investments. In privately owned homes and co-ops there is a strong connection between the ownership and the responsibility amongst residents and stronger economic incentives for investments, but at the same time limited in-house knowledge about sustainable solutions; and the administration is not committed to promoting sustainable FM. In private renting the owner has a strong focus on economic performance. The tenants feel little ownership and have short time-horizons on the return of investment.

One of the major differences between the various ownerships is the organization of the local operation staff (janitors or caretakers). In social housing the local janitors often are in-house and employed by the housing organization, whereas the privately administered co-ops or rental housing sometimes carries out the local property operation by external service operators (janitors). Then the local operators are not very closely connected to the SFMO and according to Nielsen et al. (2012), this has significant importance for implementing sustainable housing operation, whereas mentioned above the local operators are key actors.

2.2　Virtual communities and participation

Social media is defined by Lipschulz (2015) as media that can support participation, and that invites the users to openly share their opinions with other users. Citing Tracy L. Tuten, he states that: *"social media refers to online communities that are participatory, conversational, and fluid. These communities enable members to produce, publish, control, critique, rank and inter-act with online content. The term can encompass any online community that promotes the individual while also emphasizing an individuals' relationship to the community, the rights of members to collaborate and be heard within a protective space, which welcomes the opinions and contributions of participants"* (Lipschulz, 2015).

The social media researchers, Kaplan and Hanlein (2010) classify social media based on the following factors: 1: the richness of the medium and the degree of social presence it allows; and 2: the degree of self-disclosure it requires and the type of self-presentation it allows. "The higher the social presence, the larger the social influence that the communication partners have on each other's behaviour". ''Social presence'' is defined by the acoustic, visual, and physical contact that can be achieved with other people via the media, meaning that the media facilitates aware-ness of other people. Media richness is the medium's ability to support effective communication and decision making, which is higher in face-to-face communication than for telephone communication and higher for "chat" than communication by e-mail or forums. "Self-presenta-tion" is based on the desire people have to make a nice or advantageous impression on other people to create an image close to their personal identity or self-understanding. "Self-disclosure" is the medium's possibilities for supporting how users can show personal information such as thoughts, emotions and opinions of what they like or dislike (Kaplan and Haenlein 2010).

Koh et al. (2007) studied 77 virtual networks, and they strongly recommended that there should be local opinion leaders in those networks raising questions of common interest and making other contributions of interest to the network. The opinion leaders should not tip the balance between users, as equal access and participation are important principles.

Because this paper investigates the possibility of using social media to improve residents' sustainable practices in their everyday lives, the medium's normative role becomes interesting. Marres (2012) discussed "the normative powers of thing" in her book "Material Participation" and argued that "political and social research much consider the *specific* normative capacities of non-human entities and the particular challenges this poses for specific normative concepts and ideals". When media are combined with, for example, visualization of energy and water consumption data from indoor climate metres, and when they are used to inform or transform normative values and affect users' environmental awareness, then media have normative capaci-ties. One of the important parameters then is that different media have "variable normative capacities for engagement" in connection with the whole setting they are part of. Through their user interface, different social media have different possibilities for supporting residents' engagement and participation, and equal access or moderator rights also impact that. There could be different concepts, ideas and values embodied in different types of media, and it is important to consider how they contribute to the performance of participation.

Looking closer at the virtual community, it might be relevant to study whether and how the residents engage in different "communities of practice" (Lave and Wenger, 1991) on the media, forming various interest groups and sharing knowledge and opinions about common interests over time. The virtual community is not in itself a "community of practice", but a common subject of interest could be a group who wants to make a physical change in the neighbourhood. Accordingly, Lave and Wenger stated that situated learning takes place by participation in communities of practice. Members of various interest groups engage in learning processes characterized by "legitimate peripheral participation" where newcomers learn from more experienced members. The processes are supported by a "shared repertoire of resources: experi-ences, stories, tools, ways of addressing recurring problems—in short a shared practice" (Lave and Wenger, 1991).

Social intranet media might support this shared practice by online FAQ, user manuals and online reification of shared repertoire. The housing organization can support the communities of practice's engagement, skills/ knowledge, visibility/ storytelling and alignment (Knudsen et al., 2001)

3   APPROACH

This study has identified 18 cases where social media are in use, and the study sets out to answer the following question: How do private and social housing organizations experience the possibi-lities and barriers of using social media in operations management?

The study was carried out as a hermeneutic qualitative mixed method of FM organizations' use of social media and their sustainability goals and consists of 3 parts: (1) qualitative interviews, (2) an internet survey and (3) a case study with 18 examples of social media use.

(1) Qualitative interview study: Initial interviews with key stakeholders, the two national housing associations BL Social Housing in Denmark and Property Federation Denmark, and the two large housing organizations Lejerbo and KAB established the overall themes of the qualitative study. Four other social housing organizations and three private housing administrations were selected for qualitative interviews. Interviews, case studies and analysis were carried out by architect Helene Hjort Knudsen, who has worked as a communications consultant and environmental consultant in the bigger social housing companies. The qualitative interviews were conducted with communication managers, operation managers (at the strategic level) and environmental managers. Open semi-structured interviews were conducted to identify the following:

a: The typical communication between the housing organization and the residents.
b: The use of social and interactive media, barriers and possibilities for its use, and identification of case studies.
c: Environmental issues considered important by the strategic operation managers.

The interviews were recorded on tape, and most of them were transcribed. A summery was sent to the informants, and the citations were sent later. A meaning condensation of the qualitative interviews was performed, and the survey further investigated the findings.

(2) Survey of social housing organizations and private property administrations: The qualitative study was supplemented by two surveys. One was sent out to ten large or medium sized private property administrations and 20 smaller administrations. Among the organizations answering the survey were eight of the large property administrations and two of the smaller one. The other survey was sent out to 14 of the large social housing companies that administrate more than 2,000 homes. Nine of those administrate more than 5,000 homes.

(3) Case studies: Based on the interviews and literature studies, 18 case studies were defined with particular values of interest as scholarly examples. The social media cases were described based on a literature study of the evaluation reports, through interviews and/or studying the media. In the following section, the different social media are placed in a system according to their ability to support residents' participation and/or residents' self-representation and self-disclosure with reference to Kaplan and Hanlein (2010). The cases represent various strategic priorities of the housing organization. In all cases, the social media

support the organizations' communication with the residents of the administered housing areas, and the communication concerns matters of local operation such as energy and water consumption or repair work in the homes.

4   RESULTS

4.1   Sustainable operation management in social and private housing

The survey findings show that there is a greater focus on the sustainable operation of social housing than private housing. At the strategic level, the social housing organizations have overall environmental goals but might lack an operation action plan. Of the ten social housing organiza-tions that answered the survey, only four of the organizations have a strategy for energy opera-tion. Although five of the organizations monitor fluctuations in the consumption of electricity, heating and water, only one of the organizations has a strategy to influence the residents' beha-viour. Only the larger private organizations take care of the operation and monitoring, and four of the larger administrations answered with the following: "No, we do not have a strategy concerning energy savings, corporate social responsibility or sustainability".

Based on the interviews, it can be concluded that the operation managers observe that the following two environmental areas are of greater interest than others: 1) The heating of apartments and 2) the proper ventilation of apartments connected with the indoor environment. Energy consumption for heating accounts for 80% of the total energy consumption of apart-ments. By monitoring the resource use in the building management system, the environmental manager from Boligkontoret Danmark observed that the heating consumption patterns in 50% of the apartments are not appropriate (Knudsen and Nielsen, 2015). There are apartments where all heating is turned off, apartments where only one thermostat is turned on, and apartments with huge heating consumption compared with others. For each degree the temperature in the apartment is lowered, there is a 7% savings on the heating bill; therefore, it is important to provide knowledge to the residents about more correct heating practices.

The local boards in Boligkontoret Danmark tell their operation managers, that they expect them to take the responsibility to inform residents about the correct heating practices: "The overall feedback from the boards is, 'We are not professionals, and we do not know when we have incorrect behaviour. Basically, we want you, as the professional administrators to take responsibility'", according to the Environmental Manager of Boligkontoret Danmark.

The conclusion from one of the projects, where the operations team conducted visualization of energy consumption is that "there is a need for information, professional guidance and specific instructions about correct user behaviour" (Exergi, 2014). Another conclusion is based on the interviews and the survey: the operation management and the local janitors are very important stakeholders for influencing the residents' sustainable behaviour. They communicate about matters of operation such as indoor climate, energy consumption and waste collection. The main focus of the communication department in the housing organizations is what more generally concerns the residents. Following Nielsen et al. (2012), this difference is important for implementing sustainable operation. In the social housing sector, the local janitors can be seen as a resource when it comes to influencing resident behaviour as they have great knowledge of the residents, the residential area and data from BMS (Building Management System). The private co-ops and owner-occupied dwellings

might lack those resources in the organization. Here, the local board is in charge, and they might need information and resources from outside the organization, e.g., from the municipality or non-profit NGOs.

4.2   Social media can support resident participation

The study presented 18 different social media cases defined by the type of social media in use:

A: SMS service communication from operation to residents (1 case)
B: Web applications for visualization of energy consumption (8 cases)
C: Web applications for supporting communication from residents to operation (3 cases)
D: Facebook groups supporting neighbourhood communities (2 cases)
E: Other social media supporting virtual communities (3 cases)
F: Websites with social media features (1 case)

Of the 18 cases, 7 cases are elected as scholarly examples of various ways to use social medias. The 7 cases are described below:

- *Case 1: The visualization apps* (type B) affect energy consumption and are implemented on screens in the home. They do not support communities or activities among the residents and are more related to top-down communication to affect the residents' behaviour.
- *Case 2: The 24-7 mobile app* (type C) is an advanced "mail option" developed by DEAS that allows residents to contact the administration whenever it is suitable.
- *Case 3: The My Home app* (type C) was developed by the social housing organization KAB as a mobile app. The operation provides information about maintenance and advice about water and energy savings. The residents have profiles and can post messages and activities.
- *Case 4: Facebook groups* (type D) are used by the *KAB Bolig+* social housing departments. The groups are used for organizing operation activities among the residents, who have the obligation to keep the residential areas. The groups also support different social activities.
- *Case 5: Borigo-8book* (type E), which is used by the private housing estate *8-house* in Ørestad and administered by Boligexperten, is a social intranet media with profiles for residents, the local board, the housing administration and the local operations team. All members have equal editor rights.*Case 6: Puls* (type E) is used by social housing departments and was mainly developed to support residents' democratic participation in connecting with general meetings. Members have a personal profile and can make proposals for the general meetings and other postings.
- *Case 7: Prosedos website* (type F), which is used by the private housing cooperative "Køb-mandsgården" and administered by Boligexperten, provides personal profiles for the members, an activity calendar and the ability to create postings. The local board has more editing options than the residents.

Figure 1 illustrates a relative model of the social media cases. The placing is not based on coordinates but is estimated based on comparisons among the different media in the figure. Media that do not provide personal profiles are placed lower on the scale of self-presentation (SP) and self-disclosure (SD), and media without equal editor rights or where the options for resident communication are limited are placed with a relatively low degree of participation. The residents' communication in a Facebook group for the housing area or on Borigo-8book

can be characterized as bottom-up communication, where residents impact their everyday life by communicating on the media. All subsites (walls) on Borigo are open to all users, as are the personal profiles, whereas they can be closed in a Facebook group if you are not "Facebook friends" with all of your neighbours. In that respect, there is more self-presentation and self-disclosure on Borigo-8book than in a Facebook group.

Figure 1: Model of Social Media Cases
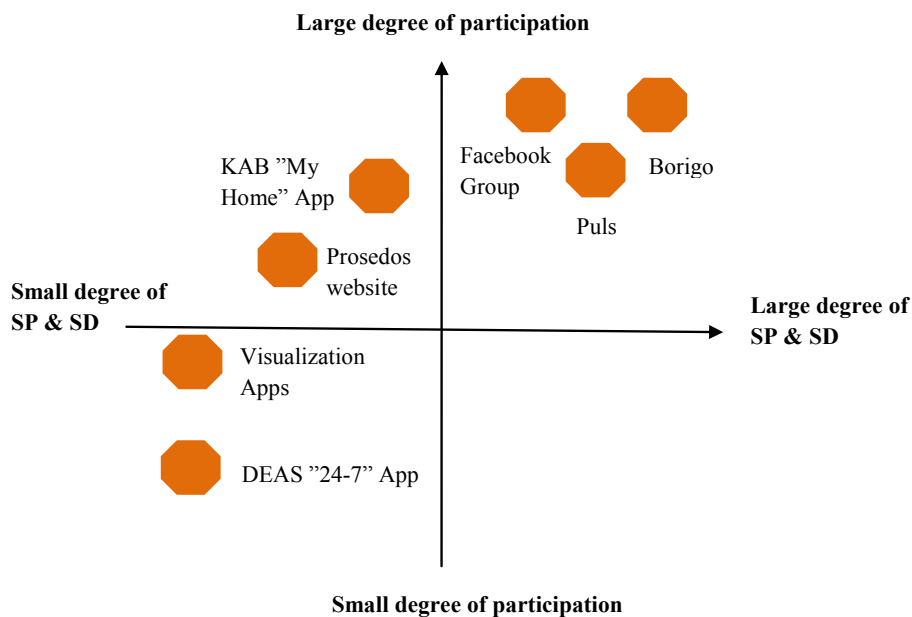
At Puls, the operations team has more editor rights than the residents, and group sites can be closed to non-members. Therefore, the medium does not provide equal participation. The study shows that residents' participation is lower on the KAB My Home app, Prosedos website and Puls than on Facebook and Borigo-8book, which could be due to a lower degree of self-presentation and self-disclosure and a lack of user equality.

According to Lipschultz (2015) and Kaplan and Haenlein (2010), the level of residents' partici-pation and sharing of knowledge depends on the design of the media interface and the degree of self-representation and self-disclosure. Equal editor rights and transparency for all users, as well as a trusting environment on the medium significantly impact the participation on the medium. Personal profiles and equal user rights are therefore important for social media to support resident participation.

4.3   Sustainable building operation with use of social media
According to Lipschulz (2015), residents do not use social media because they want to talk about operations matters or sustainable behaviour. They use social media for fun, relaxation, and excitement and to obtain information about the world. An example from this study is that residents in the 8-house in Ørestad formed 24 activity groups proposing projects such as a common fitness room, a common laundry, and workshops in the basement. In addition, all types of physical meetings take place. The interesting finding of our study is that when residents use Facebook or Borigo-8book, they also talk about operations, e.g., when the heating bill is sent out or when a resident recommends a new device such as the "Danfoss

Eco Living" adjustable thermostat. Following Marres (2012), social media has the capacity to influence residents' values and behaviours when they share knowledge of their heating practices and other daily practices. Normative processes take place in the discussions of the heating bill or the problems with temperatures in the hot water system. After being used for five years, Borigo-8book also supports "communities of practice" on different subjects, e.g., the "workshop group", the "laun-dry group" and the "photo group". Borigo-8book is searchable and contains a "shared repertoire" such as written advice on the use of different equipment in the homes. In this way, newcomers can search the media and learn about their neighbours, the property, and various topics that have been discussed over time.

Reports from three large social housing organizations using "Puls" shows, that digital general meetings increase resident participation and that residents develop more proposals about subjects concerning the local department. In one fsb department, the participation increased from 7.65% to 56% and in another case from 17.2% to 35.7%. (Knudsen and Nielsen, 2015).

Based on interviews with operation managers in the social housing organization KAB (KAB My Home app and Facebook groups) and the private housing administration Boligexperten (Borigo-8book and the Prosedo website), there are the following benefits of virtual communities in residential neighbourhoods: (1) Operation management obtains important knowledge of the residents' needs and wishes for change and can understand whether an issue is a small problem or a big problem. (2) Administration time is saved when residents find answers to their opera-tions questions on the social media. (3) The virtual community is an effective communication channel for the many residents when the operations team wants to test new ideas or actions. It provides instant feedback.

The barriers to using social media are the following: (1) Not all residents use social media; less than 50% of Danes over 50 years old are Facebook users. (2) In some residential areas, the residents have reading difficulties, and some active residents might be more confident in physical meetings than on the internet. The opposite can also be true. (3) The operations team must be prepared to meet critics on social media and must use time for being present and answering questions.

The aim of this study was to investigate the possibilities of using social media to support sustainable facilities management. The conclusion is that social housing organizations and muni-cipalities that cooperate with local social housing organizations to achieve CO_2 reductions can benefit from using social media in communicating with residents. Operations management obtains important knowledge of the residents' needs and wishes for change, and the virtual community is an effective communication channel that provides instant feedback. The use of social media can support resident participation, bottom-up communication and co-creation. The different media strategic capabilities are described in the above model and Figure 1.

With reference to Lave and Wenger (1991), this paper proposes that virtual communities can be platforms for *communities of practice on sustainability* when the residents chose to form an environmental interest group in the neighbourhood. Virtual communities provide the possibility of "reification" of a "shared repertoire" (Lave & Wenger, 1991) such as specific advice from operations, which can be visualized by video, and the shared advice and opinions of neighbours. The virtual communities provide an online platform for visualization of consumption in a media that the residents might already use on a weekly basis. Therefore, it provides a basis for a learning process where the less active and less environmentally

experienced neighbours learn from the more active and experienced environmental frontrunners. There might even be some sustainability change agents in the neighbourhood. By sharing knowledge, ideas, experiences, attitudes and opinions, this learning environment might be able to support a normative change process over time that can lead to more sustainable practices in the neighbourhood.

5   PRACTICAL IMPLICATIONS

Housing organizations have strategies for saving energy and reducing CO_2 in their housing stock, and they want to influence residents' behaviour and social practices for heating and indoor climate. This paper shows that virtual communities offered to local neighbourhoods might be important platforms for resident knowledge sharing and co-creation of new, more sustainable practices to support neighbourhood communities of practice on sustainable behaviour.

Some of the abovementioned social media mostly support top-down communication from the housing organization to the residents, while the virtual communities in the upper right corner of Figure 1 support bottom-up communication and knowledge sharing among the residents. It is important for the social media to be an intranet for the neighbourhood with open personal profiles, equal editor rights and opportunities to form interest and activity groups with their own subpages and with features such as an activity calendar. It is also important for the member roles to be clear.

Social media cannot stand alone but must be supported by communication and a change process, which also includes physical meetings and information and knowledge sharing from the FM organization to the residents. The local janitors or caretakers can represent the housing organi-zation on the platform. They are important stakeholders for supporting communication with residents as they have profound knowledge about the building stock, the heating system, the BMS, and the residents.

Housing organizations with various ownerships have different needs for municipal support. In private co-ops or owner-occupied dwellings, there might be a board with a strong incentive for a change process but also a need for proper knowledge, data, and support from the municipality. Municipalities should focus on supporting private housing administrations or housing coopera-tives with information and advice on sustainable operation and training for local caretakers and janitors.

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3.3 KPI VISUALIZATION SUPPORTING THE INVOLVEMENT OF FACILITY MANAGERS IN EARLY DESIGN

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ABSTRACT

Purpose: To facilitate the involvement of FM professionals during in the early design phase using a key performance indicator (KPI) visualization tool that presents energy and life cycle cost results from BIM tools. BIM tools capability of simulating and predicting different parameters that can be utilized by FM professionals and later be used as FM key performance indicators (KPIs) to support their decision making process

Background: The use of building information modelling (BIM) in Facilities Management (FM) is a central topic of study in the construction industry at the moment. Most of the current research in the subject is focused on using BIM to efficiently deliver handover building information, support maintenance activities and close the loop in the building lifecycle. However, the use of BIM opens another set of opportunities for FM professionals that can help them to be part of a more integrated design process.

Approach (Theory/Methodology): This project uses design science methodology. The use of BIM for FM has been widely discussed in the last years without achieving tangible benefits. Within this context, design science research is an accepted problem-solution finding method that is suitable for this study. Design science would mean designing a framework/tool as an artefact that would help the construction industry but essentially facility managers make use of BIM and support their decision making.

Results: The designed artifact Multi-KPI tool presents an interactive way to visualize different indicators using sophisticated graphics for decision making.

Practical Implications: By using the Multi-KPI tool, a facility manager is able to influence in an integrated design process which opens a new set of innovative opportunities for the FM field that can positively impact the building lifecycle.

Keywords:
Facility Management, Building Information Modelling, Key Performance Indicators, Early design, KPI visualization.

1   INTRODUCTION

During the last decade building information modelling (BIM), lean practices and integrated project delivery methods have been the major drivers of innovation in the architecture,

engineering and construction (AEC) industry. With the increasing complexity of building projects and increasing number of unknowns, the combined use of these three methods has allowed for making more accurate predictions that can meet the client requirements, cost, schedule and quality of the project (Khanzode et al., 2007). After experiencing the benefits during design and construction, the project owners are also interested in extending the benefits of BIM in Facilities Management (FM) and possibly cover the building lifecycle. BIM for FM has been a topic of discussion for several decades, but in practice the implementation in FM is still in an early phase without yet being as successful as in design and construction. A range of potential applications of BIM in different areas of FM have been proposed in the literature such as for operation and maintenance (O&M), asset management, space management, performance management and as a building information database (Forns-Samso et al., 2015). However, the implementation in these areas bring along organizational, technological and process issues that need further investigation. In addition, research in this area is predicated on the premise that facility managers are only involved in the operational phase limiting different approaches on how BIM can be a useful tool for facility managers. Additionally, a thorough description of the FM industry has been constantly overlooked or mainly focused on operational activities and neglecting the value input facility managers can bring in supporting strategic level decisions in the design phase.

2   STATE OF THE ART

Facilities Management is said to cover all aspects of property, space, environmental control, health and safety, and support services, and it requires that appropriate control points are established in the organizations (Alexander, 2013). As a young discipline, the FM business field is developing rapidly and continuously (Elmualin et al., 2010). In the past FM was often regarded as merely a sub-profession such as maintenance, caretaking, or cleaning of buildings or it was considered as a secondary discipline of principal professions in the categories of real estate, engineering, architecture and construction (Atkin and Brooks, 2009). The current trends indicate that FM will be moving from operational to strategic because of its potential to in creating value for business activities (Meng and Warren, 2015). As such, the participation of FM professionals is growing, evolving and not only active in the post construction phases but also in the early phases of design.

Management functions can be distinguished at tactical and strategic levels. Tactics are action plans involving managerial operations for specific and routine activities (Johnson et al., 2008). Such activities are for example, safety procedures for prevention or proper use, maintenance plans and care of maintenance resources. Activities on this level support responsible behaviour in the workplace and the continuity of working conditions. At the strategic level there is consultation and non-routine planning aimed at making the best, long-term use of the organization's physical resources and overall facilities. Johnson et al. (2008) see management strategy as dealing with the complexities of ambiguous, non-routine situations which can affect the direction and future of the whole organization. Strategic decisions demand an integrated approach since the entire organization should move in the same development direction. Strategy is needed to cope with the prospect of an unknown and changing future. Although long term forecasting can only hypothesize about the future, strategic planning aims to reduce uncertainty by choosing a preferred path and a reasonable long term direction for the development of the organization.

Research goals and objectives

To widen the scope in the use of BIM for FM, its implementation should not only focus in facility managers supporting operational activities but also involve them actively in early design phases where FM professionals can provide valuable input in the decision making process, add value in the facility design and lead to a more integrated design process.

The goal of this study is to propose a platform that compiles dynamic simulation results from different BIM platforms and present the simulation outputs as Key Performance Indicators (KPIs). KPIs can be visualized and analysed by facility managers to improve the decision making process. KPIs can be for instance, total energy consumption, CO_2 emissions, total cost of energy consumption, investment cost, maintenance cost.　The following are the specific objectives for this study:

(1) Widen the scope of BIM for FM to be used in the early phases of design
(2) Employ different simulated KPI outputs useful for Facilities Management
(3) Visualize and analyse the relationship between input variables and KPIs using a sensitivity analysis and uncertainty analysis
(4) Demonstrate using visualization techniques the generations of different scenarios and supported decision making

BIM for FM

The research in the area of BIM for FM has increased rapidly in the last years. A recent literature reviews by Forns-Samso et al. (2015) summarizes the potential BIM uses in different functions of FM. The area with stronger focus is in supporting maintenance activities in building operations. Such potential uses include visualization and location of building components with access to real time information concerning attribute data and historical maintenance information. It also facilitates the scheduling of maintenance tasks and the ability to virtually develop a maintenance program without need of making a site visit. However, all of such uses depend on the accuracy, consistency and reliability of the data.

The second category with stronger focus is information management. Information management deals with improving data management during the lifecycle, handover information, as-built/as-maintained model used for the operational phase. Articles in this category investigate about interoperability, information exchange standards such COBie, IFC, FMie etc. and data management procedures. The vision in this research area is geared towards a lifecycle information management approach by capturing information from initial phases of the project through demolition. Major concerns with this implementation are towards the processes and roles for data capturing and data maintenance during the building lifecycle. Supportive concepts are used from industries such as manufacturing, automobile, and shipping with a strong focus on product lifecycle management (PLM). In addition, the literature considers emerging requirements for the capture of Building Performance Attribute Data.

The third category is the use of BIM for building performance which is mostly concerned with tracking and monitoring energy consumption, thermal performance, and components performance. Based on the literature building performance can be measured by integrating other systems such as requirements management, energy simulations tools and building automation systems.

The fourth category is in the area of asset management which is strongly related to maintenance activities but are more closely related to tactical decisions such as assessing the service life of components, maintenance programs, historical data and predictions about

equipment failures and replacements. The area of asset management seems to have wider publications from Australia and UK.

The fifth area is space management which is concerned with activities related to real estate functions and cost. Publication numbers in this area are the lowest but it could be because already sophisticated systems such as Computer Aided Facility Management (CAFM) or Integrated Workplace Management Systems (IWMS) have been widely used in the area of space management and BIM has not found a distinctive application from what already exists.

As described BIM for FM has many potential applications. However, there are only a few studies that show potential uses of BIM for FM in the early phases of design and how to support strategic level decision in FM. With that premise the current study gives a perspective how BIM can be utilized by FM professional in the early phases of design.

Early involvement of fm expertise during design
The involvement of FM professionals during early design phases is perceived of high value for entire facility lifecycle. Jaunzens et al. (2001) produced a guide that includes the participation of the FM team that is part of a client organisation in the design of future facilities and how the FM team´s position within the client organisation, its level of expertise and relationship with the design team affect this participation. In this study, they were able to identify issues relevant to FM which should be stated in the design brief, namely maintenance, flexibility and adaptability and the environmental policy.

Jensen (2009) proposed a typology of four mechanisms for knowledge transfer, to establish an integration of building operation considerations in building design. Jensen's mechanisms of knowledge transfer are the following: (1) Utilizing building operation experiences to create codified knowledge, increasing designers' awareness as a result, (2) Boosting the skills and capabilities of facilities managers, increasing designers' awareness as a result; (3) Using power to guarantee that designers seriously take into consideration building operation issues through FM participation; (4) Using power to guarantee that design teams seriously utilize codified knowledge.

Wang et al (2013) proposed a framework with the use of BIM to engage facility managers in the early design stages. The main activities improved were in space planning, energy analysis and maintenance planning. Using BIM as a source of information proved to be valuable for collaboration and reduction of life cycle costs. Enoma (2005) states that FM involvement at the design stage will add value to the facility by "ensuring less 'rework', emphasising value for money, efficient control of the supply chain and team work". However, the main barriers of FM involvement are the increased cost in with their participation and when the client is not the end-user of the building.

FM Key Performance Indicators
KPIs have become progressively more established within several industries as a performance measurement system. The advantages of using KPIs in FM is to direct the managerial effort towards more important areas of performance, and can be embedded in the FM services contract to clearly present the required outcomes and their relevant monitoring and control (Loosemore et al, 2003). It is important that KPIs are relevant, measurable or quantifiable in order to make appropriate comparisons (Lavy et al., 2014). The majority of KPIs generated in FM are the ones related to the cost of maintenance and operation, revenue, space management, and environmental and safety issues.

KPIs have become a part of growing area of analytics, a field that deals with prescriptive analysis. Prescriptive means that decisions regarding how to improve the performance of a facility are made based on data analysis. It utilizes the process of optimization to identify the

best solution. In other words, it prescribes how to achieve the best outcome considering the effects of variability. This is recommendation phase where decision and support are coupled with expert opinions to create tactical and strategic guidance for the organization. The process of data analysis may be performed using actual or simulated data that is based on reasonable assumptions. In summary, the process of analytics can be effectively used with simulated data to analyse the relationships and impacts of KPIs.

Within this context the analysis of different KPIs using simulated data can be beneficial for facility managers during the early design phases to support their strategic level decisions. Different BIM platforms are able to assess the facilities lifecycle performance using simulations such as ECOTECT, TRNSYS, RIUSKA etc. However, they are not extensively used by facility managers because, as explained previously, relevant FM KPIs contain a wide range of parameters that cannot be interpreted by a single simulation platform. Therefore, there is a need for a platform that can visualize a different set of parameters derived from different applications. This research try to cover that gap by presenting the Multi-KPI tool described in the next section.

3   APPROACH

This project uses design science methodology. The use of BIM for FM has been widely discussed in the last years without achieving tangible benefits. Within this context, design science research is an accepted problem-solution finding method that it is suitable for this study. Design science would mean designing a framework/tool as an artefact that would help the construction industry but essentially facility managers make use of BIM and support their decision making process. Vaishnavi and Kuechler (2004) described a model of the general process followed by design science research and its multiplicity of as practice variants.

The process for design science research contains different steps and the expected outcomes from each step:

(i)   *Awareness of the problem* which uses different sources to find an interesting problem in an industry or a reference discipline. The outcome is the proposal, formal or informal, for new research effort.

(ii)   *Suggestion* is the following step from the proposal, it is an essential creative step where a new functionality is envisioned or enhanced from an existing one.

(iii)   *Development* which focuses on the novelty of the artefact being developed and it does not necessarily have to be construction of an artefact but design of it.

(iv)   *Evaluation* is where the artefact is evaluated according to the criteria explicitly explained in the proposal. Deviations from expectation, both qualitative and quantitate, are carefully noted and must be explained. It also contains an analytic sub-phase where hypothesis are made about the behaviour of the artefact. (v) *Conclusion* is the end of the research cycle and final stage of the research effort. The result concludes with the deviations of the behaviour of the artefact from the revised hypothetical revisions. It places a great emphasis on the knowledge contribution in the area of research.

In this project we focus on the suggestion-development phase where the artefact is envisioned or partially created as part of the development phase.

4   RESULTS

Multi-KPI Decision Support Tool
The development of Multi-KPI is intended to support multidisciplinary work and enhance collaboration between projects teams. Also, it should support the facility manager, owner, decision maker, in analyzing the impacts of KPIs. The Multi-KPI tool helps teams to work in a more structured way but enabling flexibility and interaction in the analysis of alternatives facilitating the decision making process. Multi-KPI tool uses concepts in the development of decision support systems (DDS) tools in information systems. As such, the Multi-KPI should function as a critical tool for the rapid comparison of different evaluation criteria that could support facility managers. Therefore, Multi-KPI should help the complex decision making process, assist in evaluating alternative options or scenarios, deal with complexity and have a clear, reproducible procedure. The Multi-KPI is developed as a web-based decision making application that uses a graphical multi-attribute utility analysis to evaluate and compare alternatives based on key performance indicators.

Energy Simulation
Simulation modelling has usually been used for the facility´s energy performance. Augenbroe (2002) stated simulation modelling is now being more widely applied in post-construction phases such as commissioning and FM. In fact, simulation has become an integral part of the whole building design, engineering and operation process. In this project we use energy simulation platform RIUSKA (Jokela, 1997) to obtain the different Key Performance Indicators related to energy consumption and CO_2 emissions.

Cost Simulation
Life Cycle Ccost Analysis (LCCA is used to evaluate the economic feasibility based on the calculation of the equivalent values of all the important costs that occur within the life span, with particular focus on buildings or the major components of buildings (Shin and Cho, 2015). An LCCA is conducted using the following four steps.

(i)   The analysis target is identified, which is the first step toward making a cost-effective decision by creating and evaluating the alternatives that can meet the minimum performance standards.

(ii)   The basic assumptions are established for the LCCA, including the analysis period and discount rate. In addition, the initial investment cost, operating cost, alteration/replacement cost, and other associated costs are confirmed, and the time of occurrence of each cost is verified. Because these cost items occur at different points in time, it is important to convert each cost to the value at a single point in time.

(iii)   The LCC is calculated for each alternative by adding up the costs according to the type for each alternative.

(iv)   The related indices are calculated to evaluate the economic feasibility (the LCCA) including the net savings, savings-to-investment ratio, and payback period. In addition, a sensitivity analysis can be implemented to complement the LCCA methodology, which will provide reliability to the LCCA results.

Sensitivity Analysis
The subject of Sensitivity Analysis (SA) is to learn about the influence each design variable has on the studied KPIs. This knowledge is needed to perform educated design changes to improve the design in exactly the desired way. The aim of the sensitivity analysis step is to find a design with optimised KPIs. Figure 1 shows an example of the different design parameters and their influence on the different KPIs.

Figure 1: Visualization of the of key variables through a sensitivity analysis
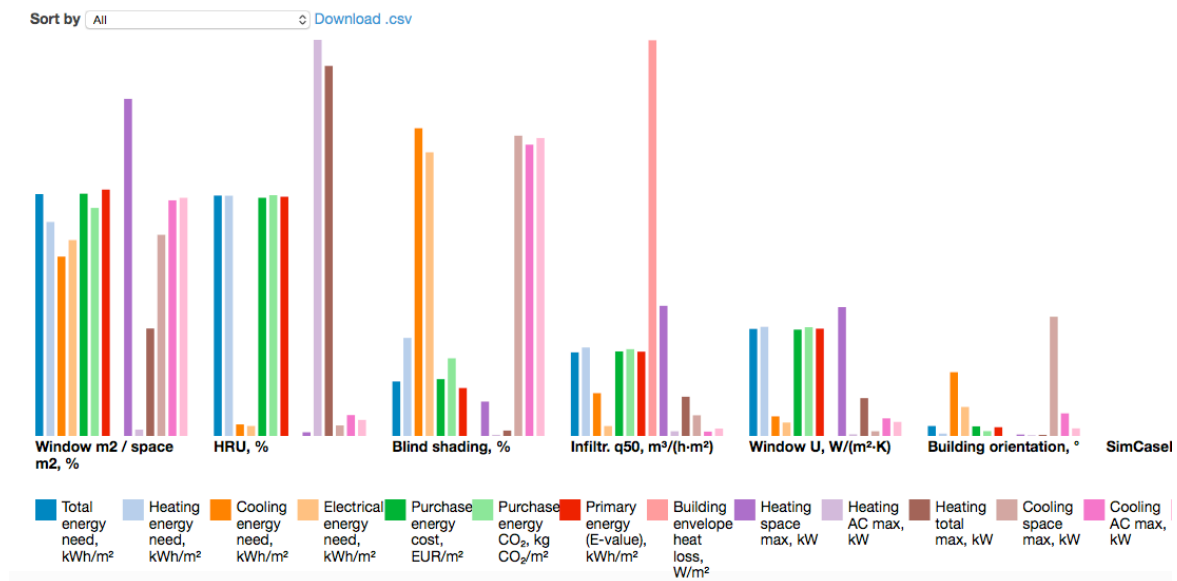
KPI visualization

Applying analytics to conceptual design has proven difficult because a problem typically has multiple targets and is imprecise with respect to one or more of these objectives (Shaw et al. 2008). The interaction of professional expertise and computer-based exploration therefore is essential for the process to be successful. Facility managers need to be able to understand general performance trends as well as variable sensitivities in order to make informed decisions in guiding the optimization process. Advanced plotting tools that enable multi-dimensional data visualization have proven useful for this purpose such as pareto graphics (Khajehpour and Grierson 2003), hyper radial visualization, parallel coordinate (Parmee 2005; Parmee, Abraham et al. 2008) plots and radar charts have proven useful for this purpose.

Figure 2: Parallel coordinate plot for the decision-making using the developed Multi- KPI analysis prototype tool.
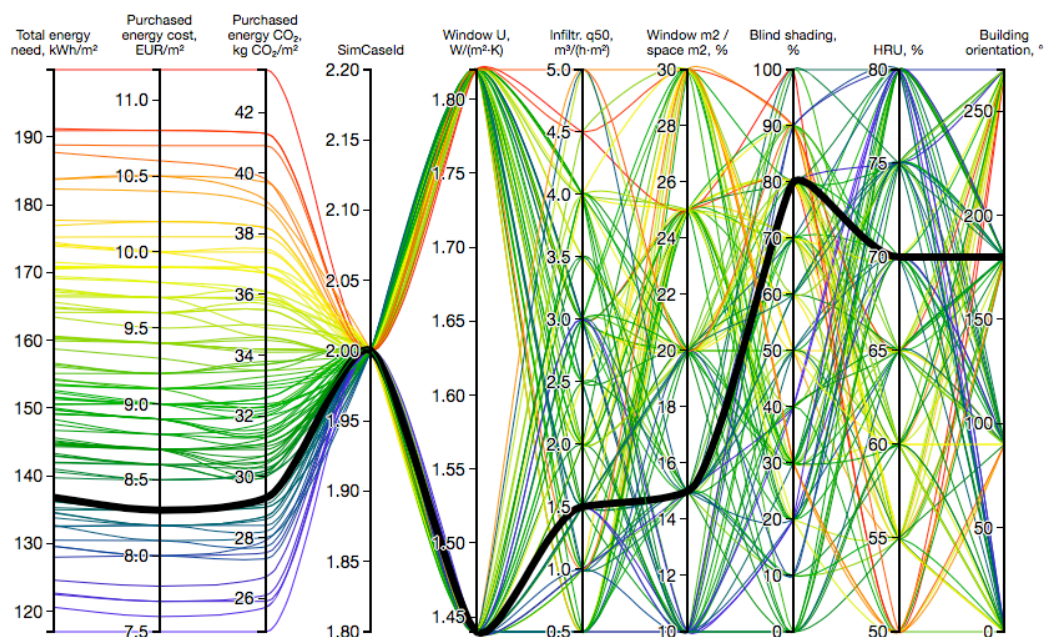
Parallel Coordinate Plot (PCP) is a simple way to visualize multi-dimensional data in two dimensions as shown in Figure 2. PCP shows each of the desired variable and the KPIs are presented in parallel to the coordinate axes. Each axis can have its own value range and can either be continuous or discrete variables. Discrete variable axis enables the use of non-numerical values. The visualization shows the result obtained or the results of the values of the variables depending on the approach taken, and combined these with a certain result of all the values of the line between the axes.

The value of the variable ranges can be adjusted so it facilitates the selection of the best solutions within a desired number of parameters and therefore achieve the best desired result. It is also easy to visualize by assigning to each result and its constituent variables on the line that falls within the desired ranges. The color visualization also helps to determine the most appropriate solution. By utilizing interactive visualization options to restrict the values of the parameters and their results, so that solutions that not fall within those parameters will change colors to for example, gray, therefore we can better focus on a limited number of solutions.

Although the number of variables and the objective function that can be presented in this type of visualization can be infinite, the large amount of variables will make the visualization difficult to read and find correlations of the variables may be difficult. Appropriate use of the quantitative objective function variables and visualization strategies facilitate the use and understanding.

Figure 3: Decision making analysis via scatter diagram.
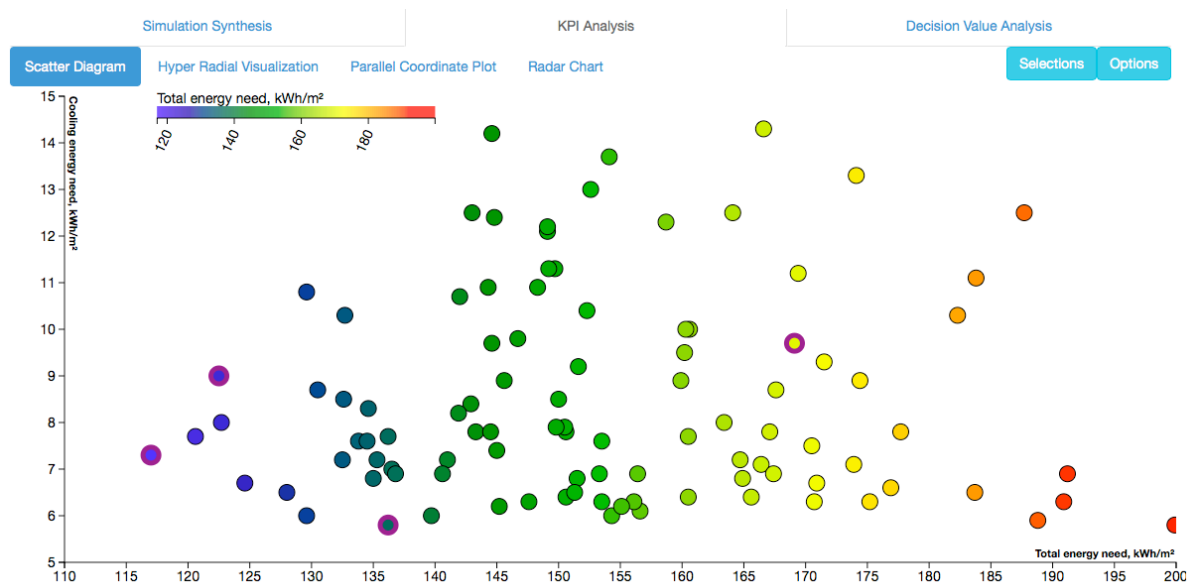
The scatter diagram is usually used to analyze the relationship between two variables. The pattern of the intersecting points can graphically show the relationship of the variables and usually validate or invalidate cause-and-effect relationships. Scatter diagram graph can be represented in two variables of the objective function, however a third variable is also possible but projection a three-dimensional visualization could be difficult to read and

interpret in practice. A more intuitive way to use the third dimension is the coloring of the points of the third objective function value and the color legend, graphs, presentation as shown in figure 3.

5   PRACTICAL IMPLICATIONS

As described above, FM is a complex and fast growing business that responds to the demands and economic pressures of the built environment. Latest trends indicate that FM, which traditionally focuses on technical issues, is having stronger impact on a strategic level. In other words it is developing from purely technical to more market driven service. The role of facility managers in early design should become more prominent. The use of different BIM tools enables FM professionals to make various long term predictions. The Multi-KPI which gathers different simulation results could be a powerful tool to be used by facility managers to visualize different KPIs related to FM that can improve can their decision making process.

ACKNOWLEDGMENTS

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4

APPROACHING ASPECTS OF VALUE CO-CREATION IN RELATION TO SERVICE INNOVATION AND FM

4.1

How can FM Service Providers Improve their Service Delivery through Value Co-creation?

Vitalija Petrulaitiene, Eelis Rytkönen and Suvi Nenonen

4.1 HOW CAN FM SERVICE PROVIDERS IMPROVE THEIR SERVICE DELIVERY THROUGH VALUE CO-CREATION?

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ABSTRACT

Purpose: The value created in the network of users, customers, and service providers will be the competitive advantage of businesses in the future. Facility management (FM) organisations, in order to be innovative and stay competitive, need to understand the evolution of business logic and apply it in practice. Hence, the aim of this paper is to study value co-creation opportunities for FM by analysing various service businesses and identifying the key points for successful service development in FM sector.

Approach: First, the literature on value co-creation and added value of FM is studied. After this, available services for knowledge worker are analysed by using Business Model Canvas in order to identify the evolution of business. Interviews with practitioners in FM-service provision supplement the previous knowledge from the analysis of services.

Results: As a result, the ways to co-create value are listed. Empirical results are validated by applying them into value co-creation concept based on the literature. Identified ways to co-create value help practitioners to understand new business logic and pinpoint opportunities for FM to exploit it. This paper contributes to the academic discussion by introducing the phenomenon of value co-creation in FM research.

Keywords:
FM services, Workplace, Knowledge workers, Value co-creation.

1   INTRODUCTION

Facilities management (FM) plays an important role in any organisation's business. The objective of FM is to provide the setting and services that: (i) support the effectiveness of organisation, (ii) contribute to the development and creativity of the occupants, and (iii) benefit the community (Alexander et al. 2013). The list of FM objectives by Alexander et al. (2013) accurately defines main challenges of this paper. FM needs to provide services that empower employees and create value not only for the customer organisation but also for the community. The value of FM comes from establishing strategies and processes that connect

and effectively utilise a network of physical, environmental, and human resources. At the same time, the topic of value co-creation in networks of actors has been receiving a lot of interest in service science research. Myerson (2012) and Vischer (2012) argue that, in experience economy, learning and co-creation are key processes that lead to new business opportunities and service innovations.

Thus, this paper looks at the concepts of added value from FM perspective and value co-creation from service science. These two theoretical streams are later connected with empirical findings from service analyses and interviews with FM practitioners. The analysis results in a better understanding of added value opportunities and perceptions of FM value to organisations. For practitioners, this paper suggests ways, how FM can develop their services by collaborating with other stakeholders and, thus, gain competitive advantage from created ecosystems.

2   STATE OF THE ART

2.1   Value co-creation mind-set

Value co-creation has become a buzz-word in recent research world. Even though a vast body of research discussed the topic of value co-creation, the approaches are scattered. For example, in S-D (service-dominant) logic, service is the main basis of exchange, and goods' value is actualized through consumption, maintenance and adaptation of the good to person needs. In this case, value is always co-created as it is a result of actions by provider and consumer (Vargo and Lusch 2008). In service sciences, value is co-created through "integration of existing resources with those available from a variety of service systems that can contribute to a system well-being" (Saarijärvi et al. 2013). Service system is understood as value co-creation configurations from people, technology, and value propositions. (Vargo and Lusch 2008; Baron and Harris 2008). According to Saarijärvi et al. (2013), value co-creation is a concept that captures the phenomenon of changing roles of customers and firms. Customers, in general, do not seek for products themselves but they seek for satisfaction that these products bring (Mitchel et al. 2008).

Customer involvement in the value creation processes is analysed by Kozinets et al. (2008) and Kristensson et al. (2008). Customer involvement in new product development process produces higher value as it is based on users' real-life experience. From the level of customer involvement, value co-creation can be compared to customization process. In customization, customer's role is stronger at the end of innovation process and it takes a reactive position responding to manufacturer's proposal, whereas, in co-creation, customer is actively involved from the very beginning of innovation process. (Kristensson et al. 2008). Provider's role in co-creation process is to support customers and other partners in the network by providing resources that "fit into their practices" (Storbacka et al. 2015; Mitchel et al. 2008).

Based on the previous research, value co-creation can provide benefits for companies and customers in few different ways: by increasing economic value (Bitner et al. 1997; Mustak et al. 2013; Terho et al. 2012); by improving consumption and usage experiences (Gentile et al., 2007; Payne et al., 2008; Mustak et al. 2013); and by stimulating product and service innovation (Sawhney et al., 2005; Bitner et al., 2008; Mustak et al. 2013).

Michel et al. 2008 discuss ways how services can be innovated through value co-creation by embedding know-how into objects, by changing integrators of resources, and by

reconfiguring value constellation. Embedded know-how requiring less skills from the users can be called a smart offering. Value constellation means a combination of multiple actors and resources to co-create value. An example can be combining public transportation and car rental services into one offering through combined ticket (Mitchel et al. 2008). The term "value co-creation" is used widely but there is a lack of overall agreement. It might refer to a design process, way of understanding innovations, or value propositions. Here, we refer value co-creation to a creation of value in a network of companies and customers through interactions, hence, developing new business opportunities.

2.2   FM and a concept of value

The topic of added value in FM and Corporate Real Estate management (CREM) research has attracted much attention during the last decade (Lindholm et al. 2006; Appel-Meulenbroek 2014; CABE 2005; Jensen 2010; De Vries et al. 2008; Alexander 2012; Nagy 2013 and others), analysing different aspects of value and considering it from FM and CRE perspectives. Growing awareness of real estate, facilities, and services related to it might have had an effect on the interest in the concept of added value of real estate (Van der Voordt and Jensen 2014). There are few commonly used theoretical frameworks that try to catch the concept of value in FM, e.g. FM Value Map developed by Jensen (2010), and value parameters connected to CRE strategies, developed by Lindholm (2008). Both of them are based on Value Mapping and cover value attributes in relation to Balanced Scorecard division – finance, processes, people, and customers. Jensen (2010) uses FM Value Map to show that the value in FM is created within a network of relationships; it takes several stakeholders into account and shows a holistic understanding of value (Coenen et al. 2013). FM Value Map considers the value in FM from the supply-side perspective.

Coenen et al. (2013) were one of the first authors to study the added value of FM from the customer perspective (demand-side) which is a much more service-oriented approach. For example, employees of an organisation are the users of space; they do not seek for space or products related to that space but they expect that space and service there would empower them to get their job accomplished in an easy and quick manner (Mitchel et al. 2008). As a result of changing needs of the customers and the way work is executed, FM must be seen as an enabling tool that facilitates the way people work. A similar approach and higher attention towards customer value in FM is noticed in Business-to-Business (B2B) marketing literature. In the service industry, the customer is a part of the service production process, and, thus, customer focus influences value more than in the goods' industries. (Jensen et al. 2012). Katchamart and Shiem-Shin (2014) claim that FM can enhance a client's operational performance and business outcomes, this way directly impacting the end users' perceptions and satisfaction. FM services have a high impact on customizing infrastructure, workspace and FM services that are relevant to all stakeholders: clients, business units, and end users.

Nowadays, FM discipline is seen as a relationship management in a network of partners (Jensen et al. 2012). According to Coenen and Schäfer-Cui (2013), FM adds value for customers through business relationships (B2B) and understanding of customer needs and expectations. Jensen et al. (2012) concluded that the added value of FM also depends on beneficiaries, thus, different stakeholders should be taken into consideration. Here, we do not analyse all stakeholders but we differentiate "customers" into clients, customers, and end users for a holistic understanding of the customer value (CEN 2006; Hinks et al. 2012b). Because of the hybrid form of transactions and the need to provide services to business clients, customers, and end users at the same time, FM can be referred to a B2B2C management discipline (Coenen et al. 2013). The value of relationships might be defined in

various ways but, usually, it is a difference between relationship benefits and relationship sacrifices. Relationship benefits include, e.g. responsiveness to needs, flexibility, or supplier know-how. Relationship sacrifice usually has both monetary and non-monetary components, such as economic cost for aforementioned, and inconvenience for the following (Coenen and Schäfer-Cui 2013).

2.2   The understanding of value in service sciences and FM
Literature review on the added value in FM and value co-creation helps us to conceptualize the understanding of value. Table 1 tries to capture the differences in understanding the value from FM and value co-creation perspectives.

Table 1: Added value to customers from FM and value co-creation perspectives

	FM		Value co-creation	
Clients	Improved performance		Improved economic value	
Customers	Improved processes		Improved experience	
End-users	Improved satisfaction		Improved experience and consumption	

Traditionally, FM, first and foremost, is oriented towards improving the performance of business. That is reached by improving processes and increasing user satisfaction. Therefore, the value was created in a collaboration between service provider and a client. End-users were never really considered the main focus group of stakeholders. From the perspective of value co-creation, the value for business comes from an ecosystem around the end-user. By improved experiences and consumption, the economic value for business is then created. From the table we can notice that the understanding of value in FM and value co-creation is different. In FM, it is more of a top-down approach where product or service improvements are coming from the collaboration of clients and service providers. In value co-creation, a network of stakeholders is necessary but the leading role is given to the end-users, improving products or services based on their needs. For FM service improvement, we take a value co-creation approach. High attention towards end-user leads us to analysis of services that support office worker and enable to produce outcome.

3   APPROACH
Qualitative approach was used in order to build a preliminary model from the collected data (Eisenhardt 1989). We built initial insights from the review of the literature in topics of added value of FM and value co-creation, and then generated insights from a case study through analysis of services and interviews with FM practitioners. Analysed services gave insights for further development of the research and topics to discuss with FM practitioners in the interviews. The data from interviews supplemented the knowledge from analysis of services and helped to develop a sound conceptualization of value-based service in FM field. This principle follows the steps of "getting started, selecting cases, crafting instruments and protocols, entering the field, analysing data, shaping propositions, enfolding literature and reaching closure" introduced by Eisenhardt (1989).

3.1 Services supporting office worker

For the analysis of services, at the beginning, we took 103 service businesses from different business scopes that can be related to office workers' needs. We focused our attention towards emerging businesses in order to understand directions where the world is moving. The data was collected from the Internet sites of services. We analysed the list of services by using Business Model canvas tool (Osterwalder et al 2010) to get an idea of the business logic behind each service. Business Model Canvas tool allowed documenting how businesses create, deliver, and capture value. It also helped in structuring customer segments and revenue streams.

By within-case and cross-case comparisons of the offerings, we began to identify patterns and thematic entities between the services. First of all, we identified the main needs of a knowledge worker to get one's job done. Those were: space, technology, logistics, and community (Figure 1). For example, property owners and traditional FM service providers can be seen to act in the space sector. Technology sector related to software products, telecommunication companies and similar. Logistics sector relates to transportation of various objects and knowledge workers themselves. And community relates to various events and activities such as conferences for network development and acquiring new knowledge (Rytkönen et al. 2015).

Figure 1: Service paths for offices
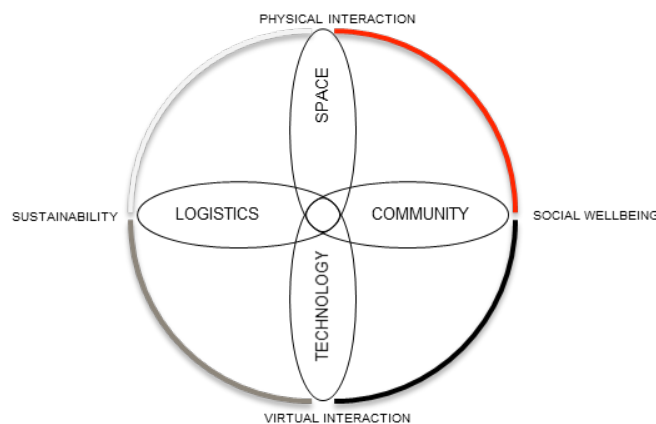
3.2 Service attributes according to practitioners

In 2015, we conducted 10 in-depth interviews with FM practitioners from different fields, including traditional FM service providers, business parks, and governmental organisations in order to understand the changing needs of knowledge workers and their requirements for services. Governmental offices represented very traditional office setting with different ways of conducting work, thus different results from interviews were expected. Also, in-house and outside service providers introduced diverse points of view towards knowledge workers' needs and requirements. The themes of interviews were: changes in office market, user needs and requirements, and service development in general and specific to industry. All interviews were recorded and transcribed, then coded and categorized. We applied multiple case studies' design as case studies are suitable for exploring topics with the lack of strong theory, and conditions relevant to the studied phenomenon need to be taken into consideration (Yin 2003).

Due to limitations of this paper, we do not discuss the results of analyses of topics in changes in office market, specific user needs and requirements, but concentrate on FM service development for better office employee support.

Table 2 includes four main service attributes that were mentioned in more than three interviews and considered relevant.

Table 2: Service attributes identified in the interviews

INTERVIEW NUMBER	1	2	3	4	5	6	7	8	9	10
User – a centre of service	X	x	x	x	x		x	x		x
From B2B to B2C	X	x		x						
Packaged services	X	x	x	x			x			x
Levelled services			x			x	x		x	x

These service attributes included the following perspectives:

User – a centre of service
Interviewed industry professionals highlighted the user-centric approach in the network of customers, service providers, and end-users. The most important measurement of service success has become user experience and user satisfaction which is partly related to increased role of the end-user and higher freedom of choice.

From B2B to B2C
This point of attention is closely linked to the previously described attribute of users being a centre of service. Different role of the user emphasises the need for changes in the business logic. Provided service should become a "personal service for someone".

Packaged services
Nowadays users are willing to buy a full service package, instead of searching and buying separate services and/or products to satisfy their need. Packaged services might also include components that a user otherwise would not even think about. However, packaged services do not mean that there are limited possibilities, but they can be packaged based on end-users' requirements.

Levelled services
A possibility to choose suitable level (e.g. high-end or satisfactory services) for oneself increases user satisfaction and can improve cost balance for the organisation. Adjusting service levels to customer and end-user requirements was one of the intensively discussed topics during the interviews.

4   RESULTS

In service analysis, it was discovered that traditional businesses mainly operated in one of the four service paths and their offerings fell into one of four aforementioned categories, whereas novel and fast growing businesses functioned by connecting these paths between at least two service branches. New service branches connected space and community, community and technology, technology and logistics, and logistics and space. In our framework, we named

these new paths and service offerings based on the needs that they are fulfilling for office employees: Meet'em for connecting community with a specific physical space, Tech'em – for empowering community through technology and know-how, Track'em for connecting technology in order to reduce used resources related to logistics, and Transport'em – for reducing resources for transportation (Figure 2).

Figure 2: New service paths developed by network of partners
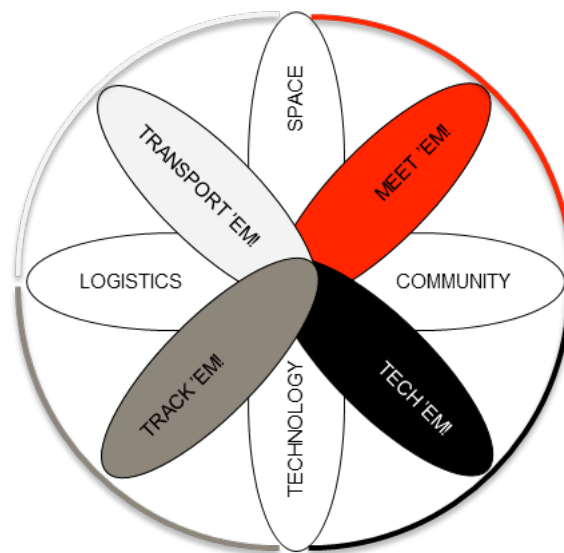
The following examples demonstrate services for knowledge workers in the new branches.

Meet'em
New services act as platforms for collaboration by connecting space and community services. Examples include: HUB Australia, where bank shares its lobby as a co-working space for its clients and workers, Adidas group learning campus, or HUB13 which provides co-working space as well a community feeling through networking events for its users.

Tech'em
Communities that originally were created around a physical spaces are moving to digital world, thus, becoming services for knowledge workers. For example, online education platforms, such as coursear.org, are changing university communities by allowing others to join, share, and create knowledge together. Online recruiting platforms, such as elance or Taskrabbit, connect either individuals with individuals or individuals with companies based on the skills and tasks to be performed.

Track'em
GIS technology and Internet of Things (IoT) enable new services, such as Nokia HERE or Foursquare. These solutions facilitate real time tracking of objects, people, and spaces, and allow users to get the most out of the location they are at.

Transport'em
New services are emerging from connecting service providers and sharing resources from a certain physical space with the help of technology. For example, Mobility-as-a-Service is a

solution being developed by City of Helsinki in Finland, which aims at connecting all means of transportation into one platform for a monthly fee. Uber platform is another example of connecting resources (cars and drivers) through a platform (app) in certain space (city) for easier, cheaper, and faster travelling.

Thus, the analysis of services suggested four emerging service business directions for knowledge workers. These new paths are based on the connecting different resources related to FM (physical, environmental, and human resources) and adding value to organisations through end-user experience and satisfaction.

Interview results indicated that value co-creation within a network of partners and user-centric approach is a direction where services are moving in practice. By working together with a network of partners and end-user, FM can improve service consumption, experience, and add value to end-users and client companies. Table 3 represents the results from the interviews and service analyses that are placed into the preliminary model from the literature part Table 1, explaining, how value can be improved by implementing value co-creation strategy.

Table 3: Added value to office market through value co-creation

FM solutions from practitioners	Value co-creation	
Solution developed by many	Improved economic value	**Clients**
Resource reduction; packaging and levelling of services	Improved experience	**Customers**
Changing communication and sharing know-how	Improved consumption and experience	**End-users**

Improved economic value with a solution developed by many
Packaged solutions, created by many and serving exact needs of clients can bring in economic value by saving time and reducing costs that might otherwise increase by training to build solution on one's own. Solutions that connect two or more traditional service paths such as space, community, technology and transportation enable shared consumption of resources.

Improved customer experience through resource reduction; packaging and levelling of services
Various smart solutions inside office buildings (e.g. embedded in the office building The Edge) learn based on users' preferences or consumption of building facilities such as lightning, air conditioning preferences, or movements. The collection of big data can improve employee satisfaction, support their work activities as well as reduce costs related to real estate. IoT technologies empower service levelling and enable personalised service delivery, thus improving customer experience.

Improved consumption and experience by changed communication and sharing know-how
Presenting end-user as a centre for service development requires changes in communication. Increased possibilities to communicate internally and externally improves user experience as well as opens new business opportunities through co-creation and service or product innovations.

To conclude, key four ways to improve value of FM services through value co-creation were identified. By applying these solutions, value can be added to end users, customers, and clients through improved consumption, experience, and gained economic value.

5   PRACTICAL IMPLICATIONS

Co-creation as a phenomenon is coming to FM field slowly. Traditional FM service providers can increase their service value by applying various co-creation strategies. An increased focus on the end-user satisfaction should become one of the main goals for FM service providers and their customer companies. FM service providers should collaborate with other service providers in order to offer better or all-in-one service package, including providers of space, technology, transportation, and community. Services could be digital, packaged, and levelled to be easy to use for the knowledge worker.

However, it is the first attempt to show how FM services need to be developed in order to co-create value. More empirical research needs to be done in order to have stronger arguments for value co-creation. Also, suitable evaluation models need to be developed to be able to measure the added value of co-creation.

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5

HOW TO SHARE SPACE AND ORGANIZE PUBLIC FM?

5.1

The Evolving Modern Workspace – From Organizational Offering to Serving Communities of Individuals

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5.2

Centralizing Public FM Organizations: Danish Experiences with Success Criteria, Results and Realisation Processes

Susanne Balslev Nielsen

5.1 The evolving modern workspace – from organizational offering to serving communities of individuals

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ABSTRACT

Background: Organizations, cities, nations and continents compete over talented knowledge workers who create the backbone of competitiveness of modern societies in the first world. These talents have an increasing freedom to decide where, with whom, when and how to work.

At the same time, organizations are struggling in facilitating the increasingly heterogeneous manners of working. Increasing flexibility in terms of space, time and contracts affects the supply of workspaces. Cubicles have evolved to open plan, open plan to activity-based, activity-based to city as an office and city as an office to smart flexibility in working.

However, change resistance in organizations is the other side of coin. For the end users, workplace changes are mainly emotional and experiential whereas organizations tend to manage the changes from a mainly technical point of view.

Purpose and approach: To understand the evolution of modern workspace, this study looks at five typological diagrams in workspace evolution from The New Office through to the Hybrid workspace, through to Space to Work, through to Workspace in 2013, through to Shared facilities, and finally Workspace in 2020. The aim is to understand evolution of the workspace discourse by exploring selected diagrams, reflect upon the evolution of organizational ways of working and potential ways forward.

Results: The results imply that the discourse has shifted from local towards global focus, from space of places towards space of flows and from the demands of the internal organization towards those of communal practices with external partners and customers. It can be interpreted, that the theory of spatial transformation has thus taken place in practice. Future research should be conducted on the demand of different types of spaces and collaboration practices.

Keywords:
Workspace Management, New Ways of Working, Discourse, Typologies, Spatial transformation

1   INTRODUCTION

The workspace, as we know it, is a result of multiple socio-technical forces. A focal theory to explain the transformation of space as a concept is that of spatial transformation (Castells 2004). According to Castells (2004), the society is becoming increasingly networked. He suggests the rise of the network society shifts the concept of space from being a static space of places designed for a pre-defined purpose for specific group of people towards dynamic, multi-purpose interconnected and shared space of flows where information is created, shared and applied. The space of flows is an infrastructure that connects functional nodes that operate in real time independent of geographical locations. The role of the nodes in the network are to an increasing extent determined by their functions, not locations (Castells 2010).

The knowledge practices that the workspaces aim to support are manifested in dense cities where work is disseminated around city structures, and people are offered a variety of services for executing their daily routines and tasks individually, and in collaboration with each other (Laing 2013, Lindsay 2014, Waber et al 2014). Multiple scholars in the field of Facilities Management (FM) argue that the places where knowledge work is conducted are scattered to multiple spaces which are increasingly chosen by individual instead of organisation´s choice. (e.g. Termaat el al 2014, Brinko et al 2014). This means dissemination of work from one location to hubs, co-working spaces and home offices. Simultaneously, Cole et al (2014) discuss how the freedom of knowledge workers are changing expectations of the knowledge-based workers at their main workplace setting.

Lake (2014) refers to the enablers of these new knowledge practices with the concept of smart flexibility, covering the flexibility of time, locations and contracts. These new knowledge practices require new management principles. The organizations are becoming flatter, boundaries between traditional siloes are blurring and organizations incorporate an increasing amount of flexibility (GSA 2009).

For the end users, workplace change is mainly experiential and emotional whereas the construction and real estate industry tends to manage the technical solutions (Lehtiranta 2015). Therefore, she suggests use of a Customer Experience Management (CEM) model which could benefit workplace change managers in managing the changes at the workplaces. CEM originates from manufacturing and B2C industries but Lehtiranta (2015) suggests it to be even more applicable for the construction industry, where it has been largely neglected. She argues for the better applicability based on: 1) the end user of the workplace tends to be known in advance and 2) the lower the expectations are in an industry the more efficient the improvement in the customer experience.

Due to the experiential nature of end user perception, also change resistance at workplaces is an issue that practitioners face when conducting workplace change programs and processes in organizations. One reason for this are the generational differences that Bennett et al. (2012) refer to pointing out the differences between the four generations currently working at the workplaces. Mentoring, team-based, non-hierarchical work styles, use of technology and providing collaborative workspaces are proposed as criteria to ensuring an effective transfer of knowledge between the more experienced and younger generations. Furthermore, they argue, these criteria require workspace support to be successful.

This paper aims to outline the major milestones of the discourses around the modern workspace in the field of workspace management and reflect it to how the organizations need to adapt to the changes. It does so by pinpointing milestones of changes in modern workplace typologies to management principles and end user experiences. The paper is structured under

four main sections: Literature overview, which outlines the causal relationships of the discursive typologies; Results, which provides a coherent wrap-up of the literature overview; Discussion, which notes implications and limitations of this study, and finally conclusions, which underlines the main message of this study.

2   STATE OF THE ART

In this section, six diagrams over the evolution of the modern workspace are explored: *The New Office* (Duffy 1997) which focuses on the inside of the buildings and their support to knowledge workers in the corporate world; The *hybrid workspace* (DEGW 2001), which focuses on the public-private and physical-virtual continuums; *Space to work* (Ross and Myerson 2006), which focuses on the relation of buildings in the city structure and work-life balance of knowledge workers; *Workspace 2013* (Termaat et al. 2014), which acknowledges decision power shift from organisations to individuals, *Shared facilities* (Brinko et al)*,* which identifies different types of sharing strategies in the workspace; and *Workspace 2020* (Termaat et al 2014), which focuses on the business models of a variety of services out of which knowledge workers can collect the workspace that is most suitable for their needs.

The new office (Duffy 1997)
In the latter part of the 1990's, Duffy was the first to introduce a modern workplace typology which they referred to as "The New Office". Their model described the demands of a knowledge worker in relation to space: Y-axis represents the level of interaction a space enables, X-axis representing the level of autonomy in the work setting. The different types of spaces were clustered into four categories: HIVEs, DENs, CLUBs, and CELLs - HIVE being the least autonomous and allocated to individual processes and CELL being the most autonomous space for concentrated study with least interaction. The typology is illustrated in Figure 1.

It can be interpreted, that the focus of the discourse of Duffy (1997) was inside the buildings in different spatial design layouts, and the need to support individual and interactive tasks in a corporate setting. The corporate headquarters was taken as a standard, and the employees knew more or less where to work, at what time, with whom and how. They still did not have too many options for working away from the office, as the virtual connections were not sophisticated enough. The management principles could still be based on command and control, and working was dependent on time in space. The end users did not technically have freedom of deciding when, where and how to work. Furthermore, Vos et al. (1999) built on the corporate headquarter idea but considered multiple types of offices claiming that each workplace decision must consider the place, space and use of offices in order to optimally support the activity in question.

After the corporate headquarters, a demand for greater flexibility in organizational space arrangements emerged in the turn of the millennium (Becker 2001, Gibson 2000; 2001, O'Roarty 2001, Worthington 2001). Technological evolution enabled larger and larger amount of data to be transferred, networks of smaller firms that seemed to be able to create value in an agile way started to pop up, and shorter and shorter lease times were asked for because the static nature of workspace was disturbed by the dynamic needs of entrepreneurs who searched for fast exits in the IT-boom. Deriving from the demand, a variety of new kinds of alternative space concepts evolved including serviced offices (Becker 2001), distributed workplaces (Harrison 2001), office hotels (Becker 2001), collaborative hubs and creative business incubators (Montgomery 2007).

Figure 1: The New Office typology (reproduced based on Duffy, 1997)
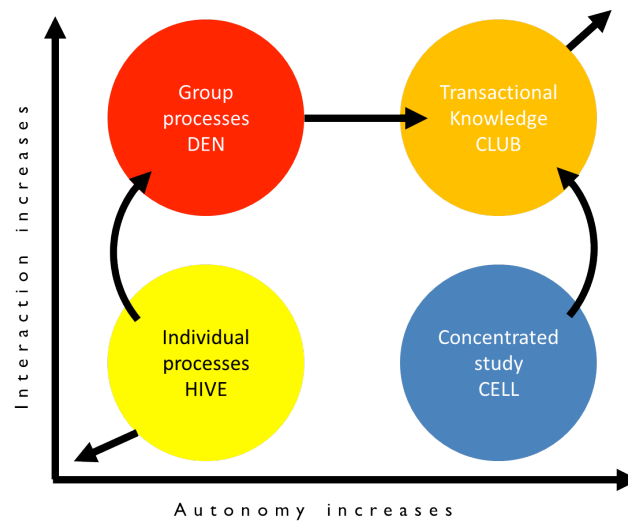
The hybrid workspace (DEGW 2001)

In the turn of the millennium, DEGW (2001) presented the Distributed workplace model, which was furthermore developed into the Hybrid workspace model focusing on the relation of physical and virtual dimensions but from point of view of the level of privacy associated in both dimensions.

Figure 2: The Hybrid workspace (DEGW, 2001)
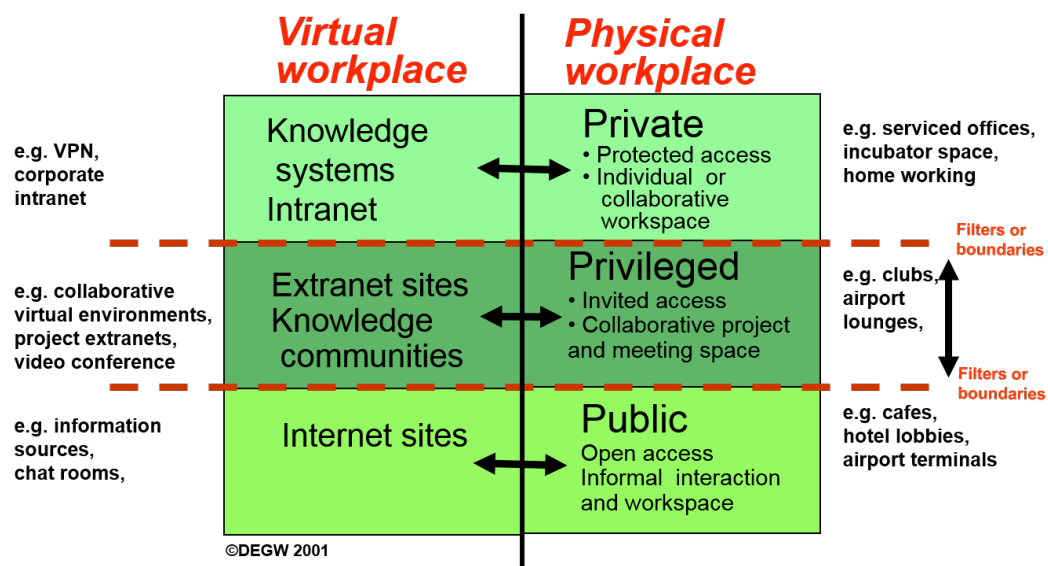
Moreover, the evolution continued. Due to exponentially evolving technological capacities, the concept of space continued shifting from a static form designed for a pre-defined purpose for specific group of people towards dynamic, multi-purpose interconnected space of flows as suggested by Castells (2004) in a city scale. Castells' theory of spatial transformation in the information age outlines the spatial transformation to take place in three abilities: *Function* described by the axis of local and global, *Meaning* described by the balance between individualism and communalism, and *Form* described by the balance between *Space of flows*

and *Space of places.* He proposes an alternative definition for space as "the material support of time-sharing social practices".

As the means, times and places of working and learning started to scatter around from the corporate headquarters based on individual daily routines, effective and efficient spatial facilitation of working became increasingly complex (Worthington, 2001; Joroff, 2002; Van der Voordt, 2004). This challenged the workplace managers in their daily work. The spatial design trends supporting working started to shift from formal spaces for specific purposes to informal multipurpose spaces (Brown and Long, 2006; Somerville and Brar, 2010) which were enabled by technological development that started to blur boundaries between the space types (Fruchter, 2001; Shabha, 2004; Milne, 2006; Dugdale, 2009). At the same time, HR, IT and Real Estate sectors in organisations started getting closer to one another and more holistic approaches were called for.

The increasingly complex environment challenged the existing technical management principles of command and control. The employee tasks and effective ways of working varied. The employees gain increasing freedom and responsibility in deciding how they conduct their work inside and outside the corporate office.

Space to work (Ross And Myerson 2006)
5 years after DEGW's Hybrid workspace, Ross and Myerson (2006) introduced a model they refer to as *Space to work*. They identified four types of spaces according to the stakeholder groups in the x-axis of physical environment and the y-axis of corporate presence. Academy represents a backend infrastructure used by colleagues for the purposes of contained work with high corporate visibility but a modest physical presence; Agora represents the front end and is used for permeable work with the customers showing off with high corporate visibility and iconic physical presence; Guild plays a role in the portfolio as a low corporate visibility but can still be of high physical presence, where the knowledge worker reflects with his peers; and finally Lodge is the place where the knowledge worker lives life with his/her family where the corporate visibility tends to be low and physical presence modest. The typology is illustrated in Figure 3.

Figure 3: Space to Work (reproduced based on Ross and Myerson, 2006)
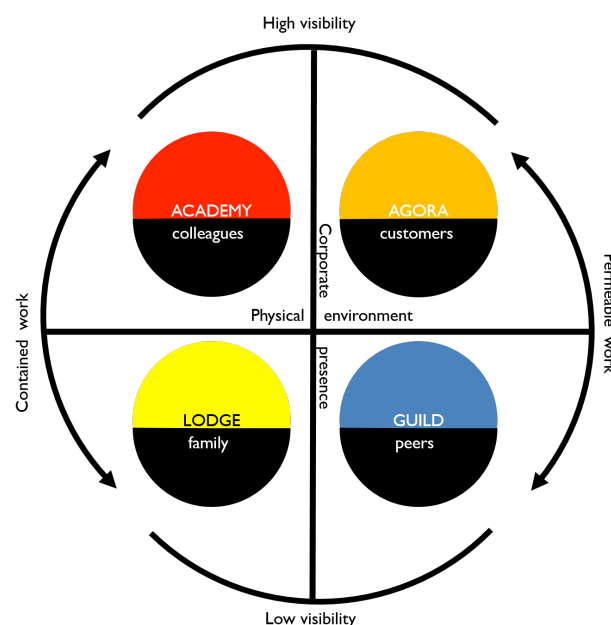
Ross and Myerson's (2006) typology has shifted the discourse from the inside of the corporate building to a more relational holistic city perspective where the corporate presence is described in relation to other parts of life and important stakeholders from the knowledge worker's perspective. Work life balance became topical and shifted the discourse towards individual needs and wellbeing but there was yet more to come.

In line with Castell's suggestion on the spatial transformation paradigm, Duffy et al (2011) proposed a shift in workplace design from Tayloristic paradigm of dividing to rule to totally opposite: a cohesion of context, design and user variables to maximize choices. The decision making mechanism started shifting from one size fits all organizational top-down decision making towards individual-driven grassroot level on-demand –based agile end user service decisions.

Then again, Matthews et al. (2011) propose collaboration personas as a design tool for workplace collaboration arguing that the end user segments in digital tool planning tends to focus on individual rather than collaborational needs.

Workspace in 2013 (Termaat et al. 2014)
Termaat et al (2014) observed the workspace as a concept from the business model perspective and suggested that in 2013, the typology would be based on the balance between external and internal focus of an action and communal and individual decision on the location of the workspace. They coin their ideas into a typology consisting of four types of spaces: Traditional offices, Business complexes, Third places, and Satellite offices. The location of traditional offices is driven by the community and the focus of action is internal. The location of Business complexes is also driven by the community but they are more focused on external actions. The location of third places is driven by individual user, and the actions are externally focused. The location of Satellite offices is also driven by individual users but the focus is on internal actions. The typology is illustrated in Figure 4.

Figure 4: Workspace in 2013 (reproduced based on Termaat et al., 2014)
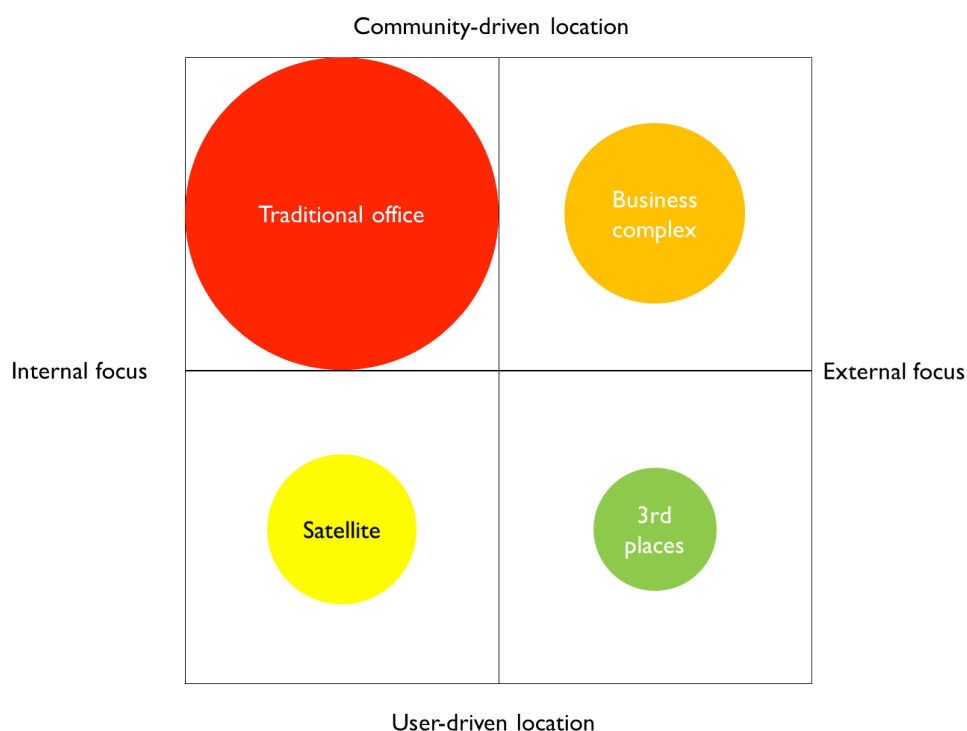
In their proposal, the discourse has shifted from work life balance back to business. The individual decision making and direction of action inside or outside the firm play a larger role than in the precedent typologies which indicates a shift to the network society structure.

At the same time, the rapidly evolving virtual technology and business model innovations have enabled underutilized physical resources to be taken into better use. This has enabled third party aggregators to link the ones in need to the owners who are not all the time using the resources. This can be seen as the rise of the sharing and access economies. (Eckhardt and Bardhi 2015). Clichy examples include but are not limited to Uber and Airbnb which are the fastest growing taxi and accommodation providers but neither own a single taxi nor real estate. In the workspace sector, Liquidspace and Worksnug are examples of alike services that link the owners of underutilized resources and the ones who need them on-demand.

Cole et al. (2014) looked into the changing culture at workplaces that the increased mobility and blurring between space types and work and leisure causes. They concluded that the increasing mobility in working can be seen to affect the employees, the employers and the facilities managers in different manners. Accordingly, it is becoming harder for the employers to attach the employees to the office as they increasingly engage in other work settings – homes, cafés and trains to name a few. Consequently, the role of Facilities Managers has a lot of potential for expanding the scope from only managing the technical side towards managing the end user – in this case the employee - experience.

Shared facilities typology (Brinkø et al. 2014)
Inspired by the idea of sharing economy, Brinko et al. (2014) identified an initial typology of the shared facilities in relation to the type of community that utilize them, when, why, and how including four types. The types are based on the form of sharing and accessibility in an organizational setting: sharing *a specific facility* (desk or workspace) *in a semi- closed community*, sharing *facilities in an open community*, sharing *physical space in a building in a closed community*, and sharing *facilities in a network of buildings and organizations in an open, semi-closed or closed community*, see Figure 5.

Figure 5: Shared facilities typology (reproduced based on Brinko et al., 2014)

| Sharing a specific facility – a desk or a workspace in a semi-closed community | Sharing several facilities in an open or semi-closed community | Sharing physical space in a building or a building itself in a closed community | Sharing facilities between users in a network of buildings / organizations in an open, semi-closed or closed community |
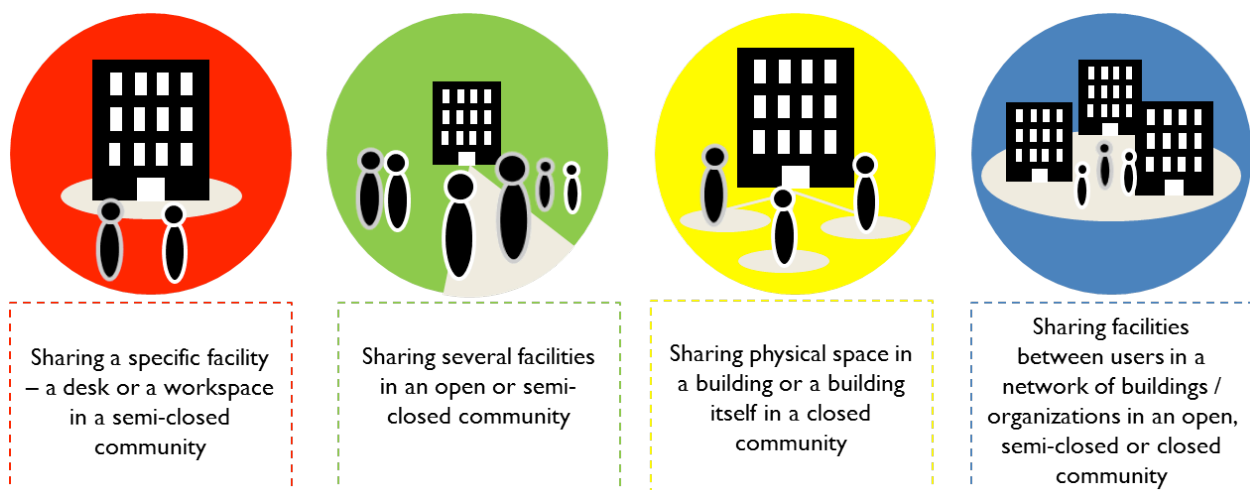
This typology pinpoints the rise of the sharing economy which has opened possibilities for third party aggregators to set up new businesses, and on the other hand, the organizations to

open up their facilities to invite collaborators in. The discourse bases on the rise of sharing economy and its effects on organizational behaviour in workspace context.

The phenomenon of co-working is focal to the shared facilities typology. Deskmag (2001) is dedicated to collecting data on co-working phenomenon and collects annually data of end-users of co-working spaces in form of a worldwide survey. Since 2010, the amount of global co-working spaces has increased from 600 to 5780 in 2014 and is predicted to increase to 37.000 by the end of 2018 (Deskmag 2014). The same survey indicates the amount of co-workers today to be 295.000 in 2014, and expected to grow to 2.370.000 co-working space users by 2018. In 2011, 54% of the coworkers reported themselves as freelancers, 20% as entrepreneurs, and around 20% as employees of small firms consisting of less than 5 employees. Inevitably, the phenomenon of co-working seems to be exponentially growing and affecting the ways in which the organizational spaces are shared.

Workspace 2020 (Termaat et al. 2014)

Furthermore, Termaat et al. (2014) predict an optimal support for knowledge workers in the future. They suggest that different types of spaces are overlapped in the same axes as their typology for Workspace 2013. They identify five types of spaces in 2020: Campus, Club, Hub, Home and Co-work spaces. Hub links all the other types together being in roughly the middle and having the largest reach on the four field. Co-work spaces are the second largest type and externally-focused, whereas Homes are dictated by individuals and are in the middle of the internal-external spectrum. Campuses that incorporate the fifth type, clubs, are the most internally focused types, the location of which is driven by the community rather than an individual user.

Figure 6: Workspace 2020 typology (reproduced based on Termaat et al., 2014)
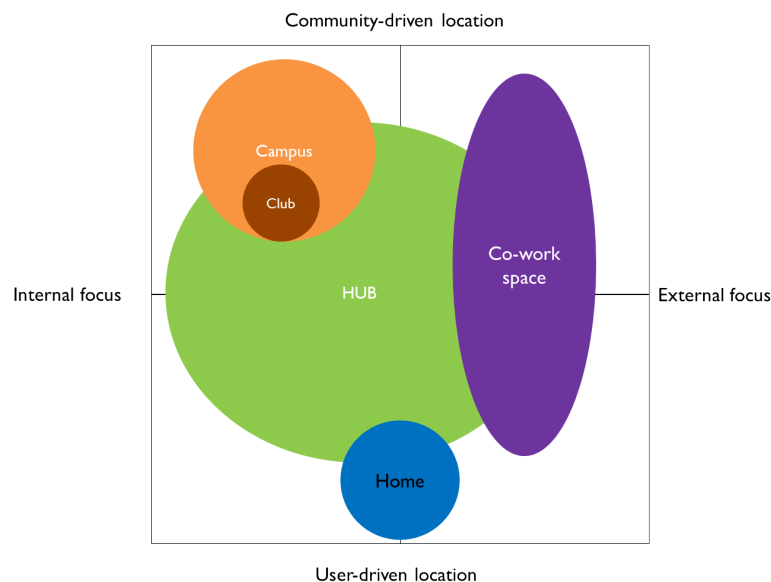
The discourse of this typology incorporates the relations of multiple space types that constitute a larger interlinked entity reflecting a more holistic approach to workspace as a service rather than separate types in isolation from one another. It seems evident that as the workspace is becoming increasingly fragmented, new services to support the interconnections between employees are needed.

Cole et al (2014) argue that while workers have specific tasks and responsibilities, they now navigate through multiple physical and social settings and boundaries in fulfilling them on a home-office continuum. Miller and Marsh (2014) discuss how the digital renaissance takes place at the offices, which is then again quite a challenge regarding the four generations at workplaces today (Bennett et al. 2012). Bennett et al. (2012) suggest that the organisations should thus focus on facilitating the internal communications and support between the four generations through four strategies of Mentoring; Team-based, non-hierarchical work styles; Use of technology; and Providing collaborative workspaces.

Lake (2014) introduces the next step from mobile working. He describes the working style of the future through the term of smart flexibility, which refers to flexibility in time, location and contracts. In his view, flexible working is not any special type of work as such – it is just the same work conducted in a flexible manner - with different tools at different times in various locations.

3   APPROACH

The discourse on the modern workspace typologies over time is reflected to the spatial transformation theory (Castells 2004). The aim is to understand how the discourse on workspace typologies has evolved along the way and how that relates to the theory on a timely continuum.

Castells (2004) argues that spatial transformation is a fundamental dimension of the process of structural change that must be understood in the broader context of social transformation. According to the theory of spatial transformation in cities takes place in three dimensions: function, described by the axis of local and global; meaning, described by the axis of individualism and communalism; and form, described by the axis of the space of places and space of flows. Castells (2004) proposes an alternative definition for space as "the material support of time-sharing social practices". In his view, space is not static but, rather, it is constituted by social relations, technological, political, social and economic forces, and transformed along with them.

4   RESULTS

Based on the analyses, the transformation of concept of space from a static state to dynamic process seems to have happened along the evolution of the modern office which nowadays manifests Castells' (2004) ideas. The discourse in workspace management has seemingly shifted from inside a single organization's walls to the connections of an organization's buildings from an individual work life balance perspective, and back to the organizational discussion on whether an individual or a community decides how to work, from where, when and with whom.

Some of the explored diagrams include same concepts such as "club" (Duffy 1997, Termaat et al 2014), and "academy" (Ross and Myerson 2006) and "campus" (Termaat et al. 2014). Comparison of the concept of "club" reveals that the same concept was the most interactive and autonomous type in Duffy et al (1997) whereas in Termaat et al (2014) it is on the internally focused community side, which can be seen as less interactive in comparison to the externally focused side. The "campus" and the "academy", on the other hand, are in the very same spot in both of the diagrams. The concepts of the different scholars seem to be very much the same with one another.

All in all, the space types seem to have come closer to each other, and smaller and smaller niches are being aimed at by a variety of service providers. Now that the free flowing information enables more decision power for individuals over their own working habits, more and more tailored solutions will most probably find their niches in the market. As indicated in Table 1, Castells' suggestion of spatial transformation from functional, formal and meaning perspectives seems to be manifested in the discourse of workspace typologies during the last twenty years.

The shift of typological discourse can be interpreted in these three dimensions. Functionally, shift has happened from local towards global focus. Formally, the movement is from space of places towards space of flows. And even though each typology has always incorporated the dimensions of individual and group practices, the meaning has shifted from that of the internal organization towards communal practices with external partners.

5   PRACTICAL IMPLICATIONS

This conceptual exploration suggests that spatial transformation can be identified in the discourse of workspace management, and consequently argues that it has taken place. The paper is not extensive but as a light observation of the trends along the way, it provides insights to causal relationships between the diagrams along the pathway of evolution of modern workspace.

Table 1: Workspace typologies in spatial transformation

Typology	FUNCTION (Castells 2004)	FORM (Castells 2004)	MEANING (Castells 2004)
New office (Duffy et al 1997)	Local organization	Space of places inside the building	Individual-organizational
Hybrid workspace (DEGW 2001)	Local organization and local community	Space of places merging into space of flows	Private-public
Space to work (Ross & Myerson 2006)	Local organization	Space of places between the buildings of life and work	Individual-internal organizational
Workspace 2013 (Termaat et al 2014)	Local individual	Space of separate places in the city structures	Individual- external communal
Typology of shared use of facilities (Brinko et al 2014)	Global community	Space of flows	Individual- external communal
Workspace 2020 (Termaat et al 2014)	Global community	Space of flows	Individual- external communal

Workspace management has responded to the challenges that spatial transformation has brought it in forms of different experiments, concepts, products and services. It is however noteworthy, that such socio-technical changes are long-lasting, and the changes in behaviors of task- and routine-oriented employees take time and might actually never change. Yet, the increasing amount of co-working and other trends imply that little by little an increasing

amount of employees will apply new practices and utilize new types of workspace arrangements now that the services are made easily accessible.

The dilemma of designing workspaces for the changing world is in that individuals increasingly choose where to work, when, with whom and how. Facilitating that freedom of choice is essential in modern workspace design. Simultaneously, there are always people who resist changes. The shift requires more proactivity from the individuals and the workplace management organizations can not anymore only rely on old management principles such as command and control but more and more emphases should be put on empowerment and support of a variety of demands of the workforce. At the same time, the individuals need to increasingly take responsibility on the work to be conducted while nobody is watching. Self-management, education and support for proactivity of employees are increasingly important when the spatial dimensions are blurring, and the best ways of working depend on individual's role and the ways they find the most powerful for them as knowledge workers.

In the future, we will most probably see more and more integrated typologies that base on the connection of physical and virtual layers of workspace together – in reality they are already connected. A lot of potential lies i.e. in approaches that augmented reality and cyber work can provide to better serve the mobile workforce. Without the increasingly integrated nature of the two dimensions, it is not realistic to proceed.

The paper is limited in not taking into profound consideration all the typologies of workspaces but using a set of examples to pinpoint some main steps along the evolution. The study could be deepened by a more thorough literature review on all the spatial typologies outlining the concept of workspace in physical and virtual spheres from industrialization to date which could also result in finding paths for more integrated approaches. Also, a comparative study into the users of these workspaces could provide valuable insights on how many are using the new types of services and spaces in reality and how many still continue on the traditional way in which fields of expertise and why.

6   CONCLUSION

Easy access seems to be the key to the workspace of the future when decision power shifts from organizations to individuals. Simultaneously, individuals need to take more and more responsibility and action to get their job done. Increasingly, emphases of the workspace managers should be put on linking the mobile knowledge workers that might have something in common because majority of the individual work can be done from anywhere, at any time, whenever. As more and more people are working by themselves, the face-to-face meetings with serendipitous connections are valued more. Therefore, the emphasis is shifting from only providing static workspaces towards creating attractive places to connect and meet and events that function as platforms for collaborating and recruiting project-based knowledge workers.

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5.2 CENTRALIZING PUBLIC FM ORGANIZATIONS: DANISH EXPERIENCES WITH SUCCESS CRITERIA, RESULTS AND REALISATION PROCESSES

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ABSTRACT

Purpose: The purpose of this study is to provide the first complete overview of how FM is organised in municipalities in Denmark and to share the lessons learned from centralizing Public FM organizations.

Background: The paper builds on (Jensen and Due 2008), who present models for organizing municipalities' FM organizations. The theoretical concept of "Strategic FM organizations" described in (Nielsen et al 2012) is used to explain the strategic differences among the models.

Approach (Theory/Methodology): The paper presents an empirical investigation (conducted in 2014 and 2015) of the organization of Danish municipalities' FM organizations. The research consists of two steps: first, qualitative case studies of 6 municipalities and their processes of centralizing their internal FM organizations; and second, an online survey with the participation of 65 of the 98 municipalities.

Results: The empirical study shows that 29% of the respondents have a centre with ownership and operation of the buildings; 45% have a central unit for building operation and maintenance, but without building ownership; and 26% have a decentralized organization. The main success criterion is a strong economy. The most frequent results are: better overview of properties and FM tasks and better use of the maintenance budget.

Practical Implications: The paper is particularly relevant for municipalities that are in the process of reconsidering their future organizational structures. A seven-step process is suggested to ease the establishment of a central FM unit.

Keywords

Municipal FM, Strategic organization, Strategic FM, Public real estate, Danish municipalities.

1   INTRODUCTION

The organisation of public FM is currently an under-studied niche within FM. It is understudied in relation to its importance to citizens because public facilities include day care institutions, schools, social housing, workplaces, prisons and hospitals, just to cite a few examples. This topic is also understudied because of its importance to the economy on institutional, municipal and national scales and because the public sector is going through dramatic changes, which is a "game changer" within FM. To understand the goal of leadership in FM in a public context, it is desirable to integrate facility planning (demand,

prognoses, and scenarios) and decisions about buying, renting or building with the building client's function and operation (Jensen 2008).

The establishment of central FM organizations in Danish municipalities has gained momentum in recent years. In 2014–15, in order to learn from past experience, the Centre for Facilities Management (CFM) at DTU and the workers association FOA (Fag Og Arbejde) jointly conducted a pilot project on the formation of municipal FM centres (Preisler Hansen and Nielsen 2015). FOA's motivation is to act proactively to influence the changes that their members (technical service personnel) experience. CFM's motivation is to improve the knowledge base for municipal property management, also called municipal facilities management (FM).

The 98 Danish municipalities are different in size but face the same challenges with respect to owning, building, operating, maintaining, developing and managing facilities like schools, day care centres, administration buildings, and sports halls. This study does not focus on other Nordic countries, but municipalities in other Nordic countries and even beyond might find the study relevant, as they too are facing similar challenges in driving the professionalization of FM within a municipality or a region.

Nationally, public FM has been a hot topic in recent years because this area of policy is seen to have great potential for increasing efficiency and reducing costs (KORA 2015). Furthermore, the building stock has a backlog of maintenance requirements and invites innovation as a new niche for smart and sustainable products and services (Foreningen af Rådgivende Ingeniører 2012).

The purpose of the project is to share the experiences of the centralizing FM organisations and provide timely and relevant input that may assist municipal efforts in strengthening the organization of FM in municipalities. This study sets out to investigate:

1. How is FM currently organized in Danish Municipalities?
2. What lessons can be learnt from municipalities that have centralised their FM organisation?

The study is important for a number of reasons. First, because it examines municipalities and their FM organisation, which is an important basis for understanding how municipal FM practices can contribute to value creation through sustainability, the happiness and well being of citizens, and economic efficiency and effectiveness. Second, there is very limited academic literature on this topic and a major need to improve the image of public organisations (Luoma-aho 2008).

The paper is structured as follows: a short summary of the state of the art, a description of the methodology, the results, conclusion and practical implications.
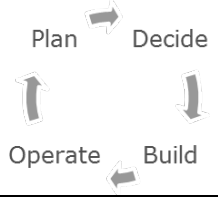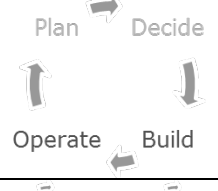
2   STATE OF THE ART

Public FM is seen as a niche within the FM literature because so few authors have specifically addressed this topic. This is not necessarily a problem, as facilities managers face many of the same issues and challenges as facilities managers in private organisations. However, public organisations are different, and there are different rules and expectations regarding their code of conduct, e.g., they are expected to make deliberate contributions to

societal development. (Alexander and Brown 2006) suggest that Public FM should strive for different strategic value sets – compared to those commonly set by private organisations – to ensure that a facility also contributes to the local community in which it is located. Galamba (2012) focuses on the special role of embracing sustainability visions in the daily work of public FM organisations, which calls for new capabilities. Other authors have studied particular types of public buildings or ways of complying with specific policy agendas, e.g., energy efficiency and digitalisation. Still, the literature that focuses specifically on public FM is limited but growing.

The organisation of public FM organisations in Denmark is the topic of (Jensen and Due 2008). They identified 4 different constellations of FM tasks: owning, planning, operating and maintaining facilities, all of which were in use in Denmark. This study will use 3 of these models, which are explained in Table 1. The 4th and most decentralised model of institutional ownership and operation is not relevant for this study of centralised organisations. The development of larger public FM organisations is seen as an important step towards ensuring efficient and effective Facilities Management and better quality in the public sector by Danske Regioner et al. (2008). Larger economic volumes – and thereby an increase in professionalization – are seen as a possible result of assembling tasks and of specialisation.

Table 1: 3 models for municipal FM organisations

Model 1	An independent FM centre With the full authority and strategic leadership to manage the municipal facilities.	
Model 2	An administrative FM centre A FM centre that manages (builds, operates) the municipal facilities on behalf of the owners, which are various administrative departments and institutions.	
Model 3	A decentralised FM organisation Where the ownership and the operation are assigned to the various administrative departments such as "Children and Youth", "Culture" and "Town hall administration."	

In Nielsen et al. (2012) the concept of "Strategic FM organisation" (SFMO) is developed to describe the organisational context of strategic FM. By focusing on the relations among owner, administrator, operator and end-users it becomes clear that different constellations also create different conditions for holistic thinking, e.g., regarding sustainability strategies. The three models represent three different concepts for public SFMO. Model 1 represents the integrated strategic FM organisation. Model 2 separates construction and operation; this is a way to structure a supply chain process that enforces the need for dialogue, coordination and partnerships between the various functions. Model 3 is similar to Model 1, but the difference is that this comprises smaller units with close relations among the owner, administrator and operator, such that the public FM organisation consists of several parallel SFMO organisations.

3   APPROACH

The following section presents the methodology and the theoretical framework used in this study. The methodology consists of two steps. Step one is a qualitative case study of six FM centres, with the goal of investigating their processes of establishing centralised FM units. Step two is a quantitative and qualitative survey sent to all Danish municipalities to verify and quantify the findings from the case study.

A number of municipalities were contacted and invited to participate in the qualitative study. The aim was to identify municipalities of different sizes, including the largest, medium, and smallest Danish municipalities (measured in population) and from different parts of Denmark. It was a prerequisite that (1) the official opening of the centre had to be at least one year before the interview was to take place; (2) the municipalities should reflect variation in population and geography to represent the variety of Danish municipalities; (3) the technical service personnel were associated with FOA and not competing workers' associations; and (4) they were willing to find the time to participate in the interviews and share additional information such as policy documents, reports, and press releases.

Table 2: Facts about the six case municipalities extracted from Statistics Denmark

Municipality and facts	Frederiks-havn	Gentofte	Ishøj	Silkeborg	Svendborg	Ringsted
Inhabitants	60.538	74.644	21.761	89.950	57.978	33.516
Geographical area in Km²	650	25	25	850	415	295
Total building space in m²	322.300	399.200	130.300	488.200	263.200	180.800
Number of buildings	722	878	285	1.299	777	393
Space pr. inhabitant in m²/person	5,3	5,3	6,0	5,4	4,5	5,4

The six municipalities in Table 2 have kindly contributed to the case study by sharing their experiences with setting up a central property centre. In each municipality, semi-open qualitative interviews were conducted with key informants: the centre director, one or more employees and a leader from a user institution. Based on these three perspectives, a storyline was constructed for each case. The questions asked were:

1. What were your goals and your success criteria?
2. What were the barriers you encountered and how did you tackle them?
3. What have you learned and what should other municipalities think about if they are considering centralizing their FM organisation?

The survey was conducted after the completion of the case studies and used the qualitative results to generate questions. Survey Monkey, a web based survey tool, was used and sent by e-mail to all 98 municipalities in Denmark through the municipality's main e-mail address. A total of 80 replies were returned, but a data cleaning process was needed to eliminate non-valid replies. The IP numbers revealed that some respondents had made several attempts before they managed to complete the questionnaire. After this data cleaning it was clear that the survey had 65 unique answers, equal to 66% of all Danish Municipalities. This is seen as a very satisfying response rate, which makes the survey reliable.

The theoretical framework is simple. The point of departure was to explore existing FM centres with more than one year of experience, so as to ensure some experience and initial results. We chose to search for 3 models of FM organisations based on Jensen and Due (2008) and Danske Regioner et al. (2008) and respondents were asked which of the three models best characterised their FM organisation. The remaining questions in the survey aimed to determine to what extent the respondents shared the same success criteria, experienced the same results and had experienced the same challenges. Thus there was a clear link between step one and two in the methodology.

4   RESULTS

This section presents the story line of each of the six cases of establishing an FM centre (Model 1 and Model 2) and the results of the survey. The cases describe Danish experiences with success criteria, results and implementation processes.

4.1   Six cases of establishing a FM centre
Below is a short description of each of the six cases: their purpose in establishing a new FM unit, their experiences and their results so far.

Frederikshavn: In 2012 Frederikshavn Municipality opened a new FM centre. The goal was to reap significant economic and qualitative benefits through a coordinated and centralized approach to property issues, including freeing the economy by creating a better view of the real estate portfolio and capacity utilization. These were incorporated into an annual savings of 1,350,000 Euro. The success criteria for the new centre were streamlining work processes, harmonizing service levels and achieving savings. Until now, these success criteria have primarily been realized through economies of scale, improved purchasing and adjustment of both resources and salaries. The focus is now more on development and opportunities rather than on costs, including optimization of operations as well as better land use and disposal of property.

Gentofte: Gentofte Properties has existed since 1 January 2008 and is one of the oldest municipal FM centres in Denmark. The centre has long since passed the establishment phase and is now a "machine at full speed." However, this does not mean that adjustments and modifications are not still being made. The immediate objective of the centre's formation in 2008 was to strengthen the building maintenance team and to streamline operations. These objectives have already been met. Since the centre's formation in 2008, Gentofte has saved between 1.600.000-2.010.000 Euro on rationalisations and redundancies, and building maintenance in the municipality is now better and more consistent.

Ishoej: Ishoej Municipality started to restructure its FM organization in the summer of 2014. The restructuring meant, among other things, that technical services at the municipal day-care institutions were centralized under the FM centre. Similarly, the previous form of organization was replaced by more flexible working communities that were better at completing tasks across policy areas, with a focus on tasks and customers. The aim of the restructuring was to strengthen the quality and level of service offered to the city's institutions and citizens. The restructuring has not been implemented with immediate financial savings in mind. The philosophy of the new organization is to think in terms of total solutions and to "focus on the customer."

Ringsted: In 2011, the technical service personnel in Ringsted Municipality were united in one central unit for building operation, and in 2014 this centralization was continued with the merger of the former Municipal Properties (building client organisation) and the former Road and Park into one complete municipal property centre. The primary purpose of centralization was to achieve efficiencies, improvements and savings in operation and maintenance teams of municipal buildings. Before the FM centre was established, Ringsted Municipality had, for a long period of time, had a backlog of maintenance and found that the decentralized maintenance funds were not always used optimally and smoothly. The centralization should improve efficiency through better coordination and cooperation among related tasks.

Silkeborg: Silkeborg Properties opened in January 2012. This consolidated ownership of all municipal buildings and all municipal property management and building maintenance in a central FM centre. The main incentive behind the centralization was an overall municipal austerity in the field. The project was recognized as immediately saving approximately 400.000 Euro, and has had ongoing savings of 1 percent annually. The primary objective of the centre has therefore been a desire for efficiency and performance optimization.

Svendborg: In January 2014 Svendborg Municipality opened a new FM centre, the Centre for Real Estate and Technical Service. The employees of the administration had twice before tried to centralize FM centre but could not gain political support. However, in 2013 the political support was there, and the decision was made. The Centre's formation was very much focused on achieving efficiencies and savings on property operations through economies of scale, better prioritization, and use of municipal maintenance funds. A goal was to save approximately 400.000 Euro in 2014, with further savings of 2 percent in 2016 and 5 percent in 2018 compared to the 2014 budget. This objective has so far been achieved. Another objective is efficiency through better land-use planning.

These six cases show relatively different formation process and results but also some overlap. The names of the FM centres show variety: both "FM centre" and "Property Centre" are in use. The results are summarized below, first, the motivation and the success criteria identified in the study; second, the results of the centre's formation; and third, the challenges that have been faced. The full project report (Preisler Hansen and Nielsen 2015) provides more detailed case descriptions in Danish.

Motivation and success criteria for the new property centres:

- Good economy
- No backlog in building maintenance
- Streamlining work processes
- Improved building operation
- Customer Focus
- Service to more (day care centres)
- Coordination of related disciplines (e.g., management of roads and parks)
- More robust organisations

Preliminary results from the centralization of property management:

- Savings are realized
- Better use of maintenance funds
- Compensation for services and maintenance levels of municipalities

- Better overview of the properties and functions
- Centralised servicing of day care centres
- Team Structure implemented
- More focus on training and development of skills

Challenges experienced before, during and after the establishment of a real estate centre:

- Political and managerial support in the municipalities is essential
- Centre formation takes time and is a costly process
- Scepticism and dissatisfaction among users has to be handled
- School leaders feel that they are losing influence
- Some headmasters report that cooperation with technical services has become more difficult
- Some headmasters experience deteriorating service levels
- Degradation of salaries, creating resistance among the technical service personnel
- Some people experience a loss of belonging and ownership
- Some employees feel pressured by disgruntled users
- Communication, involvement and dialogue are important

The case studies of the six municipalities provided a new and qualitatively valuable description of the managerial process of establishing a new and centralised FM organisational unit. However, the case studies did not indicate the extent to which this was common for all Danish Municipal FM organisations. The next section reports the results of the survey, which aim to validate and quantify the findings from the case studies.

4.2　Survey of FM organisations in Danish Municipalities

4.2.1　Characteristics of the current FM organizations

Of the 65 municipalities that replied, 19 (29%) have an independent unit (Model 1), 29 (45%) have an administrative centre (Model 2) and 17 (26%) have a decentralised centre (Model 3). Some commented that there are exceptions, e.g., that the decentralised model matched their FM organisation the best, but at the same time they have centralised single building services. This indicates a rich variety in how Danish municipalities have organised their FM, and that there are various combinations of the archetypes Model 1, 2, and 3.

The investigation of the timespan since the opening of a FM centre (Model 1 or 2) shows, based on 48 replies, that 30% of the centres (at the time of investigation) were newly established, as they had existed for only 1 year or less. A total of 28% had between 2-4 years of experience and 42% of the centres had more than 5 years of experience. The merger of municipalities in 2007, as a result of the Municipal Structure Reform that reduced the number of municipalities from 273 to 98, can explain some of the centres that have 7-8 years of experience. In the survey we asked those with decentralised centres if they planned a reorganisation within the next year. The survey showed that 41% of the municipalities with a decentralised FM organisation are in the process of planning a reorganisation, and 59% are not planning a reorganisation.

4.2.2　Success criteria for the new FM centres

A total of 47 centres (only Model 1 and Model 2) replied to the questions about success criteria and the results are displayed in Table 3. The centres generally share the same success

criteria, citing the economy as the most dominant. Only 56% of the respondents replied that "coordination of related disciplines" is very important or important, which might indicate that the focus on FM as a mature multidisciplinary profession is overlooked in the Danish context. Some respondents used the opportunity to comment and add missing success criteria. These additional success criteria are:

- Improved standard per m^2 on the same budget
- Most value for money in the areas prioritized in the municipal strategy
- Properties should provide the best possible facilities
- Transparency of expenditures
- Holistic thinking over sub-optimization
- Low consumption and green energy

Table 3: Success criteria for public FM centres in prioritised order

Order of priority	Success criteria	Very important or important	Neutral	Less important of not important	Do not know, not relevant, no answer
1	Good economy	96 %	0 %	0 %	4 %
2	Improved building operation	92 %	4 %	0 %	4 %
2	Customer Focus	92 %	4 %	0 %	4 %
2	Streamlining work processes	92 %	4 %	0 %	4 %
3	More robust organisations	82 %	10 %	0 %	8 %
4	Service to more (day care centres)	80 %	10 %	0 %	10 %
5	No backlog in building maintenance	74 %	16 %	6 %	4 %
6	Coordination of related disciplines	56 %	24 %	8 %	10 %

Overall, this overview of success criteria illustrates the complexity of the targets that the FM organisations have to achieve. This leads to the next section, which reports the respondents' self-evaluations about the effect of forming a FM centre.

4.2.3 Results of establishing an FM centre

A total of 47 respondents (19 independent units (Model 1) and 29 administrative centres (Model 2), with at least one year or more of experience, answered questions about what they have received by establishing a FM centre. Table 4 show the answers. As high as 90% answered, that the centre has led to a better overview of properties and FM tasks, and more that 60% answered that it has also helped on all other success criteria. Realisation of cost reduction, however, had the lowest (62%) score. A few comments emphasized that when they answered that the centre had not lead to cost reductions, this should be understood as saying that the centre had not led to additional cost savings. The FM budget was, in at least one case, reduced before the centre opened because of expected cost reductions. This indicates that municipalities might have had greater success in reducing costs than one can immediately see from table 4.

Table 4: The results of centralizing the FM organisation

Order of priority	Results	Yes to a high degree or to some degree	No, only to a minor degree or not at all	Do not know/ not relevant
1	Better overview of properties and FM tasks	90 %	2 %	4 %
2	Better use of the maintenance budget	88 %	0 %	13 %
3	Centralised service of day care institutions	75 %	6 %	9 %
4	Focus on education and competence development	72 %	11 %	17 %
5	More equal services and maintenance within the municipality	70 %	11 %	19 %
6	Team structure implemented in the FM organisation	68 %	14 %	17 %
7	Cost reduction	62 %	21 %	17 %

It should be noticed that the percentage of answers "don't know or not relevant" is higher than in the previous set of questions (table 3). The answers imply that this is due to uncertainties, as the establishment of the centre is still in process and it takes time to for the effects to show. In addition, the municipalities are also facing the general lack of explicit knowledge about the new centres' performance, as described by Jensen et al. (2012).

4.2.4   Challenges experienced in the process of establishing a centre

The case studies identified a number of challenges in the process of establishing a FM centre (Model 1+2). The surveys aimed to test to what extent the identified challenges were unique to the six cases or general for FM centres established in Denmark. A total of 47 centres answered this set of questions and the answers are shown in Table 5.

At the top are the managerial challenges that most experience: "Establishing a centre takes time and is resource demanding" and "Headmasters, who previously had their own maintenance budgets, experience a loss of influence". The least-reported challenge is reluctance due to reduced salaries and changed working conditions among the technical service personnel. This is a minor issue either because there have been no changes or because the personnel have accepted the changes out of fear of losing their jobs, a fear they reported in the interviews in the qualitative part of the investigation.

Table 5: Managerial challenges in the process of establishing an FM centre

Order of priority	Managerial challenges	Yes to a high degree or some degree	No, only to a minor degree or not at all	Do not know or not relevant
1	Establishing a centre takes time and is resource demanding	81 %	6 %	13 %
2	Headmasters experience a loss of influence	66 %	15 %	19 %
3	Headmasters experience a reduced service level	53 %	19 %	28 %
3	Some employees feel pressure from unsatisfied users	53 %	34 %	13 %
4	Lack of communication, participation and dialogue	49 %	38 %	13 %
5	Mistrust and satisfaction among users	47 %	40 %	13 %
6	Headmasters experience that collaboration with technical service becomes more complicated	43 %	32 %	25 %
7	Lack of political or managerial support	40 %	51 %	9 %
8	Reduced salaries and changed working conditions causes reluctance among the technical service personnel	28 %	38 %	34 %

5   PRACTICAL IMPLICATIONS

The paper is particularly relevant for municipalities that are in the process of reconsidering their future organizational structure in Denmark. The study provides guidance for reflection on how to lead a reorganization process and a pre-understanding of what issues might arise in such a process. This will hopefully lead to less frustration among employees and the experience of a clear and relatively smooth process, as the strategic leaders of the process will have a more nuanced pre-understanding of advantages and possible pitfalls.

On the basis of the municipalities' experiences and recommendations, the following seven steps are outlined to ease the establishment of an FM centre:

1. Start with what you can agree on.
2. Make a strategy for employee information and involvement.
3. In the initial phase, make a plan for the future operation of the schools.
4. Bring in external expertise if you lack time or skills.
5. Ensure an easy contact point for the users.
6. Determine a service level for all properties.
7. Property Centre Formation is an ongoing development and probably never ends.

The study is focused on Danish Municipalities, but concerns about how to empower FM organisations in smaller municipalities are similar in Norway (Boge and Nielsen 2015) and other Nordic countries. The Nordic culture of embracing employee perspectives on the tactical and operational levels makes this study more relevant for public FM leaders who

wish to take this approach and less relevant for those conducting their leadership in a more hierarchical power structure, where the dialogue with employees is different.

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6

WHAT ARE THE CHALLENGES FOR SUSTAINABLE DEVELOPMENT OF FM

6.1

Green and Sustainable – How are These Terms Reflected in the Context of Facilities Management?

Dave Collins, Antje Junghans and Tore Haugen

6.2

Flexibility as Enabler of Sustainability

Andreas Økland and Nils O.E. Olsson

6.3

FM's Role Towards Energy Management in Automated Buildings: A Comparative Analysis Between Passive-House School and Office Buildings in Norway

Cristian Roberto Valle Kinloch

6.1 GREEN AND SUSTAINABLE – HOW ARE THESE TERMS REFLECTED IN THE CONTEXT OF FACILITIES MANAGEMENT?

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ABSTRACT

Purpose: This paper evaluates how the terms '*Green*' and '*Sustainable*' are used in facilities management (FM) and FM relevant literature. The purpose is to develop a deeper understanding of the use of terms in new emerging products such as "green leasing" and make a contribution to terminological consistency.

Background: In sustainable development, the use of terminology is both important and a point of debate for scholars and practitioners. Owing partially to sustainability's relatively recent position as a research topic of academic interest, in addition to a series of fragmented efforts for standardisation, this has resulted in a multitude of uses for seemingly similar terminology. This conundrum of definition is especially prevalent in facilities management (FM). In a field and industry that is increasingly striving to adopt a coherent and consistent approach to its development, agreeing on standard usage of key terminology is of the upmost importance.

Approach: Using desk research and document analysis, this paper evaluates how the terms and terminology surrounding '*Green*' and '*Sustainable*' are used in academic FM publications, along with relevant literature from practice. The usage of each term will be categorised using the levels of organisation management (OM) consisting of the '*strategic*', '*tactical*' and '*operational*' levels. Findings will be discussed aiming to identify the consistencies and inconsistencies that are present in scientific and non-scientific literature in the use of terminology.

Results: The paper provides an overview and discussion into how the terms 'green' and 'sustainable' are utilised and applied in FM. The paper concludes by compiling the data found in the literature, and offers suggestions as to how these terms are used in the context of FM.

Practical implications: This paper will contribute to further developing and agreeing on standard usage of key terminology in FM along with further developing the state of the art in FM. This paper also offers scope by which to further develop the understanding of what is '*Green*' and '*Sustainable*'.

Keywords:
Sustainable Facilities Management, Green buildings, Sustainable buildings, Sustainability strategy, Green leasing

1   INTRODUCTION

With facilities management (FM) being recognised as an important academic discipline integrating fields of real estate development, building science, and management of property, construction and services, it is nonetheless in its early years as a bona fide discipline in the study of the sustainable development of the built environment and green buildings operation and usability. FM has been discussed as an academic discipline referring to six main criteria, and considering: its particular object of research, the body of accumulated specialist knowledge, theories and concepts, the use of specific terminologies, specific research methods, and institutional manifestation (Junghans & Olsson, 2014, p.70). Nonetheless, FM is in its early years, with some of the earliest research done by Professor Keith Alexander in the early 1990's (Alexander, 1992). A driver of the progression and growth in FM is the implementation of new theories and business concepts, is seen in many respects to be evolving in tandem with that of sustainable development and discussions on the sustainable built environment and green buildings (Elmualim et al., 2010, p.59) . Whilst academic and practice based research and development in FM is reaching maturity, a fully-fledged definition of terms is an ongoing process, much like the change in the role and competencies of Facility Managers (FMs) themselves. The importance of terminological development and language to adjust to research objects and develop knowledge has also been noted (Junghans & Olsson, 2014, p.72).

When considering sustainable facilities management (SFM), green property services, and the need for terminological development, an understanding as to what constitutes the terms '*Green*' and '*Sustainable*' is important for both consistency in understanding, and for providing a further contribution to the body of knowledge in the field of FM. Other fields have already taken steps towards understanding a difference between both terms. From the political sciences, Yanarella et al. (2009) made an investigation looking at the same terms, concluding that '*Green*' was associated with products and processes associated with "*low hanging fruit*", whilst '*Sustainability*', they imply, is more closely tied to whole systems (Yanarella et al., 2009, p.296). Until now however, the authors have not found a similar discussion in the field of FM.

This paper addresses the following research questions:

- How are the terms '*Green*' and '*Sustainable*' understood and utilised in existing FM relevant literature from journals and practice literature?
- To what extent is there a common understanding of the use of "Green" and "Sustainable"?
- How can the findings contribute to a deeper understanding of FM relevant terminology like "green leasing"?
- Does literature from journals and practice lead to a better understanding of where sustainable decisions are being made within an organisation?

These questions will be addressed using FM relevant literature from academic journals along with relevant literature from practice and environmental certifications. A look at each term's

position in FM organisational management will form the analytical approach, and will be used to assess the variation in the application of the terms, as well as similarities between the usages of both. This paper is a study on the contextual focus of the terms with regards to their positioning in organisational management levels. This also affords a 'critical eye' into how the usage of both terms is reflected in the decision making processes found in a formal organisational structure. The results section of this paper will present a terminological investigation addressing the existing usage and understanding of the terms '*Green*' and '*Sustainable*', before finally moving on to the discussion addressing the interchangeability and specificity of each term in the context of the research questions.

A Preliminary Understanding of the terms Sustainable, FM and Green
An initial understanding of what constitutes the terms FM, '*Sustainable*' and some extent '*Green*' is necessary for a contextual understanding of the goal of this paper. FM has been described as "*the integrated management of the workplace to enhance the performance of the organisation*" (Tay and Ooi, 2001 cited in Junghans & Olsson, 2014, p.71). With regards to FM interaction with non-core services or 'open facilities management', it is defined as "*integrated and coordinated design, planning and management of non-core services*" (De Toni and Nonino, 2009 cited in Junghans & Olsson, 2014, p.71). In terms of what differentiates sustainable facilities management (SFM), it could also be considered to "*include consideration not only of core business and support functions, but also relations with the local and global society as well as the climate and the eco system*" (Nielsen & Galamba, 2010, p.3). Sustainable FM can be considered a part of a growing body of research which includes:"*energy management* (Wood, 2006), *waste management and recycling* (Pitt, 2005), *transportation* (Piecyk et al., 2010), *carbon footprint* (Wang et al., 2010), *environmental responsibility and community engagement* (Fraser et al., 2006), *and biodiversity* (Halliday, 2007) *are the key sustainability issues being addressed in organisations*" (Elmualim et al. 2012, p.18). Similar terms occasionally used in literature are '*green property services*' (Määttänen, 2014) '*green property operations*' (Tobias et al., 2012) or '*green property management*.

2   RESEARCH DESIGN

This paper brings together evidence from an extensive literature search from academia, as well as FM practice and environmental certifications. The literature review approach was chosen due to the cross-sectional qualities such an approach can provide, as well as determine the questions that are most pressing in this field overall (Yin, 2014, p.14). Furthermore, a review provides scope to develop the definitions of both terms further in the doctoral research of one of the authors, and illustrate "*challenging questions*" (Yin, 2014, p.39). Attempting to understand the differences between '*Green*' and '*Sustainable*' could be considered one such question due to the importance in research of having a common and more widely accepted definition of terms, concepts and terminology.

Literature and Sources
Literature has been sourced from books, journals and websites from the fields of FM from the early 1990's to the present, along with other relevant fields such as property management, building design, leasing, architecture and engineering. Whilst these other fields are not considered sub-categories for analysis in themselves, they will be considered alongside literature directly from FM due to their relevance. Academic literature was sourced from Google Scholar, and came from journals and renowned conferences. The decision to use

Google Scholar as a source of academic material is due to the availability of material and extensive size of their library as opposed to rival online academic paper sources such as the digital library Jstor. The literature from this search was chosen based on its conjunctive use of the search term within the first ten results pages on Google Scholar. The first ten pages was the scope barrier in order to account for the most popular uses of the terms. For practice literature, a normal Google search was conducted, organised by 'popularity' and using 'incognito' mode on the internet browser 'Google Chrome' to remove a cookie based browser bias. There nonetheless however exists some bias due to geographical location. Although Google may not be considered the most scientific means to accumulate literature, it can be nonetheless considered important due to its presence in the internet search engine industry from the perspective of a web presence of FM providers. The decision to use Google over other search engines such as Yahoo! is also a reflection on the popularity of Google and the related Google Scholar over their competitors. The chosen sites from this search were also based on their conjunctive terminological relevance within the first ten pages of the results.   Both academia and practice searches used the conjunctive keywords searches of: '*facilities management green sustainable*', '*sustainable green property services*', '*green sustainable buildings property management*' and '*facilities management sustainable green development*', with some refinement (e.g. removing 'golf turf management') where necessary.

In order provide a more holistic approach to green and sustainable issues in FM, relevant technical documentation from two of the world's foremost environmental certifications/ assessment methodologies for the built environmental will be investigated, using the same analytical approach as the academic and practice literature. One methodology is the British founded but globally franchised Building Research Establishment Assessment Methodology (BREEAM), which dominates the European certification market. Owing to the location of the authors, the BREEAM standard for Norway (known as BREEAM-NOR) will be the franchised documentation of choice. The National Scheme Operator (NSO) for BREEAM-NOR is the Norwegian Green Building Council (NGBC). The second certification is the United States of America (USA) centric Leadership in Energy and Environmental Design (LEED), operated by the United States Green Building Council (USGBC).

Analytical Approach
This paper will analyse the literature by looking at the extent to which each usage of the terms '*Green*' and '*Sustainable*' are at the organisational management (OM) levels of '*Strategic*', '*Tactical*' and '*Operational*'. This was chosen due to the organisational efficiency implied by the categories in translating sustainable agendas into "*measurable operational targets*" (Elmualim et al., 2010, p.59). This framework is also used in FM practice, and, for example, is at the heart of the EN 15221-1 standard for 'terms and definitions' in FM (BIFM, 2015). Atkin and Brooks (2015) provide a definition of the three management levels in an FM context. According to Atkin and Brooks the **Strategic Level** "*is largely about setting the direction for the organisation and ensuring that the means for achieving its objectives are in place*". The **Tactical Level** is the "*organisations broad intentions to be turned into workable plans, and might call for new processes and procedures as well as changes to those that exist*". Finally, the **Operational Level** aims to "*perform work according to laid-down procedures and not to deviate*" (Atkins and Brooks et al., 2015, pp. 46-47). The management levels will be used as a framework that will assist in a more tangible understanding of the scope of the usage of the terminology, through an approach that can be understood by academia and practice. The literature was then analysed by taking references referring directly to '*Green*' and '*Sustainable*' terminologically, then placing them

at each of the management levels depending on their contextual placing considering the management level descriptions by Atkin and Brooks. It is hoped that this approach will further an understanding as to the organisational relevance of each term in order to better facilitate a more commonly accepted understanding of the '*Green*' and '*Sustainable*' in both academia and practice.

The use of organisational management as a categorising tool was also chosen due its usefulness in the categorising of the decision making processes in organisations. An understanding of the term and terminological placing of '*green*' and '*sustainable*' in an organisational structure can allow for a more clear understanding as where in the '*strategic*', '*tactical*' and '*operational*' levels of an organisation are decisions on a sustainable approach being made. The importance of correct decision making procedures in this context is already recognised in literature, where Epstein and Buhovac (2014) for example state that in order to integrate such an approach into day to day decision making there needs to be the "*combination of a clear and well-articulated and communicated sustainability strategy, senior management commitment to a broader set of objectives than profit alone, and utilising appropriate structures and systems to drive sustainability through the organisation*" (Epstein & Buhovac, 2014, pp.23-24)

The process of 'per text' analysis was also critical in order to understand the usage of both terms. The 25 texts chosen for analysis were read in their entirety, and it was noted how they used '*Green*' and '*Sustainable*' along with the contextual intention of their meaning. They were then categorised as to whether they were 'practice' or 'academic' in nature (often in relation to category of the overall text). Finally, any relevant use of the terminology was placed at one of the OM levels based upon how closely the specific reference to either term fitted the descriptions of each level noted in the previous impact. The authors were also mindful of the more directed FM specific meaning in FM literature, as well as the indirect references and relevance to FM in literature not directly on the topic. This could be in the form of literature on the likes of 'sustainable building management' or 'corporate sustainable decision making'. An approach like this was necessary in order to understand the nuances in context and meaning that could be lost out outside of immediate references to FM, or even '*Green*' and '*Sustainable*'. This analytic approach also guided the direction and process of the literature research before the analysis and discussion were formally conducted.

3   RESULTS

3.1   The usage and definition of 'green'

Academia
At the time of writing in December 2015, a Google Scholar search of '*Green Facilities Management*' will generate 924,000 hits (Google, 2015a). The search does not generate results that use the search term conjunctively. Whilst many of the hits do not directly relate to FM, there are nonetheless numerous relevant documents included. Baharum *et al.* (2009) in their work on 'green FM intellectual capital' associate the term '*Green*' as an active term in their context, associating it repeatedly in their work with the terms "strategic" and "practice" (Baharum et al., 2009, p.268). Hodges (2005) used the term in a similar manner, with the word "practice" being coupled with the term '*Green*' throughout the majority of his paper. Due to their use of 'practice' in the context of energy reduction measures, this can be considered to be at the '*Operational level*'. That being said, he also uses the phrase "*green and sustainable*" together in much of the paper, using it 16 times out of 45 mentions of

'*Green*'. Whilst this could imply that the author feels that both terms are broadly interchangeable, the solo usage of '*Green*' is used when the terms 'practice' and 'building' are mentioned in the text. The word '*sustainable*' is also often used separately in the context of practices on the '*Operational level*', with 2 references of it in the context of 'sustainability strategy'. To this end, it can be considered that Hodges (2005) sees little separation between each term (Hodges, 2005). Dixon *et al.* (2014) in their work on energy management, mention FM in the context of the emerging leasing product 'green leasing' in the sphere of "*the extent to which they allow alterations and data sharing*" (Dixon et al., 2014, p. 428). Whilst the definition of green leasing and their scope is currently not standardised (Collins and Junghans, 2015, p.135), the wording implies a focus that leads towards the '*Tactical level*' in the context of data sharing.

Referring to 'Green FM' and it's services as a conjunctive term in academic literature, Jensen *et al.* (2012) offer one of the few instances of Sustainable FM being referred to as "*Green FM*" in scholarly literature, viewing it in tandem with '*Sustainability*' by offering a definition of 'Green FM' that is similar to the earlier Sustainable FM definition, mainly by associating it with the likes of energy reduction, added value and operational cost savings (Jensen, 2012, p.212), placing it at all three levels of the model. A definition as to what constitutes 'Green Property Services' was offered by Määttänen (2014) who described it as "*services that reduce negative impacts to the environment and human health while fulfilling the needs of the occupants and maintaining the property's conditions and characteristics*" (Määttänen, 2014, p.2). This covers two of the OM levels, particularly the '*Tactical*' and '*Operational*' levels when looking at maintaining the needs of users, owners and the building itself. Another rare mention of Green FM can be found in a paper being titled '*End-user requirements for green facility management*', where the term '*Green*' is mentioned only twice, and not defined or clearly contextualised, with no mentions of the term '*Sustainable*' outside of references (Nousiainen and Junnila, 2008).

Practice
There are numerous examples in FM practice that refer to the term '*Green*'. International law firm DLA Piper in their report entitled '*Green Facilities Management Contracts*' recognise the importance of understanding that 'Sustainable FM' and 'Green FM' are both in need of clarification. They imply early in their document that both terms are used "*synonymously*" and "*environmental friendliness, economic efficiency and social compatibility are to be given equal consideration where possible*" (DLA Piper 2014, p.7) . They effectively reinforce the interchangeability of both later in the report, stating that a "*Green Facility Management Agreement is usually a standard contract which has been extended by individual provisions to achieve sustainability*" (DLA Piper, 2014, p.12). This could imply DLA Piper are associating '*Green*' with '*Tactical level*' considerations on the grounds that it refers to a written agreement that would include requirements, and '*Sustainable*' with more a reference to the '*Operational level*' day to day activities of FM providers due to the 'individual provisions' implications. Regarding the overall report content, much of it is concerned with the contract stage of FM provision, and thus more directly placed at the '*Tactical level*' due to such agreements requiring targets in excess of the strategic approach, yet come before day-to-day operational activities in the OM pyramid. The globally operating FM company ISS has begun to move proactively into Sustainable FM, with its first service marketed as such being that of 'Green Cleaning'. Their promotional material describes the incentive for their clients as "*being green and supporting environmental sustainability may be at the heart of your company brand*" (ISS, 2014, p.2), and their own as "*we are proud to offer you the possibility to take your sustainability ambitions to the next level*" (ISS, 2014, p.5). Their usage of each

term provides some contradiction as to what they mean by usage of '*Green*' and '*Sustainable*'. Whilst the latter quote could imply that both are interchangeable, the first part of the citation considers '*Green*' as being a '*Tactical level*' term, whilst '*Sustainability*' appearing to have a more company policy '*Strategic*' quality to its meaning.

Environmental Certifications
The term '*Green*' has been noted in some of the technical documentation available from the leading environmental certification associated methodologies. In the case of the BREEAM-NOR technical manual, there are 104 references to '*Green*'. Aside from reference to the NGBC, the majority of references refer to 'Green Leasing', as a '*Tactical level*' means by which landlords and tenants can improve the environmental credentials of their buildings (NGBC, 2012). Beyond this, there are several mentions of a green lease alternative, that of the 'Green Building Guide', which is a non-legally binding document that requires tenants to provide fit outs that uphold the BREEAM standards of the building that they occupy (NGBC, 2012, p.21), which can also be considered '*Tactical*' due to be term and target related documentation. Beyond this, the only substantial mentions are of greenhouse gases. BREEAM also offer a certification called 'BREEAM In-Use', which deals with the operational phase of a buildings lifecycle. The international technical manual for this certification notes 33 mentions of '*Green*', but have considerations on several OM levels. Their references to 'sustainable design' and 'sustainable buildings' straddle both the '*Strategic*' and '*Tactical*' level considerations, whilst the more numerous references to 'green procurement' appear to sit more comfortably at the '*Tactical level*' as they describe a policy approach featuring specific targets and requirements (BREEAM, 2015). In the case of the LEED user guide, there are a total of 20 mentions of '*Green*', mostly relating to non-FM relevant issues such as 'Green vehicles'. 'Green Cleaning' is the only other reference to the term that is relevant for this paper, and is used almost exclusively at the '*Operational level*' due to references to cleaning practises on a day to day basis (LEED, 2014). Going more in depth to FM related documentation and looking at their rating documentation on their FM relevant 'Building Operations and Maintenance' program, the only references beyond some patented technologies also refer solely to green cleaning (LEED, 2016).

3.2 The usage and definition of 'sustainable'

Academia
A Google Scholar search of the terms 'Sustainable Facilities Management' in December 2015 generates more than a million hits (Google, 2016b). After some refining of the search terms to remove the likes of 'golf turf management' and other irrelevant terms, it still generates 592,000 hits (Google, 2015c), although not all of them will be relevant to the intentions of the search. For the sake of clarity, the terms '*Sustainable*' and '*Sustainability*' will be used interchangeably as their literal meaning is virtually the same contextually.

As in the case of the term '*Green*', a popular usage of these terms are also proving to be broad and illusive. Also as in the previous term, it is not difficult to narrow down relevant literature for the purposes of this paper. Valen and Olsson (2012) in their work on FM in Norwegian municipalities refer to Sustainable FM at the '*Operational level*' 'value driven maintenance' in the context of the installation of sustainable technology (i.e. waste management, energy efficiency technologies) during the upgrade of existing buildings (Valen and Olsson, 2012, p.290, 299). Elmualim *et al.* (2010) view the metaphorical 'jumping off point' for '*Sustainability*' being in sustainable development and thus, the '*Strategic level*' (Elmualim et al., 2010, p.58)**.** Much of the article follows this theme, with only passing

mentions of deeper activities in FM, that arguably remain in the '*Strategic*' due the repeated references to a "*sustainable perspective*", and in many respects is to be considered a bona fide business strategy (Elmualim et al., 2010, pp.59,60). Some of the references to '*Sustainable*' and '*Sustainability*' however are context based and cannot necessarily be considered concrete in definition by their respective authors. Enoma (2005) for example, exclusively refer to the term in the context of its '*Strategic level*' importance. This however is due to the paper addressing the role of FM's solely at design stage (Enoma, 2005), an aspect of context that the reader should remain aware of in many publications. There are other examples of an exclusively '*Strategic level*' usage of the terms, with Haugen (2008) for example using them in the context of 'development' during building upgrades (Haugen, 2008).

Practice
In practice based literature, the references to 'SFM' and 'Sustainable Facilities Management' are almost non-existent. A more refined search of terms such as '*sustainable facilities solutions*' and '*sustainable building management*' in a Google search in December 2015, however, yields some useful links. American multinational conglomerate 'Honeywell', in the FM and building management part of their company, incorporate '*Sustainability*' in their website advertising literature. Their focus in this regard is mostly on energy management, with some supplementary references to "*green building operations and maintenance*" and behavioural change (Honeywell, 2016). Their references mainly refer to '*Strategic level*' considerations, with arguable considerations also of the '*Tactical level*' due to referrals to the likes of LEED. There is no mention of '*Operational level*' considerations, most likely due to the promotional nature of the website. Examples of Sustainable FM provision can also be found on the European market, like in the case of British FM service providers Almeda. Founded in 1981, they have taken the rare step of using the term of phrase "*sustainable facilities management*" in their promotional materials. Their website not only engages '*Sustainability*' in their companies operating philosophy, but also goes into detail in using terms such as "*soft sustainable facilities management*" and dealing with Energy Performance Certificates (EPC's) (Almeda, 2015). To this end, it could be suggested that Almeda actively refer to all three OM levels. The globally operating construction, building management and FM company VINCI take a more holistic view towards integrating sustainability as a part of their business practises, seemingly covering all of the OM levels in a systematic way. At the '*Strategic level*', they promote their sustainable business model, showing how they integrate their core business philosophies into the triple bottom line of 'economic', 'environmental' and 'societal' sustainability (VINCI, 2015b). At the '*Tactical level*' they have their company sustainability policy that deals with issues such as whole lifecycle sustainability considerations and impact assessments (VINCI, 2015a). Finally at the '*Operational level*' (within the scope of promotional literature) they promote result based key performance indicators (KPI's) showing an 83.7% diversion of waste from landfill, and a 10.1% reduction in CO_2, amongst numerous other environmental results (VINCI, 2014, p.24).

Environmental Certifications
Referring once again to BREEAM-NOR, their technical manual offers 39 mentions of '*Sustainable*' and '*Sustainability*', that are presented in a variety of contexts. Good practise on sustainable design and procurement are of particular note, placing them in the '*Strategic*' and '*Tactical*' levels respectively. Sustainable innovation is also given substantial space, which could be considered '*Strategic*' overall, but leading into '*Tactical*' where context relevant. Sustainable water treatment is also given a chapter in the manual. Other notable mentions refer to the *Operationally* focused 'sustainable performance' and *Strategically*

important 'corporate social responsibility' (CSR) (NGBC, 2012). In the technical documentation for BREEAM IN-USE, there are 53 references to the term. Once again the '*Tactical level*' procurement and supply chain management are key focus, but they also feature equally as '*Tactical*' 'sustainable management practises' and the more '*Operationally*' inclined 'sustainable energy management' (BREEAM, 2015). The demands for the '*Strategic level*' CSR are also important in this documentation, noting that for owners, renters and developers, increasing the sustainability of existing building stock is a stakeholder demand that needs consideration (BREEAM, 2015, p.23). The LEED user manual has 12 mentions of the term, the majority of which refer to procurement and purchasing, with one mention once again of cleaning practises, in the form of securing sustainable cleaning equipment (LEED, 2014), placing all of the references firmly at the '*Tactical level*'. Their Building Operations and Maintenance documentation also features 12 references, all of which refer to less relevant 'sustainable agriculture', however, there is one reference to sustainable procurement (LEED, 2016). As per the section on '*Green*', the environmental certification uses the terms '*Sustainability*' and '*Sustainable*' across all three OM levels.

4   DISCUSSION

In this section of the paper, the extent to which each of the terms '*Green*' and '*Sustainable*' touch on the organisational management levels of '*Strategy*', '*Tactical* and '*Operational*' with regards to the results sections categories of 'academia', 'practice' and 'environmental certifications' will be discussed. The implications of the results on research and practice will also be considered.

Defining and Understanding 'Green' and 'Sustainable'
The discussion of the results is presented in Table 1 which outlines how the literature has been used for both of the terms. Each separate contextual usage of the term has been noted e.g. if a paper uses the term '*green*' at the tactical level consistently throughout a paper it only counts once, however if it is used in two separate levels in the same paper it would count twice. This ensures and makes clear that each separate contextual usage was the focus of the study, and not simply the amount of times either term was mentioned.

Table 1 below outlines the degree to which each of the contextual usages of the terms '*Green (G)*' and '*Sustainable (S)*' are noted across the OM levels and where they feature in '*Academia (A)*', '*Practice (P)*' and '*Certification Methodologies (C)*'.

Table 1: Usages of the terms 'Green (G)' and 'Sustainable (S)'

OM Level	G-A	G-P	G-C	S-A	S-P	S-C	OM Level G Total	OM Level S Total	G + S Total
Strategic	1	1	1	3	2	4	3	09	12
Tactical	2	3	4	0	2	5	9	7	16
Operational	3	1	2	1	2	2	6	5	11

Total Green: 18	**Total Sustainability:** 21

Overall, the literature analysis demonstrates a broad interchangeability between the terms, although some of the weighting of roles differs. In the literature research and document analysis in this paper, '*Green*' has been used the least of the two terms, yet it seems it has been used the most malleably. '*Sustainability*' however has been found more widely in both academic and practice literature, yet has seen a more significant OM weighting closer to the '*Strategic*' and '*Operational*' levels. This implies that there is inconsistency in the way that both terms are being utilised when considering both of terms in isolation.

When it comes to the categories of 'academia', 'practice' and 'environmental certification', utilisation is broadly fragmented. For academia, '*Operational level*' considerations seem to dominate in the case of '*Green*' whilst in case of the '*Sustainable*', this is mostly considered '*Strategic level*' in the eyes of academia. Practice spread their usage of '*Sustainable*' equally over the three OM levels in the literature, and is also the dominant term. In practice, the marginally less used '*Green*' is used considerably more at the '*Tactical level*', with only one usage on each of the other two levels. Environmental certifications mainly use '*Sustainable*', and mostly use it at the '*Tactical level*', although they utilise the other two levels substantially. Although they use '*Green*' less, the weighting mirrors that of '*Sustainable*', with the '*Tactical level*' taking the most attention with scattered utilisation across the other OM levels. With regards to a common understanding of both terms, the interchangeability implied in Table 1 and lack of usage consistency between both terms can risk causing difficulties in both academic research and practice based implementation. When bringing both terms together and combining academic and practice, the results reflect a '*tactical*' focus on shared '*green*' and '*sustainable*' issues within an organisation in the context of FM.

Practical implications and deeper understanding of FM relevant terminology
When discussing sustainable FM it is also important to consider its impact on its sister fields of the 'sustainable built environment', and the study of green buildings. The previously mentioned concept of '*green leasing*' is an example of an FM relevant product that is being hindered by the difficulties in finding more widely accepted definitions of '*Green*' and '*Sustainable*'. Whilst '*green leasing*' is the most commonly used term, a Google search will illuminate that terms such as '*sustainable leasing*' and '*energy aligned leasing*' are also found in literature from research and practice (Google, 2016). This not only causes difficulties when attempting to source information from the perspective of practice, but also results in difficulties in presenting research in way that will be easily accessible by it's intended audience. The interchangeability between usage of terms like '*green property services*' and '*sustainable facilities management*' also risk muddling the decision process for end users, as well ongoing development. Should a potential service user look for '*green*' service provision, this lack of consistency in terminological use may result in the user being unable to find certain service, purely because the more suitable service is instead marketed as '*sustainable*'.

From the perspective of academia more directly, '*SFM*' or '*sustainable facilities management*' dominate as terminologies in research into FM and sustainable development. As noted earlier, Google Scholar does not generate hits for '*green facilities management*' as a conjunctive term, implying that this terminology enjoys a more consistent usage in academia than in practice. That being said, this consistency does not follow through when looking at both '*Green*' and '*Sustainable*' as terms in isolation. This latter inconsistency illuminates an existing research and arguably innovation need in the field of FM and its associated disciplines.

Whilst the authors acknowledge the difficulties in definitively resolving this conundrum in a paper of this size, the different levels of OM and their uses in the covered literature could be a starting point for a more in depth debate on this topic. This approach could also be employed outside of FM. A deeper look at definition conundrum could be useful in the fields of the social sciences, engineering and in architecture, all of whom are grappling with their own debates on the '*Green*' and '*Sustainable*'. There is also scope that further research could help with a more definitive terms standardisation that could be of use in the further development of Sustainable FM from both the perspectives of academia and practice.

Sustainable Decision Making in Organisations
When considering the weighting of both terms from the perspective purely of organisation management, the results illustrate some fragmentation but also a degree of focus with a small margin. In the case of '*green*', the weighing of usage focuses more towards a '*tactical*' application overall, whilst '*sustainable*' is a term that is sees an overall '*strategic*' level focus. When looking at both terms in conjunction, a '*green*' and '*sustainable*' approach is more focused at the '*tactical*' level. Whilst the literature reflects both terms individually at different levels of organisation management, a broader focus on the issues that both terms may share, decision making marginally closer to a '*tactical*' level consideration within an organisation. This can have a direct impact for organisation management. When considering the example of a green lease, the tactical level of organisation management is where the environmental targets, benchmarks and requirements are set within leasing clauses, associated documentation and even negotiations, all of which impact the FM approach and requirements to that tenancy. In a more practical context, this provides cause to reflect on whether it would be more efficient to move a '*green*' and '*sustainable*' decision and policy based focus further up the organisational management pyramid to the '*strategic*' at a higher level, or whether the '*tactical*' level is already the optimal stage to consider this type of decision making. It is also important to state however that the results did not indicate that both terms had an ownership of the '*tactical level*', but rather saw a larger contextual weighting.

5   CONCLUDING REMARKS

In concluding this paper, the results and subsequent discussion show a diverse range of usage of the terms '*Green*' and '*Sustainable*' that offer little in the way of overall consistency. Whilst academia is somewhat more consistent in some of its terminological usage (such as in the case of acronyms like 'SFM'), there is a usage chasm in terms of a pan discipline or pan industrial usage of the terms overall.

This paper concludes that despite more than 25 years of FM research, there is still further work that needs to be done by academics and industry leaders to standardise of both terms. Existing standardisation deficits risk slowing or muddling the development of environmental efforts within FM and other industries; however, a consistent discussion could go some way towards progress. There is even room to consider that even many of us working actively in this field are not being consistent or noting a difference between the terms '*Green*' and '*Sustainable*' ourselves, and should consider further research provide better clarity and consistency in their usage. For research, practice and organisational decision making, there is a notable research need to better understand how to use these terms. Furthermore, we are reminded that we are still early in the story of sustainable FM, with plenty of work still to do.

We should also remain mindful of one more thing, that '*Green*' and '*Sustainable*' development is not an event, but a process that moves incrementally towards its wider intended goals.

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6.2 FLEXIBILITY AS ENABLER OF SUSTAINABILITY

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ABSTRACT

Purpose: There are changing expectations for sustainability coupled with demands for efficiency in planning, constructing and maintaining the built environment. We study modularization as a potential response to these changes.

Background: Adoption of sustainability principles is shaping construction, project and facility management. Balancing the social, economic and ecological dimension and handling the long versus short term perspectives is at the core of sustainability.

Approach: A literature review in the disciplines of project management, facility management and construction management provide an analysis of flexibility as enabler of sustainability. The building concept of "Super Cubes" is presented as an illustration of how modularization can provide flexibility and be an enabler of sustainability.

Results: Long-term thinking does not translate into "planning for everything", but rather into realizing the need for incorporating flexibility in buildings. Initial experiences with the Super Cube for school buildings are mixed. Only a few Super Cubes are constructed. Benefits of modularization have only partially been realized. Its use has been limited, as construction costs and energy use have been higher than expected. Parents have strongly opposed its use, claiming that the cube is not a "proper" building.

Practical implications: Construction costs of the modules have been high, partly due to the demands for flexibility. Economies of scale are not achieved. The problems with parents strongly opposing its use illustrates increased need for early involvement of stakeholders.

Keywords:
Flexibility, Sustainability, Modularization, Off-site construction

1   INTRODUCTION

Balancing factors within the social, economic and ecological dimensions and properly handling trade-offs in time (the long and short term) and space (local, regional and global effects) is at the core of sustainability thinking. Buildings are constructed with expected lifespan of forty years or more. Their physical life spans can be almost indefinite when carefully designed, constructed and maintained (Ashworth 1997). This makes it likely that they will be used in ways other than what was foreseen during construction. Long-term thinking hence does not translate into "planning for everything", but rather into the need for incorporating flexibility in buildings. The need for flexibility revolves around at least three types of current and future stakeholders in the building: the users of the building, the owners

and society. Users typically focus on how the building supports their activities in the building. Owners focus on return on investment and life cycle cost of the building, and how the building support strategic objectives. The larger society has interest in how a building supports a sustainable and attractive environment and how the building interacts with other parts of the built environment.

Different disciplines have developed their distinct approaches to sustainability. We have reviewed literature from the disciplines of project-, facilities- and construction management to identify cross-cutting themes in the scientific literature related to sustainability. The interest for different aspects of flexibility as an enabler for sustainability is one such theme. Several authors have illustrated the connection between sustainability and adaptable buildings (e.g. Arge (2005); Bullen (2007); Kincaid (2000); Wilkinson, James et al. (2009)). Adaptability is a key design criterion applied on buildings were there is expected to be changing needs (Hansen and Olsson, 2011). Adaptability of buildings can be achieved through three approaches according to Bjørberg, Verweij et al. (2009); elasticity, generality and flexibility. In this terminology, flexibility is a sub-issue of adaptability, focusing on how easy it is to change the building by rebuilding it.

We present Oslo's "Super Cube", a modular building concept specially developed for the Norwegian capital's schools, as an example of buildings were movability has been introduced at the potential cost of "ordinary" adaptability. The modules are factory made and can significantly reduce construction time as groundwork and module construction can be carried out in parallel. The cubes are flexible with regards to the initial configuration of modules and they can be demounted and moved if needed. The modules thereby provide a dimension of flexibility to their owner's portfolio of buildings, but leave little room for changing user needs.

2   STATE OF THE ART

The following section is based on a literature review of the approach to sustainability in the three disciplines of project management, facility management and construction management. It will provide the foundation for an analysis of flexibility (and in particular, modularization) as enabler of sustainability. The following journals were subject to the literature study: *Facilities, International Journal of Project Management (IJPM)* and *Construction Management & Economics (CME)*. The searches were conducted using the terms "sustainable" and "sustainability" in article titles, keywords and abstracts. Articles that used the words sustainable or sustainability in other context than that of "*sustainable development*" were removed from the sample. An overview of the sample is shown in Table 1.

The adoption of sustainability-principles from sustainable development is shaping the development and innovation in construction, project and facility management. The most quoted definition of sustainable development is "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" as presented by the UN commission on Environment and Development (1987). Their report was pivotal in introducing the multi-dimensional approach to development; only when factors and effects within the environmental, economic and social dimension were accounted for would development turn "sustainable" in the long term.

Table 2: Overview of journals for the literature review

Journal	Keyword hits in search	Articles removed based on abstracts	Final sample of articles
Facilities	12	2	10
International Journal of Project Management (IJPM)	23	8	15
Construction Management & Economics (CME)	20	4	16
Total	**55**	**12**	**43**

The short form *"sustainability"* is used to describe the endurance of systems and processes. The term may be used with a set of criteria to describe the result of a short-term decision (providing *a sustainable outcome as the solution to a limited problem*) or as the result of a long-term development (*providing sustainable solutions to a wide set of issues*). It might also be used as a *characteristic* of a development and a *quality* of a process. "Sustainable development" and "sustainability" are vague terms by intention; their position at the top of the global agenda requires them to be. The UN's work on developing "Sustainable Development Goals" incorporate 17 goals and 169 related targets (UN 2016). The ambiguity has a price in the form of confused stakeholders, effectively diluting actions taken to incorporate sustainability principles in practice. Different disciplines' interpretations of "sustainability" vary with traditions and with regards to *what* it is that is to be sustained. Kidd (1992) presented six traditions or roots from witch the interpretations of sustainability trace their origin; *ecological carrying capacity, resource depletion, biosphere, critique of technology, slow/no-growth and eco-development.*

2.1   Sustainability in construction

The construction sector has long been identified as a culprit with regards to sustainability, and especially environmental impacts. It uses three million tons of raw material and generate 20% of the solid waste stream (Graham 2000). The construction industry is an important sector with regards to the economic and social dimension, contributing 10% of EU GDP along with 20 million direct jobs (EU 2015). In response to increased attention and changing expectations from customers and mounting pressure from regulators, "sustainable construction" evolved. 11 out of the 16 CME-articles in the sample represent or refer to "sustainable construction" (Hill and Bowen 1997, Bossink 2012, Mokhlesian and Holmén 2012). "Sustainable construction" encompasses design and planning phases of projects, as well as the phases following the construction (Hill & Bowen, 1996). The majority of the articles in the sample that deals with the subject, adapt a primary focus on resource use and emissions during the construction phase. In the long term, environmental impacts in the form of emissions during construction, creation of materials and demolition are small compared to energy consumption in buildings operational phases. Buildings are responsible for 30% of climate gas emission and 40% of energy consumption (UNEP 2009). However, operating energy represents by far the largest part of energy demand in a building during its life cycle (Sartori and Hestnes 2007). Ross, Bowen et al. (2010), Shi, Zuo et al. (2012) and Chen and Chambers (1999) show how certain aspects of sustainability (such as water usage) can be of special importance due to the projects locations. Industrialized construction (Eriksson, Olander et al. 2014) and the use of prefabrication and modularization (Jaillon and Poon 2008, Jaillon and Chi-Sun 2010) are proposed as approaches to sustainable construction.

2.2   Sustainability in project and facilities management

Sustainability is a fairly new topic in project management literature, with the majority of publications dating from the last ten years (Silvius and Schipper 2014). There is ongoing debate about the extent of which "traditional" project management tools and methods are sufficient to incorporate sustainable principles, or if a new paradigm must be established within the field (Schipper, Rorije et al. 2010, Eskerod and Huemann 2013). The sample articles from the project management journals cover several types of projects including construction of buildings (Herazo, Lizarralde et al. 2012) and infrastructure (Lenferink, Tillema et al. 2013, Zeng, Ma et al. 2015, Zhang, Gao et al. 2015). There is a special emphasis on sustainability in project appraisal (Abidin and Pasquire 2007, Al Saleh and Taleb 2010) and on sustainability competence (Beauséjour 2009, Hwang and Ng 2013).

Facilities management (FM) is an interdisciplinary approach integrating principles of business administration, architecture and the behavioral and engineering sciences (Cotts et al. 1992, Cotts 1999, IFMA 1998). Alexander (1992) created an early structure for the FM work field. He identified processes, services, facilities and objectives as important categories with regard to the organizations' primary activities and encircled FM from other disciplines. Jensen, Voordt et al. (2014) and Jensen, Andersen et al. (2014) identify sustainability as important elements in future development and research within FM. Several authors state that FM is a discipline in transition and that FM departments and personnel are well-suited to promote sustainability initiatives (Price, Pitt et al. 2011, Sarpin, Yang et al. 2016). Development towards "Sustainable FM" is driven by enterprises adapting strategies for sustainability in their mission statements as well as new legislation (Elmualim, Shockley et al. 2010). Price, Pitt et al. (2011) found that medium and large enterprises were more likely to have adopted sustainability policies. Their study also identified that having a sustainability policy in place increased the likelihood of sustainability initiatives being embedded in the company. Although the social dimension of sustainability is at the core of FM, environmental sustainability receives special attention in the sample articles. Energy efficiency is identified as a key component in contributing to environmental sustainability in Adewunmi, Omirin et al. (2012), Aaltonen, Määttänen et al. (2013), Junghans (2013). Langston (2012) approaches sustainability through the adaptive reuse of buildings.

2.3   Sustainability and uncertainty

Uncertainty limits the ability of the organization to preplan or make decisions about activities in advance of their execution (Galbraith 1977). Uncertainty is a key driver for project *flexibility* (Olsson 2006). Pinder, Austin et al. (2011) in Finch (2011) state that rising expectations can serve to reduce a buildings service life even though the building remains in good condition. A building's *service life* extends as long as it functions above a minimum acceptable level of performance (Iselin and Lemer 1993). Pinder, Austin et al. (2011) point to three interrelated factors that explain why buildings can be subject to obsolescence; buildings tend to be fixed, designed to be durable and with a particular use in mind.

2.4   Modularity

Modularity is a concept within both construction and project management, as an enabler of flexibility. By applying modularization, a project can be split in several sub-projects with the freedom to explore and apply particular solution suited their needs. In construction, modularity is an approach where components of the building are preassembled in modules at a factory before being transported to the construction site for installation. It is often associated with concepts such as prefabrication, pre-assembly and off-site fabrication. Modularization allows for parallelization of tasks in construction projects, as groundwork and

module construction can be executed at the same time. Modularization also provides for potential cost savings due to specialization in tasks, application of manufacturing approaches in production and increased ability for learning. Blismas, Pasquire et al. (2006) point out that evaluations of off-site construction versus on-site tend to have a narrow focus on cost, ignoring both "hidden costs" and benefits. Modularization provides potential for reducing common sources of construction waste. Faniran and Caban (1998) point to reductions in waste due to design changes, leftover material scraps, wastes from packaging and non-reclaimable consumables, design/detailing errors, and waste due to poor weather. Modularization can also facilitate planning and design, saving both time and resources. Modularization generally provides reduced internal uncertainty. Modularization can also reduce external uncertainty as shortened lead times means decisions in planning and design can be made closer to the point in time when the building will be in use. The effects of using modular construction are summarized in Table 2.

Table 3: Effects over the project life-cycle of module-based construction

	Front-end	**Planning**	**Execution**	**Operations**	**End-of-life**
Project management	Reliability in estimates (cost & time)	Reductions in planning time	Reductions in construction time, reliability, less re-work	Fewer "start up" issues, known maintenance/operations needs and costs	Reliability; modules are well-known
Sustainability	Known resource use		Predictability, shortened construction time	Opportunity for modules to be "optimized" for their operative phase	Facilitates design for end-of-life/cradle to cradle
Uncertainty	Reduced uncertainty due to reduced lead-time	Reduced internal uncertainty	Experience in constructing and operating modules lead to predictability	Reduced uncertainty due to experience from use of modules in similar settings	Reduced uncertainty due to reduced "uniqueness" in product
Facilities management	Client, owner and user needs	Efficient implementation of needs in the design	Ensuring that design intentions are fulfilled	Efficient management of the building, user satisfaction, return of investment for owner	Experience feed-back to future projects

3   ILLUSTRATIVE CASE: OSLO'S SUPER CUBES

The Super Cube was conceived by Oslo Municipality in 2010-2011. It would serve as an alternative to traditional custom-built school buildings. The City Council had signaled that *cost efficiency* on the municipal level were to be the decisive factor in constructing the school portfolio. Standardization was to be key in the construction and rehabilitation of schools. Guidelines were developed for all types of buildings in the municipality's portfolio from kindergartens to retirement homes. The rationale behind the drive for standardization was potential cost-savings (due to economies of scale) and predictability in operations and maintenance, uniform and plain demands to suppliers and contractors, increased ability to transfer experiences and a drive for sustainable, environmentally friendly buildings.

Illustration 1: Interior and exterior of Super Cube at Skøyen (photo: Undervisningsbygg)

The drive for standardization has so far not resulted in two identical schools ever being constructed. The Super Cube was supposed to be both cost-effective and efficient in planning and construction. The concept consists of factory-built units of 3x3m, 3x6m or 3x9m. The Super Cube fulfils the demands for permanent school buildings, even though it is developed to provide temporary capacity when needed. The units are between 85% and 90% finished when leaving the factory, yet leave sufficient room for both external and internal customization to not render a "temporary" feel. Each unit consists of a steel frame, enabling stacking height of 4 units. Technical installations are put above the ceiling, providing simple access. Factory building would ensure predictability (no moisture in the construction), economies of scale and learning effects would provide the grounds for additional reductions in cost and failures/mistakes. The units can be produced in the factory simultaneously as the groundwork was executed on site. Each Super Cube project incorporates a contractor for the groundwork (preparing play areas and landscaping), adding some complexity to each project. However, compared to custom building, each Super Cube project is less complex. Using the Super Cube has reduced the time spent in the planning process. Super Cubes are regarded as "pre-approved" as long as the project is included in the "school capacity evaluation", a 10-year plan for development of school capacity revolving on a 5-year basis.

3.1   Flexibility aspects of Super Cube compared to traditional school buildings

The time savings in using the Super Cube are mainly due to parallelization of groundwork and module-production. The Super Cube has thus made the agency more responsive to events and reduced the uncertainty related to certain decisions. The introduction of the Super Cube has also reduced lead times for adding capacity to existing schools due to "fast tracking" in the Municipality's project quality assurance scheme. Time-savings made possible by these two traits of the Super Cube (parallelization and fast-tracking through planning and approval) have had an unforeseen effect in the form of unhappy neighbours and school-parents. Both school-parents and neighbours are key stakeholders in school construction or extension projects. The reductions in lead-time create a sense of urgency and a risk of stakeholders feeling "not heard or listened to". In custom-built school-projects, there might be sufficient room to adapt plans and designs to stakeholders' input even after the early phases of groundwork and construction has started (even though this is rarely ideal for progress). Stakeholders' concerns resulted in delays in the construction of the two first Super Cubes, and stakeholders making sure they were heard through the media. Although the Super Cube reduces the lead-time for project delivery, there is still significant rigidity in the decision process leading up to the decision, and external factors that influence the lead-time after the decision point (such as the module-supplier's production capacity).

The flexibility in the Super Cubes has not been fully exploited at the current point in time, as there has not been need for adding (or removing) additional capacity at the schools equipped with Super Cubes. It is not expected, however, that capacity needs change so quickly. The movability of the modules are incorporated as a response to uncertainty in demand for capacity for the medium-long term and not the short-term fluctuations. The "fluency" of the Super Cubes can be expected to increase over time however, as more schools are equipped with Super Cubes. The flexibility in the Super Cube is primarily in the form of capacity. Once the modules have been installed, there is little (or no) flexibility with regards to adaptability to changing user requirements. The modules are designed to accommodate changes and upgrades to surface materials (due to wear and tear). Functional changes will imply "customization" of the Super Cubes, taking them one step closer to "traditional" custom-built schools.

The development of the Super Cube is still an ongoing process. Many of the benefits of modular construction can only materialize once there has been produced a significant number of modules. Learning effects have been observed in both the fabrication of modules, as well as in installing them. Earning effects are key to limiting re-work and on-site adaptations. Future modules will also benefit from feedback on how the current modules work in practice.

The investment cost (per square meter) for the constructed Super Cubes have been higher than the average investment cost for custom-built schools in Oslo. Two factors driving the cost associated with each module are the movability (for reuse) and ability to stack modules. These properties are essential for the flexibility aspects of the Super Cube, but come at the price of high demands for structural integrity of each module. The operational costs of the Super Cubes have also been higher than expected, and they have been plagued by "start-up"-issues with ventilation and heating systems. The Super Cube concept will be developed and pursued further in the coming years. Several options are being investigated in order to reduce the costs associated with each module. One such option is in reducing the movability and ability to stack modules. These modules will have lesser demands for structural integrity, at the expense of flexibility. Introducing these alternative modules will also potentially reduce some of the economies of scale in producing and handling (or organizing) the modules. Another option currently being investigated is extending the Super Cubes to kindergarten and nursing homes. Adding production volume will make it more attractive for potential suppliers of the modules, along with the potential for further cost-savings due to economies of scale. The modules must most probably be thoroughly re-designed in order to accommodate the requirements for alternative use.

5   PRACTICAL IMPLICATIONS

We have studied how flexibility and module-based construction are a shared approach to sustainability in the disciplines of project, facilities and construction management. Although the rationale for modularization and flexibility is interesting, there exists a trade-of in flexibility as expressed by potential adaptation of the building for other uses vis-à-vis movable buildings with "fixed" use. This paper has presented some of the experiences from Oslo's "Super Cube", a modular building concept specially developed for the Norwegian capital's schools. The modules are factory made and can significantly reduce construction time as groundwork and module construction can be carried out in parallel. The cubes are flexible in the sense that modules can be added or demounted and moved if needs change. However, high construction costs have limited the use of the cube, making economies of

scale hard to achieve. Alternative means for reducing costs of the modules have therefore been explored. The cube has also run into problems with parents strongly opposing its use under the pretext that the cubes are not "proper" buildings illustrating increased need for early involvement of stakeholder when the lead-times are reduced.

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6.3 FM'S ROLE TOWARDS ENERGY MANAGEMENT IN AUTOMATED BUILDINGS: A COMPARATIVE ANALYSIS BETWEEN PASSIVE-HOUSE SCHOOL AND OFFICE BUILDINGS IN NORWAY

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ABSTRACT

Purpose: This study explores the relation between the automated features in low-energy facilities and the extent to which building occupants are perceived to have an impact on energy consumption.

Background: IT developments have enabled the delivery of automated energy efficient facilities able to provide fast response to changing user needs. As buildings become more automated, building occupants face increasing restrictions regarding the manipulation of building systems.

Approach: This paper presents the findings from two "Passive House" certified buildings in Norway. The methodology includes individual semi-structured interviews with at least one representative from the following user groups: building occupants, facility managers and building owners.

Results: Building operators perceive that the actions of building occupants have little or no impact on the use of energy within the facilities they occupy. The restrictions posed by the automated features in the building are often cited as the main reason giving way to this perception. Findings suggest that efforts to integrate building occupants in the practice of energy management may be hindered by these perceptions.

Practical implications: This study suggests that building operators of automated buildings are likely to neglect the impact of building occupant behavior on energy consumption. Hence, operators are likely to disregard their responsibility to influence organizational change towards sustainable behavior. These perceptions may affect opportunities for energy reduction, data gathering, and ultimately the opportunity for the facilities management industry to add greater value to the design phase of buildings.

Keywords:
Automation, Facilities Management, Building occupants, Energy efficiency, Social practice

1   BACKGROUND

The need for highly energy efficient buildings is well established. The construction of *Green buildings* does not equal energy efficient buildings (Mokhtar, 2014). Buildings do not always perform according to design intentions. This issue is widely studied under the term "energy performance gap" (EPG) (Bordass et al., 2004; Turner & Frankel, 2008; Menezes et al., 2011). Evidence of the EPG is copious (Carbon Trust, 2011). Many studies agree that lack of understanding at the design phase regarding how buildings are (to be) used and operated is one of the most important factors influencing the gap. Technically, this lack of information

can mean that building designers do not always possess the data necessary to produce accurate predictions on energy consumption. Instead, calculations are often based on benchmarks which fail to account for the heterogeneity of and variability within different building types (Demanuele et al., 2010; Menezes et al. 2014).

In turn, this may lead to poor specification of the technical systems in the building, resulting in increased capital spending and running costs for the facility. The vast majority of efforts aimed at improving the energy performance of buildings are founded on the optimization of its technical systems (Valle & Junghans, 2014). Approaches include but are not limited to: improved decision support systems (e.g. FMM), continuous system fine-tuning (e.g. CCx), and IT tools that support the modelling (e.g. BIM), integration (e.g. BMS), monitoring, automation and control of building systems (BACS) (Lawrence et al. 2012). Nevertheless, insights from the social studies of technology (STS) indicate there is a mismatch between the logics of design and actual use of "smart" systems (Aune & Bye, 2005). As indicated by Walker et al. (2015): *"actually realized carbon performance is evidently a function of both how a building is designed and formed (its fabric, technologies, layout and so on) and how it is lived in, the practices that are performed on an ongoing basis."* Consequently, "smart" technologies may fail to achieve their full technical potential (Shove, 1998; Aune & Bye, 2005). There are many other factors influencing the energy performance gap (Bordass et al., 2004; Morant, 2012; De Wilde, 2014); yet, the examples above suggest that the study of energy management as a practice requires a systemic view that accounts for the mutual relations between the building and its users. In turn, efforts to bridge the performance gap should support the planning and implementation of energy management as a sociotechnical practice. This can be achieved through energy management frameworks that aim to optimize the technical systems in buildings and influence behavioral change towards an energy conscious workforce. However, as facilities become more automated, building occupants experience less freedom to manipulate the systems that affect their comfort. Consequently, perceptions from both facilities managers and building occupants with regards to their expected level of participation and collaboration in the practice of energy management may be affected.

This study argues that facilities managers who operate highly automated buildings are likely to neglect the impact of building occupant behavior on energy consumption. In turn, they are prompt to neglect their responsibility in influencing organizational change towards sustainable behavior. As a result, these perceptions may hinder opportunities for energy reduction, data gathering on how buildings are used, managed and operated, ultimately affecting the extent to which the facilities management industry can add value to the design phase of buildings. Furthermore, the chance to create a knowledge-base that is unique to the FM service industry will be missed. This paper develops in the context of an interdisciplinary research project (MINDER[1]) that seeks to describe energy management practice in non-residential (NR) buildings in Norway. MINDER brings together the knowledge and expertise of social science, design and facilities management, to provide a systemic view of how the practice of energy management takes place in NR buildings (Berker et al., 2014; Valle & Junghans, 2015). This study assesses the role of facilities managers (as represented by building operators at the operational and strategic level) on the extent to which they are willing to engage with building occupants in the practice of energy management.

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[1] MINDER – Methodologies for Improvement of Non-residential buildings Day-to-day Energy efficiency Reliability.

1.1   The role of FMs in the management of energy in automated facilities

Traditionally, the FM service industry had been associated with the delivery of routine building maintenance tasks, sitting at the reactive end of its professional spectrum. Today, the industry is viewed as a multidisciplinary profession that supports the optimal functionality of buildings through the strategic integration of the people, processes, space and technology (International Facilities Management Association). Atkin & Brooks (2013) argue that evolution of the industry is in par with business´s need for increased effectiveness of the workforce and technologies for information and communication (ICT). Energy Management is one of the services that can be provided by facilities managers (hereon FMs), and is usually driven by legislation on health, safety and environmental issues (Atkin & Brooks 2013). The FM service industry has been recognized to play a key role in the planning and operation of energy efficient buildings (EN 15221-1, 2006).The strategic, tactical and operative levels at which FMs interact with the organization has been theorized (Haugen, 2003; Novakovic et al., 2012; Atkin & Brooks, 2009; Junghans, 2015). FMs contribution to the planning stage is grounded on the industry´s accumulation of experience-based knowledge regarding the operation of buildings (Leaman et al., 2010; Boyd, 2013). Collaboration between building designers and facilities managers can influence the costs of securing the optimal operability of energy efficient buildings (Novakovic et al., 2012).

However, stakeholder integration need first overcome significant socioeconomic hurdles, such as: 1) FMs lacking the necessary knowledge to engage effectively with contractors at the design table (Preiser & Vischer, 2005; Bordass & Leaman, 2013); 2) fragmentation of the construction industry (Fulford & Standing, 2014), and; 3) stakeholder integration remaining a service that must be requested and paid by building owners who do not always understand the value of such investment (Way, 2005; Way & Bordass, 2005). At the operational phase, FMs´ contribution can be appraised from two perspectives: Firstly, the FM service industry is at the forefront of delivering all services aimed at ensuring that buildings are maintained and operate to their optimal capacity. This includes lighting, heating, cooling, ventilation, hot water and small loads and appliances (IEA, 2013; Hong & Lin, 2013). In the context of energy efficient buildings, small power equipment represents a significant component of energy consumption (Menezes et al., 2014). In Norway, nearly 80% of the energy consumed in non-residential buildings is in the form of electricity (ENOVA). In this sense, FMs have the opportunity to deliver building management services in a way that supports the efficient use of operational energy. Secondly, FMs are perceived to be strategically positioned to lead organizational change towards sustainable behavior (Elmualim et al., 2012).

An increasing number of studies support the value of educating building occupants on aspects relevant to the building's energy features and overall performance (Janda, 2011). Evidence suggests that building occupants who are more aware of the energy features in their buildings are more likely to accept disturbances regarding indoor comfort. Additionally, they are more willing to collaborate in organizational efforts towards achievement of institutional energy efficiency goals (Bordass et al., 2004; Janda, 2011, Mokhtar, 2014). As legislation tightens and technology matures, the construction industry is able to develop increasingly efficient, yet significantly complex building structures, envelopes and systems. ICT have enabled a faster and more comprehensive response to changing occupant needs. Also they provide outstanding support for data collection, and the monitoring, control, integration and automatization of buildings´ technical systems. Building Information Modelling (BIM) has gained increased attention in its affordance to facilitate the modelling of building structures, technical systems and associated electrical feeding grids (Lawrence et al., 2012). In turn, BIM can support the reduction of energy use as well as improve the efficiency of fault

detection and diagnosis (FDD) processes. Lawrence et al. (2012) make the case for energy informatics paving the way for the balance between energy efficiency needs and building occupant comfort. In light of current trends and evolution of ICT, it is only expected that FMs become lead users in the application of these technologies. However, such adaptation is sure to demand further expansion of the knowledge and skills necessary to implement them, as well as better understanding of the sociotechnical implications resulting from appropriation of these technologies.

2   APPROACH

A qualitative exploratory approach was used to develop of a systemic view of energy management practice. The method is founded on theory from STS and entails the fragmentation of energy management practice into four key building blocks, namely: 1) actors; 2) processes and tools; 3) knowledge and skills, and; 4) desired outcomes. The interconnection between people (actors) and technology (processes and tools) was introduced in the previous sections. The block "processes and tools" account for both hard (technologies) and soft (non-technological) measures considered in energy management practice. Similarly, knowledge and skills account for both experience-based knowledge as defined by social learning (Sørensen, 1996) and the competences necessary for the effective use of a particular process or tool. From this, a semi-structured questionnaire was developed.

Building occupants, operators and owners were interviewed. Interviewees were asked to provide information about energy management and consumption in the context of their day-to-day work practice. Relevant issues discussed with interviewees include but are not limited to: 1) people and activities that have or have had an impact with regards to how energy is used and managed in the building, and; 2) value of end-user participation in the process of energy management.

A total of 8 case studies (4 office and 4 school buildings) were collected. Case study selection is based on three criteria: 1) the buildings must have significant potential for total energy savings in Norway; 2) the sample must include both public and private entities; 3) the buildings must be certified low-energy buildings. For this study, two "passive-house" certified buildings were selected, belonging to school and office building types. This selection maximizes the opportunity to learn from different work environments (school versus office) as well as energy management approaches (outsourced versus in-house). Valle et al. (2016) provide a more in-depth description of the approach for case study selection and analysis.

2.1   The case studies

Building "S" was constructed as an annex to an existing building in the period 2008-2010. It is constructed alongside a primary school and a community sports center. The school is located in Norway. Average temperature is registered between 5-6 degrees Celsius. The school has 6,452m^2 of heated area. Originally planned as a low-energy building, the "boxed-shape" design provided an opportunity to secure government funding and reach for "passive-house" standard certification under Norwegian standards (NS3700/3701). Predicted net energy use was calculated at 70 kWh/m^2 year. In the classrooms, energy efficiency features include automatic blinds as well as sensors for the regulation of temperature, ventilation and motion activated lighting. Energy is managed remotely by the municipality with periodic visits to the building for maintenance and repairs. The energy bills are paid by the school.

Building "O" was constructed as an annex in the period 2011-2013. This research facility encompasses office rooms, laboratories, auditoriums and meeting centres. The building is located in Norway. Average temperature is also registered between 5-6 degrees Celsius. Net energy use was estimated at 71 kWh/m². Small windows placed high up in the ceiling open up automatically allowing for cross-ventilation, but can also be opened manually. Most windows at reach level can be opened for natural ventilation. A combination of fixed and automatic shading aims to provide balance between heat gains natural lighting. The building is fitted with demand ventilation and energy a motion sensor lighting system. Energy is managed by an in-house team of 2 building operators.

3   RESULTS

3.1   Building "S": Energy management practice in a school environment

The School Teacher (ST) | representing the building occupant: In addition to being a teacher, the ST is partly responsible for overseeing that organizational procedures comply with health and safety regulations. The ST argues that school staff can influence the building´s energy use through actions such as the opening of windows. Regardless of the automation features in the building, he recognizes opportunities for further energy savings: *"if we remember to turn it off (referring to light switch) then you save ten or twenty minutes (of) light, and if you do that every day."* The ST indicates that increased knowledge on the building´s function would generate a positive impact on the pupil´s acceptance of the building´s temperature. As a learning ground, further benefits are perceived through embedding knowledge about the building´s energy features with day-to-day learning activities. The ST indicates that FMs have the responsibility of managing energy for the organization, as well as that of guiding occupants in making better use of the building: *"[they] should tell us if they know things to improve ourselves and we should get… the teachers to do the right things."* The ST describes contributions from building operators in the context of energy monitoring and providing maintenance for the technical equipment.

The School Owner (SBO) | representing the building owner and strategic facilities manager: The SBO represents both the building owner and energy management team. The SBO recognizes that building occupants have an impact on energy use through the amount of days that the building is used. He indicates that it does not matter who uses the building. The SBO specifies that his team does not get involved in the process of how the building is used or rented out by the occupants. He explains that complains from users can be perceived as feedback, and are the only meaningful form of exchange between the energy management team and building occupants. In this context, he indicates that although feedback from building occupants can be useful in highlighting opportunities for improvement, ultimately he supports a complete disconnection between the two roles (i.e. building occupants and facilities managers): *"[What] makes it most easy is that they (referring to building occupants) do what they are paid for doing, education, taking care of pupils… For me it´s ´keep away, keep away, keep away´"*

The Energy Manager (EM) | representing the operational facilities manager: The EM indicates that the key objective at the phase of design was to develop a facility that was able to regulate itself and could be controlled from a remote center. The EM indicates that building occupancy has the largest impact on energy consumption in the building, and clarifies that from a behavioral perspective, building occupants have little or no impact on energy consumption. With regards to opportunities for sharing knowledge with building

occupants, the EM indicates that teachers should do teaching, and suggests nothing is to be gained from increasing their awareness on energy relevant aspects. He indicates that building occupants are clients, and as such, have no part in the process of managing energy: *"It is not our customers who are taking [care of] energy; it is only us."* The EM indicates that the most important aspects for effective energy management are developing knowledge about building automation and keeping the customer satisfied.

3.2   Building "O": Energy management practice in an office environment

The Office Researcher (OR) | representing the building occupant: The OR works as a full-time employee within the research organization. The OR indicates that building occupants can influence the use of energy in the building, as well as the work dynamics of the facilities manager: *"...if people start opening windows and doors and stuff...they can influence a lot. And also I guess they can influence through making the building operator do his stuff differently, if the workers want to."* Communication between the building operators and occupants is framed around issues of maintenance. The OR does not recall having been informed about proper use of the building, a responsibility she believes to lay in the hands of the building operators. Nevertheless, she perceives that there is no need for this type of information: *"It's not so much that I need to know, because, [it] pretty much fixes itself. I mean, I don't feel the need to do a lot of things manually."* The OR perceives that good energy efficiency is a direct result of good maintenance practice. She recognizes that basic information about how the building works would be good, as she has in occasions misinterpreted that some systems are automated when they are in fact manually operated. Overall, the OR perceives that the building is functioning as it should, and does not recognize any reason for which its performance would be lower than design intent.

The Research Building Owner (RBO) | representing the building owner: The RBO works as the Director of research. The RBO indicates that the building operators (later referred to as House Masters) are the only ones who can impact how energy is managed and used in the building. She suggests occupants cannot interfere with how energy is used as they cannot interfere with the automatic systems. The RBO indicates that the building contains a large amount of office equipment, but she is dismissive of the impact from small power loads as computers and laboratory equipment are common to academic companies. The RBO mentions that although she can manipulate the radiator in her office, she opts to open the doors and windows as these provide a faster route to changing the room temperature. She points to an inefficiency within the automated light system, but justifies it on the merit of personal benefits: *"it's unnecessary to light up the whole floor just for me. It might also be a strength that the whole floor is flashing up if you are afraid of being alone. It's not so scary when I come in."* The RBO argues she does not the need further information about the building. She perceives that the building is performing really well, but she acknowledges that the performance has not yet been properly monitored.

The House Master (HM) | representing the operational facilities managers: The HM is part of a team of 2 people who have the responsibility of managing energy in the building, as well as caring for a wider range of building services. Both come from an IT background, as building automation is seen as the most important competence for the good operation of the building. Controlling the heat in the building is perceived as the single most important aspect in regards to the energy management of the building. The HM perceives his role as the only one that matters in the aim of ensuring good energy performance. He specifies that occupants with single-offices have additional control over room temperature; however, he indicates room adjustments have little significance on the overall performance of the building.

Moreover, he perceives that the building is designed to mitigate the adverse effects from user actions. The HM dismisses the impact of small loads in the building: *"it's an office building so we don't have very much equipment. We have something in the lab..."* He notes that patterns of building use are very predictable, following standard 8 to 4 schedules. Communication with users is deemed as strong. Occupants are encouraged to notify the FM team when things are not working in the building. His colleague (referring to the second House Master) has the habit of sending e-mails to inform building occupants about problems with the facility.

4   PRACTICAL IMPLICATIONS

This section discusses the role of facilities managers from the perspectives of building occupants, building owners, and building operators. We aim to describe the extent to which facilities managers are expected to contribute to the development of an energy conscious workforce in the context of highly automated non-residential buildings. Particular to this approach is the creation of an image that is based on the perceived level of influence and impact of building occupants over the energy consumption of the building they inhabit. In addition, we examine the extent to which each user group values the opportunity for building occupants to take part in the process of managing energy within the building they occupy.

4.1   FMs role from the perspective of building occupants | ST and OR

Both building occupant representatives acknowledge that their behavior can have an impact on energy consumption. The school teacher indicated that energy savings are possible through turning the lights off before the automated system deactivates them. In this sense, building occupant interventions can be perceived as user-enacted rules that can support the logic of design of building automated systems (e.g. to save energy through the deactivation of the lighting system when is not needed by its users). The office researcher demonstrated understanding regarding the influence that occupant behavior can exert over the work routines of building operators. Occupant actions can trigger new service demands for the FM department. Increased collaboration between both actors can lead to increased energy savings and a reduction of FM service requests to the FM department. Communications between building occupants and operators is expressed as a two-way channel limited to the handling of complains. The role of FMs is perceived as one that is meant to ensure that all building systems are running properly. Lack of communication between building occupants and operators is not necessarily perceived as a flaw, but a logical result of the perceived good performance of the building. Perception on the facility's performance is shaped to a great extent by the understanding that low-energy facilities are able to fix or regulate themselves. Both representatives agree that it is the responsibility of the building operators to guide building occupants to responsible energy use. The fact that building occupants do not actively demand for this information does not necessarily imply that it is not deemed important by them.

4.2   FMs role from the perspective of building owners | SBO and RBO

The SBO acknowledges the strong significance of building occupancy patterns on energy consumption; however, he is dismissive of the influence of occupant behavior on a building's performance. One may argue that a significant portion of the variations in occupancy patterns are the result of the occupant's behavioral choices; for example, when building occupants choose to work late at night or over the weekends. As a building owner, the SBO is aware of his responsibility in managing the users, yet he clears his team from the responsibility of

intervening with regards to how the building is used. It is understood that school buildings in Norway have the right and obligation to accommodate activities in service of their community; however, one must agree that tighter collaboration between school staff and the SBO could result in usage schedules that optimize how energy is consumed in the building. As long as occupancy patterns are assessed as a variable that is non-related to behavioral aspects, the opportunity to manage the extent to which buildings are used is further reduced.

From the perspective of the RBO, energy performance is fully dependent on how the building is controlled by the building operator. Buildings are meant to fulfill a function; in this sense, the RBO fails to perceive any potential misuse of energy resulting from the "regular" use of the building. The previous implies that any amount of energy used for the achievement of the core function of the building is energy "well" spent. In turn, this view negates efforts to increase the efficiency of energy consuming processes related to core function (e.g. educational activities in schools or health activities in hospitals). The RBO identifies inefficiencies in the building systems, such as entire floors lighting up as she enters the building at night by herself; yet, she defends the system´s response on the premise of an associated psychological benefit (i.e. reducing the fear of being alone). In practice, building occupants who are faced with similar situations may opt not to inform FMs about the need to regulate the building systems, thus missing opportunities to reduce energy usage.

Neither the SBO nor RBO envision opportunities for further collaboration. The SBO goes as far as perceiving that feedback from occupants interferes with his team´s ability to do a good job. Moreover, the SBO encourages the removal of the building occupant as a player in the practice of energy management. The RBO perceives that communication between the building operator and building occupants is necessary when the building does not perform according to expectations. The difference in views can be explained by the inherent differences in their roles as building owners. The SBO sits outside the building and is part of team with the responsibility of managing the building. In contrast, the RBO sits within the building and holds greater face-to-face accountability with regards to building occupants.

4.3   FMs role self-assessment | EM and HM

The building operators at both the school (EM) and office (HM) buildings agree that building occupants have no significant impact on energy consumption. Two key aspects enforce this view: Firstly, the presence of technological features that support the automation of the building systems. Building occupants are only able to interact with the building through a limited set of actions (e.g. manipulation of windows and radiators), whereas building operators are able to control the bulk of the building´s energy flows. Secondly, the view that energy management practice should focus on big energy expenditures. In this sense, individual occupant interventions such as adjustments on room temperature are not as significant as the energy required to maintain a comfortable temperature for the entireness of the building.

Although both perspectives are technically correct, they can lead to the freezing of action towards monitoring and influencing end-user interactions. For example, the HM dismisses the impact from office and laboratory equipment in comparison to the energy consumed on heating the building. In turn, the logic behind the big-expenditures approach may translate into an energy management strategy that fails to address the energy consumed by small power loads in buildings. In addition, one may argue that the HM´s failure to acknowledge the impact of people behavior misguides his understanding regarding how the building is used at a larger scale. The HM indicated that the building is used on a predictable manner,

although we learnt from the building owner representative (RBO) that the building is also used during the weekends. This does not necessarily mean he is not aware of this issue, but he may opt to accept all weekend energy expenses as natural traits within office buildings.

A contrasting view between the EM and the HM is expressed regarding their attitudes towards building occupant engagement. The HM team encourages good communication with building occupants. The content of these communications has not been assessed, but the openness towards exchanging information is an important step towards further collaboration. Conversely, the EM shares a similar view to that of the school building owner (SBO), in that building occupants should trust that the building operators are caring for the building in an optimal manner. As a result, opportunities for integration of building occupants in the practice of energy management are reduced. In turn, negative attitudes towards engagement and collaboration affect opportunities for energy reduction, data gathering, and ultimately the FMs industry opportunity to provide valuable feedback in the design phase of buildings.

Figure 1 illustrates the perspectives of different user groups on the impact of building occupants on energy consumption and willingness to engage with one another on the process of energy management

Figure 1: Perspectives of different user groups on the impact of building occupants on energy consumption and willingness to engage with one another on the process of energy management
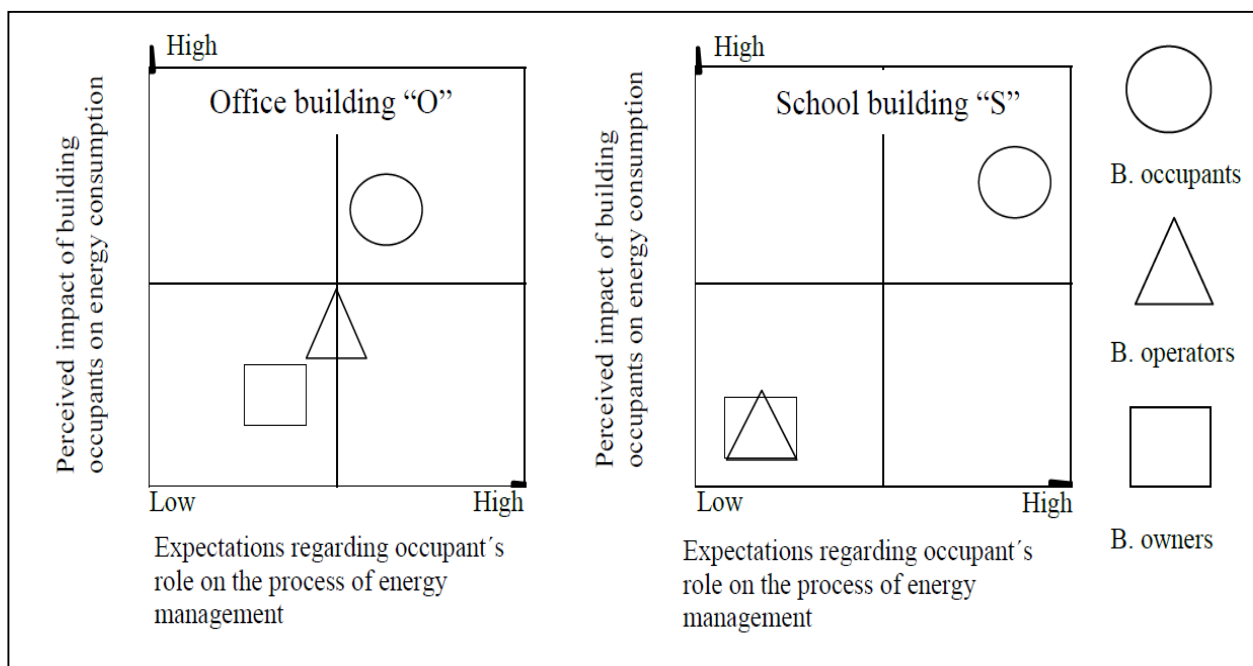
5   CONCLUSION

This study gathered the views from building occupants, building operators and building owners. It highlighted perceptions that can lead to missed opportunities in the reduction of energy use and data collection in non-residential buildings. In general, building operators and owners did not perceive that building occupants need to play a significant role in the practice

of energy management. The level of automation of the facility seems to be an important factor influencing these attitudes.

From an exploratory perspective, six lessons are taken requiring further study: 1) the opportunity for occupant intervention as a user-enacted rule that can support the logic of design of building automated systems; 2) the impact of educating building occupants as means to reduce the number of unnecessary service requests to the FM team; 3) the risk behind the logic of "big-expenditure" thinking to energy management; 4) the opportunity for embedding energy management practice into the core activities of building occupants; 5) the disassociation between occupant behavior and building occupancy patterns, and; 6) Lack of concern for energy consumption of core-function loads (e.g. computers, lab equipment) deemed as natural traits of the various non-residential building types.

This paper acknowledges that the findings are limited to the particular experiences of the interviewees and influenced by the building context within which they are expressed. However, from an exploratory perspective, findings are significant and in line with current interests from both academia and industry alike in the context of reducing the energy performance gap from a sociotechnical perspective. From a theoretical perspective, the strategic, tactical and operative levels of facilities managers need be expanded to include not only key objectives in the practice of energy management, but the potential pitfalls as highlighted in this study.

ACKNOWLEDGEMENTS

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7

HOW CAN WE CREATE FACILITIES THAT ARE USABLE AND ADDS VALUE?

7.1

Integrating Security into Building Design and its Effects on FM

Julie E. R. Indrelid and Nils O. E. Olsson

7.2

How FM may Contribute to Happiness - The Oscar Approach

Svein Bjørberg, Alenka Temeljotov Salaj, Anne Kathrine Larssen and Knut Boge

7.1 INTEGRATING SECURITY INTO BUILDING DESIGN AND ITS EFFECTS ON FACILITIES MANAGEMENT

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ABSTRACT

Purpose: This paper investigates the present situation with respect to professional knowledge and competence regarding building security. It also maps how security measures are handled in the construction process and what this implies for facilities management.

Background: Security has become a global concern, including management of secure buildings. The recent terrorist attacks in Brussels underline what appears to be a global present and continuous security threat. In Norway, the attention towards the topic was especially raised and triggered by the terrorist attacks on July 22, 2011.

Approach: This paper aim to give an overview of the terminology and international best practices related to the planning and design of secure buildings. In addition to a literature review and data gathered from interviews, the findings are based on a questionnaire that maps competence and on a case study of the planning process for the future ministerial complex in Oslo. We have also mapped the presence and scope of skilled security professionals in Norway. The case study includes a document review and in-depth interviews with participants involved in the planning process.

Results: The findings indicate that there are no established or standardized practices for analysing and addressing the security risks as they relate to the end product, i.e., the building structure itself. This makes it difficult for both clients and facility owners to evaluate and compare building security competences and design solutions. Moreover, aspects related to security are often not considered until late in the project design, typically after the overall objectives and general design solutions have been established.

Practical implications: This implies that physical security measures are added at a later stage in the design, which results in non-optimal solutions that often create problems over time for facilities managers, users and other stakeholders of the building.

Keywords:
Security, Buildings, Design, Competence, Risk

1   INTRODUCTION

The purpose of this paper is to study how security aspects of buildings are addressed and the way in which security aspects are integrated into the planning phase of a construction project.

Though the discussion and findings presented herein are based on a review of international studies, the empirical section of the paper contains data from a Norwegian case study.

Sadly, security has become a global concern when it comes to the usability and management of buildings. In Norway, the terrorist attacks on July 22, 2011, triggered a significant increase in the awareness and attention given to this topic. Resent attacks in Brussels underline what appears to be a continuous and present threat. The security measures implemented to reduce vulnerabilities and minimize the damages of crime or a terrorist attack, tend not to be integrated into building design and appear as visual add-ons to the overall design and construction of the building. Larger public and private buildings are built and planned with the intention of a long lifespan. This will require that decisions be made during the planning process that incorporate both future users' needs and future security needs. Therefore, the need for security is important to consider when designing the built environment such that the buildings are usable in a relatively distant future (DSB, 2012).

There are many arguments in favour of including security aspects in the early design phase of buildings because such ad-hoc add-ons can result in buildings that resemble fortresses and have poor aesthetic qualities and inefficient usability, which negatively affect both visitors and employees (Gustin, 2010). Furthermore, adding security features to a finished project tends to be expensive not only in terms of the implementation costs but also for the maintenance and management of the building. This paper includes discussions related to user involvement, usability and facilities management for buildings that require enhanced security measures.

By reviewing the extant literature and qualitative interviews and by the examining current principles for building security and existing professional knowledge and competences, this paper aims to propose the best practices in the field and identify the implications of integrating security measures into the building design process for facilities management. The following research questions are addressed:

- To what extent is there a uniform way of working and a uniform set of terminology for the security aspects of buildings, and what are the best practices?
- What professional knowledge and competences regarding building security are currently available?

2   STATE OF THE ART

There is a distinction between safety and security. Security typically relates to avoiding undesired actions, such as espionage, crime or terrorism, and safety relates to avoiding undesired events such as flooding or accidents (Hovden, 2004). With respect to safety, empirical data regarding frequencies can convey the probability of an event. However, with respect to security, the probability estimates are far less relevant (NSR, 2011). In a built environment, security risks involve several diverse facets, including infrastructure, construction, architecture, technology and even the psychological factors of the stakeholders (Nistov, 1999). Though there are several definitions of security risk, in general, the relevant definition adopted in this paper is that security risk is the relation between the threat to an asset and the asset's vulnerability to the threat (NS 5830). An asset can have material or non-material aspects, such as reputation or business continuity.

Throughout time, securing buildings and cities has been a complex but crucial task. There are now many books about and guidelines for secure building design. For example, *The American Design Guide for Physical Security* (2005) presents recommended designs and materials as well as information regarding their qualities and strengths (American Society of Civil Engineers, 2005). A more recent example is that of Baker and Benny (2013), who present a practical guide to physical security. There are also guidelines, such as the British Standard BSi PAS 68 for vehicle security barrier systems, that aim to protect against specific threats (CPNI, 2014).

Though real estate protection is subject to general laws and regulations, Norway's security act regulates the security of facilities of national importance (*Lov om forebyggende sikkerhetstjeneste* (Sikkerhetsloven) enacted July 1, 2001). This law states that the different ministries have the responsibility to identify buildings and national infrastructures that are of value to the nation. The owner of a facility that requires security protection has the duty to implement measures for this protection. In addition to the national laws, facility owners and facility managers must account for international regulations, such as the International Ship and Port Facilities Security Code (IMO, 2004), and for international aviation regulations and requirements, given that the aviation industry and airport security are both highly regulated worldwide. Furthermore, increasingly more insurance companies are requiring the implementation of minimum-security measures as a basis for insuring high-risk buildings.

The Norwegian Defence Estates Agency issued a handbook for security, which was the first and only Norwegian publication to provide specific security guidelines (Nikolaisen & Hauge, 2005). There are also Norwegian standards for security terminology, management systems for security and guidelines for security analyses (NS 5814, NS 5830, NS 5831 and NS 5832). Additionally, a standard for the planning of facility security factors will be published in 2016 (NS 5834), and building security is addressed in the Building Research Establishment Environmental Assessment Method (BREEAM) guidelines (BREEAM-NOR, 2012).

A number of authors have addressed the relationship between security and the influence of architecture and urban design on crime by examining how the design of urban areas can contribute to crime prevention. One approach is Secured by Design, a programme whose protected trademark is owned by the Association of Chief Police Officers UK. Secured by Design is an initiative implemented by police in the UK that supports the principles of designing out crime and combining them with physical security. The term Secured by Design was originally introduced in 1989 as part of the strategy, and today, the principles are part of a licensing scheme (OPCI, 2015). The UK government has also established the Centre for the Protection of National Infrastructure (CPNI), which provides protective security advice. The CPNI facilitates communications among different governmental/ministerial departments and promotes effective relationships between private and public sector partners. This philosophy and the practical execution of physical security have many similarities and connections to the early thoughts of writers (Wood, 1961, Jacobs, 1961, Jeffery, 1977) regarding the design of the built environment as an approach to crime prevention. In the literature, designing out crime addresses concepts such as reducing the anonymity of the offender, defining the relationship between private and public space and focusing on environmental design and physical security (OPCI, 2015), all of which are specific principles based on the ideas and methods of Crime Prevention Through Environmental Design or CPTED (Coleman, 1985, Cozens et al. 2005).

Jacobs (1961) proposed the term natural surveillance to refer to the increase in security in the built environment. Shortly thereafter, Newman discussed this concept in his "Creating Defensible Space", wherein he explained that defensible space is a socio-physical phenomenon that claims that both society and physical elements are parts of a successful defensible space. Newman proposed the four design principles of territoriality, surveillance, building image and juxtaposition. These four principles were further developed in the 1970s in many European countries and in the US. An element in this development was routine activity theory, which emphasized the context within which the crime occurred. This theory, built on the assumption of rational choice of the offender, was initially launched by Cohen and Felson (1979), who argued that three factors must be present for a crime to occur:

1. Presence of individuals who are willing and have the capacity perform a criminal act
2. Presence of suitable targets (an individual or building that is vulnerable or available)
3. Absence of capable and willing guardians

Another important theory in the security literature is displacement theory, which argues that a possible offender will be rational and avoid a well-protected target or building such that the crime is displaced onto a less protected target. On these grounds, critics claim that security measures have resulted in nothing more than displacing the crime from one location to another. There have been conducted several studies in relation to this theory, as summarized by Saville (1998). Other important publications are Sorkin (2008) and Kenzari (2012), who considered the connection between the physical environment and criminal actions. Conversely, a more proactive approach was taken by Nan (1997), who attempted to identify crime prevention measures rather than merely examine the existing level of threat. Colquhoun (2012, first published in 2004) explored the premise that a good design of a physical environment will reduce criminal activity in the area and argues that by integrating some simple crime reducing principles into the early design process, it will be possible to create an area that is more secure without harming the aesthetics or amiability of the neighbourhood. By optimizing the possibilities for natural surveillance and clearly defined borders for different types of use and by establishing and maintaining a positive image, the city or community may reduce or prevent criminal activity. Cozens et al. (2005) explained that because a potential criminal is more visible to law-abiding citizens, it is easier for criminals to be seen and caught. In addition, because well-maintained surroundings create a sense of ownership of the physical areas, he claimed that this will affect the citizens' inclinations to protect and respect their neighbourhoods.

Atlas (2013) argued that, for the most part, architects and engineers design and construct buildings without having a security designer or security adviser as part of the project team. Atlas also claimed that the architect profession used to be of the opinion that security was much like the telephone company: first, you construct the building, and you then request that a security expert install the necessary equipment. However, it is evident that today's complex construction projects require more planning and design that this to ensure a good result. Thus, architects, engineers and safety professionals must communicate with each other and coordinate their specific requirements; however, they need not perform each other's jobs. It is important that each participant appreciate what each party has to offer to the design process while honouring security as an independent and important profession.

3   METHODS AND APPROACH

The aim of this paper is to investigate the planning process, though its scope is limited to the programming phase of a construction project in Norway. As a pre-study, we conducted six interviews with security advisors from the Norwegian Defence Estates Agency, National Bank, and National Security Agency and with consultants and architects who have experience in security work from both the private and public sectors.

We have mapped the available security competences in Norway. A questionnaire was sent to 22 organizations involved in security work. The questionnaire was accompanied by a statement from Standard Norway, indicating that they supported the study, and asked recipients to participate in the study. We received answers from 12 organizations. Six companies did not answer, and two replied without filling out specific answers. Two replies were not used because the answers contained significant variance and we were uncertain about the representativeness of these answers. We thus has a total of 48 security planners, 30 security analysts and 60 technical security advisors who met the predetermined knowledge and competence criteria described in NS 5834.

Though the case study is based on the development of a new project, the principles are relevant for refurbishment and reconstruction projects as well. We conducted a case study of the planning of the new ministerial complex in Oslo, Norway. The case study was carried out during 2015, when the project was in the early planning phase. A case study report was developed, based on document review, observations of the planning process, meetings and interviews of key personnel involved. All the collection of data was done by one of the authors, while the other researcher participated in the design of the study and quality assurance of preliminary and final versions of the final report. The main source of information from interviews presented in this paper is a group-interview with representatives of the client organization, Statsbygg, which oversees and maintains government property. In addition, we interviewed those responsible for the overall security of the project in the Norwegian Defence Estates Agency.

4   RESULTS

4.1   Available competence

Table 1 shows the results of the study of the available building security competence in Norway. An interesting finding is that there is almost no postgraduate academic education in the security profession. This finding also implies that the traditional professions in a building process, i.e., architects and engineers, have little formal education in security matters when they enter the professional working arena. The questionnaire indicates that security advisors with a background in landscape architecture are the most difficult employees to recruit to a company, in proportion to the number of existing CVs.

The total numbers in table 1 do not represent the number of people but instead indicate the number of resumes/CVs that fit into the specific competence description. Some would thus be able to cover more than one of these subjects based on their experience and expertise.

Table 1: Total results of all questionnaires. The table presents the total number and the skills that the respondents believe are the most difficult to recruit. Security engineering consultants, total also includes general security consultants

Area	Number of CVs	Most difficult to recruit
1.Security planners	48	5
2. Security risk analysis	30	6
3. Security engineering consultants, total	60	8
3.1 Architects (security)	28	2
3.2 Landscape architects (security)	1	2
3.3 Structural engineers (security)	10	2
3.4 System engineers (security)	1	1
3.5 Other technical security consultants	5	1

4.2　Case study

As a consequence of the terrorist attacks on July 22, 2011, the Norwegian government gathered the majority of the ministries in the ministerial complex to the centre of Oslo, a decision that was highly influenced by security issues. The mandate for a concept report further indicated that a "necessary security" should be incorporated into the planning of the future ministerial complex. Exactly what "necessary security" meant, however, was not clearly defined. Another interesting finding was that the term Secured by Design is mentioned in the mandate. Specifically, the mandate clearly stated that the principles of Secured by Design were to be incorporated into the planning and building of the future ministerial complex. Further, the mandate specified that this required a high degree of integrated security and that security was to be included in all phases and aspects of the design and construction of the building and in facilities management.

Thus, the planning of the project and the integration and implementation of security are an interesting basis for a comparison to other projects, because it is one of the few Norwegian projects in which security was explicitly identified as a priority from the onset. In addition, this will be, upon completion, one of the largest security projects in the country. Hence, much can be learned from how such a complicated process was organized and conducted. Accordingly, the results of the organization of the planning process of the new ministry quarters in Oslo can serve as an illustration of the existing best practice for the planning of buildings for which security measures are a priority.

An analysis of five predetermined concepts was conducted. The concepts represented fundamentally different ways to resolve predetermined project requirements, including geographical location. Based on the evaluation criteria for rating the concepts, security was ranked second in priority, following effectiveness and interaction. Two of the evaluated concepts received four out of five possible points in the security category, including the chosen concept.

Establishing and determining the correct level of needed security in the total project were a challenge. The owner, user and facility manager are different ministries, and they have different views on the basic level of security needed. A great deal of challenging assessment and balancing was also required concerning the incorporation of flexible solutions into the ministerial complex to provide an opportunity to scale the security as the future threat level varies.

Such varied threat levels will, in many cases, also represent significant challenges regarding the management of the building. In recent years, there have emerged new normal states with respect to threat levels in most European countries. When a new normal arises that the current physical building security is not equipped to handle over a long period of time, the cost of operations to implement temporary security measures and preparedness can be enormous. This applies both to direct costs for increased security and preparedness and to temporary changes in facility management equipment and operating personnel, which could also become the new normal.

The interviewees stressed that needs for security will vary internally among the different ministries and will also vary over time. This means that the different departments must determine the appropriate level of security necessary to secure their assets. The demands for security are then transformed by the project into technical requirements to meet the building's overall security needs. This emphasizes how important it is for concrete solutions not to be presented too early in the planning process, but as a result of the requirements and actual security levels communicated in the next phase of the process.

5   PRACTICAL IMPLICATIONS

The first research question addresses the extent to which there is a uniform practice and uniform terminology regarding the security aspects of buildings. The case study of the planning process of the new ministerial complex in Oslo reveals that there are no established common methods for analysing security risks for buildings. Instead, the practice is based on the experiences of the involved parties and the best practices in facility planning. There is no consensus in the industry regarding the methods, processes or terminology for topics such as Secured by Design. This makes it difficult for clients and facilities owners to evaluate and compare competences and design solutions.

Standard procedures for handling security in construction projects are based on experience and can vary due to the personal preferences, strengths and weaknesses of those involved in the process. Academics, professionals and practitioners emphasize that they want to be involved in their projects earlier because this would result in the most efficient and, overall, best possible solutions for the total project. In practice, however, security measures are often considered only after important decisions about the physical design are made, thus, limiting the possibility that the security measures can be incorporated as an integral part of the project.

Because security aspects are often included too late in the project, typically after the overall objectives and general design solutions have been established, the ability to integrate security facets into the design is reduced. This means that security issues must be added during later stages of the design and building process, which results in non-optimal solutions that often create problems for facilities managers. If security is not incorporated in the early phases, the

security measures that are added later can become obstacles for good facilities management. This may, in turn, increase operational costs, impact usability and reduce the aesthetic appearance of buildings.

It is desirable to use functional specifications regarding the security performance of buildings. The involved stakeholders can then find suitable design solutions and integrate them in the overall design of the facility. Designs that provide a high degree of flexibility are preferable because the use of the buildings and the types of threats are likely to change over time. This paper also examined the extent to which professional knowledge and competences regarding building security are available. The survey and case study indicate that although there is a high degree of expertise in the private consulting environment, this primarily consists of experiences and skills combined with less formal knowledge rather than formal, specialized higher education. The quality of experience is difficult to measure for client organizations and, thus, difficult to compare when, for example, choosing consultants and other advisors.

Using the documented professional knowledge and competences about building security found in those involved in the planning process would be advantageous when evaluating security measures both before and after projects. We found that this expertise exists today and that the specific roles of the security advisor can be fulfilled by many of the private advising companies in Norway. We also found a desire among the participants for greater expertise among professional security advisers, particularly in the area of landscape architecture.

The main conclusion of this paper is that the security of buildings is often not considered until after the major decisions regarding the physical design have been made, thus limiting the possibility of integrating building security as a successful integral aspect of building design. There is no consensus in the security community regarding the use of either methodological tools or terms such as Secured by Design, which may lead to misunderstandings and uncertainty about expected delivery and challenges when comparing offers. Accordingly, practices regarding the implementation of security measures are generally based on experience because security is rarely included in formal regulations of the industry.

Finally, this paper studied and revealed what is considered the best practice in the planning of buildings that have a need for security. Best practice occurs among interdisciplinary teams that are focused on integrating security and solving security needs while addressing other project requirements. We identified the following characteristics of best practice when integrating security into building design:

- The need for security requirements are clarified early on in the planning stage, which eradicates costs associated with the late implementation of security measures.
- The client organization must possess significant expertise to evaluate the quality of the professional competence that exists in the market and to assess what is being delivered.
- An analysis of the level of necessary security begins with identifying and evaluating what assets and values the organization must protect, and then identifies the correct security level.
- The security of buildings is addressed throughout all phases of the project. This includes localization, architecture and design, construction, facilities management and demolition.
- Knowledge is transferred from public institutions to private security professionals thus forming a common platform and language for learning and knowledge transfer.

- Security measures are integrated into the existing facility management systems, thus revealing the impact that security has on the overall life cycle cost of the building.

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7.2 HOW FM MAY CONTRIBUTE TO HAPPINESS - THE OSCAR APPROACH

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ABSTRACT

Purpose: "Oscar" is a research project started in 2014 for a period of four years with the objective to develop competence, methods and analysis tools, to optimize building design in a way that will contribute to value creation for the owner and end-user throughout the buildings lifetime. From this context the Oscar concept could be translated to value for achieving "happiness".

Background: Norwegian Government`s White Paper, Stm 28 (2011-2012) "Good buildings for a better society – A future looking policy" gives aims, instruments, recognition and guidance on how to achieve good processes, stakeholders and built environment. Main focus in this policy is how governmental measures can be adapted and used to achieve sustainable buildings.

Approach: The project has a mixed approach with structured literature review, a national questionnaire survey, interviews and series of workshops with relevant persons based on their formal roles, expert knowledge and experience.

Results: The paper presents findings from literature review, survey and workshops.

Practical implications: This research provide guidelines concerning how FM can contribute to value creation.

Keywords:
Value creation, Facilities Management, Happiness, Users, Owners

1   INTRODUCTION

It is acknowledged that there is coherence between how we design and how we operate, maintain and enhance our buildings and what values the building (space and infrastructure) create for those using, managing and owning the space. "Happy users give happy organizations (core business) and owners".

The research about workplace happiness (Andrew, 2011, Diener, 2000) shows that happiness is an entirely subjective feeling of wellbeing experienced by the person, characterised by the presence of positive emotions and the absence of negative emotions. The positive characteristic of orientations to happiness that proposes different pathways to happiness may contribute to work-related wellbeing (Johnston et al., 2013). One of the proposals includes the pleasure orientation suggestions that the maximization of pleasure and the minimization of pain are the chief route to happiness, beside engagement at work and living in accordance with individual's virtues (Peterson, 2005, by Johnston et al., 2013). Interventions, which draw individuals' attention to pleasurable, meaningful or engaging aspects of their life, had the potential for increasing wellbeing (Giannopoulos and Vella-Brodrick, 2011, by Johnston et al., 2013).

Sharifirad (2013) states, that employee wellbeing attracts much attention of researchers, for the sake of happier and more productive employees. Happier people are found both healthier and more productive (De Neve and Oswald, 2012). A research from the University of Warwick shows that happiness treatments improve productivity by approximately 10%-12% (Oswald at al., 2014). Anchor (2010) says that happy companies increase sale by 37%, productivity by 31% and accuracy of tasks by 19%. When we are positive, Anchor states, our brains become more engaged, creative, motivated, energetic, resilient, and productive at work.

Chuluun and Graham (2016) researched financial issue of happiness and more over-arching concept of subjective wellbeing that attracted significant attention. Their research explored whether the externalities related to happiness at the societal and individual levels relate to firm decisions. The findings show that average local happiness (happiness inequality) is positively (negatively) correlated with both R&D intensity and firm investment. Firms in happier places, tend to invest more than firms in less happy places, and it was found that younger firms' investment behaviour more strongly correlate with local happiness levels.

Warr (2013, by Rodrigez and Sanz, 2013) explains that happiness and unhappiness clearly derive from two main sources: job characteristics and within-person mental processes, and in order to understand and enhance worker happiness and well-being, it is essential to examine patterns between those variables and happiness. From the Rokeach theory of value (1960), which stresses the more desirable individual and social forms of behaviour, we know that 'every environment surrounding 'humanity' has certain features, characteristics that need special attention, simply because they are very important for humans, their life, survival, living, leisure and work' (Temeljotov, 2005). Our physical surroundings have an impact on individual's satisfaction and hence happiness. Happiness at work would imply to experience high levels of pleasure and moderate levels of activation (Bakker and Daniels, 2012, by Rodrigez and Sanz, 2013).

From the workplace perspective, happiness is connected with wellbeing, employee's physical health, psychological health, physical safety and wealth (Andrew, 2011). Happiness includes

many 'work' factors, such as work enjoyment, -enrichment, -relationships, -life balance, -variety, -teams, -recognition, -reward, -meaningfulness, -engagement, -equity, workplace leadership and -community. The mottos in happiness environments are 'happiest minds', 'healthiest hearts' and 'harmonious lives'. There are different ways to achieve happiness, from providing nicer offices or entertainment to securing a good pension scheme, higher wages and other benefits, and guaranteeing a good level of stability (Allen, 2015, Oswald et al., 2014). Another way is acting 'to create happiness at work' suggested by Kierulf (2016): random acts of workplace happiness, hire happy people, stop negative behaviour, celebrate success and celebrate mistakes. Allen (2015) suggested four key areas to focus on: autonomy (feeling of control), relationships (liking colleagues and supportive and friendly environment), progress (against goals they care about), and meaning (feeling work has a purpose).

Cloutier et al. (2014) presented a Sustainable Neighborhoods for Happiness Index, with an increased focus on happiness. The methodology requires communities to look critically at the current state of their neighborhood, while implementing system-thinking and analysis for how to best improve. It allows communities to improve the overall happiness of residents through a shift toward sustainability. Presented urban happiness measures are: walkability, orientation, use of native vegetation, green space connectivity/ biodiversity, access to nature, and measures of social capital. The one oriented on buildings are: number of other green certified buildings, percent of green government buildings, and number of green building business in community.

Practice shows an increasing focus of users and owners on how buildings affect the core business due to changing demands over time. By developing a better understanding of changing demands from the core businesses, it will be possible to make some assumptions on possible future needs. This leads to the need for "adaptability" of buildings to upkeep the usability, and "sustainability'' as the interaction of economy, environment and social aspects. If changing demands are not met by adaptability, the economy and use value will decrease. The same applies if facility management does not upkeep the buildings' technical functionality and standard. This will cause accumulated needs for maintenance and upgrading which in turn affect environmental and social issues. Totally, it will affect all value aspects. As stated in Norwegian White Paper (2011-2012), life cycle planning and economy is essential.

Larssen (2011) argues that in order to allow for elaborating a more professional and strategic facility management, it is necessary to develop a new understanding of roles for facility management. A central element for such new understanding of roles is the focal shift from a responsive role with an operative perspective and major emphasis on costs towards a more active role and a strategic perspective, where more emphasis is put on the effects on the organization of core activities and FMs contribution to added value. This is in line with several other researchers' conclusions (Valence 2005, Jensen et al. 2008, Jensen 2009).


3   APPROACH

The research project "Oscar – Value for User and Owner of Buildings" (2014-2017) has a main intention 'to develop competences, methods and analysis tools for optimizing building design in a way to contribute to value creation for owner and end-user throughout its life time'. The Norwegian Research council supports the project.

The project takes into consideration a clear connection between the design and operation of the buildings and values for the owners and users. To achieve value creation processes, it is necessary to have competent actors who have good tools for decision and communication through projects and processes. The research findings in the Oscar project are a result of cooperation with 20 project partners from three countries from academic, private and public sector and from all stakeholder groups. In accordance with findings from literature review and purpose of the project, the relevant stakeholder groups are owners, users, planners/designers, consultants and contractors, universities and FM providers.

The Oscar project contains three main work packages (WP), see Figure 1, with a goal to: define the knowledge on how to contribute to value in user phase as input in Early Design Phase. Focus is on characteristics, which contribute to value creation (WP1), to define execution models and processes, which contribute to value creation (WP2) and on design methods and tools with focus to safeguard and guide the process to obtain value for users and owner (WP3).

Figure 1: Value contribution model
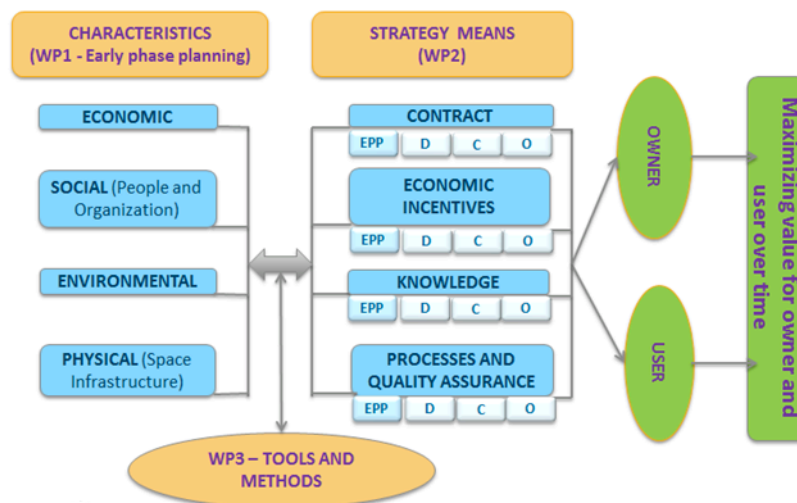
4   RESULTS

For the early phase of projects (until investment decision is made), it is found, not surprisingly, that competences have an important role. It is seen that some improvements are needed for: experience, higher responsibility, clarification of project organization, increased multidisciplinary understanding, better project manager's competence, including FM experiences in early phase, better competence of LCC, more focuses on value for client/ owner/ user. All this competence must be a part of early design phase. There is also needs for processes, methods and tools supporting early phase and needs for instruments and incentives to strengthen behaviour to achieve common goal. In the following some main findings are exposed.

4.1   Findings from the literature

"Value" is not a clearly defined concept. The word is often used within FM, but seldom accompanied with an explanation. Value management is by several researchers and practitioners pointed at as the new direction for FM (Coenen et al. 2012, Jensen et al. 2013, Finch 2011). From the literature, we find a wide specter of approaches and definitions, depending on context and perspective. In Oscar it was concluded to use the following definitions:

- Value – has to be defined in each case. It should be the strategy that reflects owners' (and users') value in the actual project, which can be translated to characteristics.
- Value creation: the process needed to achieve value.
- Added value: innovation and possibilities throughout the project process which can increase value outcome.

Within the first phase of the Oscar project, a list of characteristics and means, which can be important for the value creation, was found from literature review.

4.2   Findings from questionnaires

National questionnaires have been conducted where questions was in 5 main groups; economy, environment, social, physical and obstacles (to obtain value creation). In Table 1 some main results from those groups are shown.

The ten aspects with highest total rank on the question "based on your experience – to what extent were these aspects emphasized? (scale limited (1) - high (4))" (Perspectives: E=economical, EM=environmental, P=physical, S=social):

3. Investment costs (E)
4. Effect on core business (area utilization, logistics, workplace design) (E)
5. Energy efficiency (EM) (High demand level in legislation)
6. Indoor climate and comfort (EM) (High demand level in legislation)
7. Accessibility and universal design (P) (High demand level in legislation)
8. Energy costs (E)
9. Area use (logistics, movements of persons and transport of goods etc.) (P)
10. User involvement (S)
11. Security and safety (S)
12. Workplaces facilitating flexible ways of working (S)

Except from number 1, 3 and 6 all of these aspects can be highly relevant for the effect on end-users "happiness". The high focus on 4 Indoor climate and comfort and 5 Accessibility and universal design is natural, since Norway have strong public regulations in these areas. The negative effects on human beings due to poor indoor climate are also well documented in literature.

4.3   Findings from workshops and interviews

Several workshops executed within the partner group have given a lot of findings and confirmation of upfront assumptions. In addition, so far 12 master students and 12 bachelor student has been connected to the Oscar project. The latter group, in addition to literature study and questionnaires, have implemented interviews. Main important findings to be considered in early design phase are (not ranked):

Table 1: main results from questionnaire survey

Aspects	Highest importance	Lowest importance
Economy	• Investment costs • Effect on core business • Energy cost • Net present value of cash flow (NPV) • Life cycle cost (LCC)	• Market value in case of sale • Cost efficient services (soft FM) • Yield • Cost of workspace in user phase • Cost efficient cleaning
Environment	• Indoor climate and comfort • Energy efficiency • Use of materials and components with long life in use • Use of renewable energy resources	• Use of recycled / recyclable materials • Environment certification • Greenhouse gas emissions during buildings life • Facilities for efficient waste management
Social	• User involvement • Security and safety (unwanted incidents) • Architectonic qualities • Owner governance • Interior qualities (well-being and tidiness)	• Facilities for physical activities (gym, wardrobe) • Individual operation of sunscreens, light, temperature • Promoting pride (organizations cultural values) • Orientable (intuitive signs)
Physical	• Accessibility and universal design • Area use (logistics, movements etc) • Suitable materials for intended use and life-span • Technical condition in case of transformation • Flexibility (possibility to change space distribution)	• Generality (possibility to change function) • Innovation • Life cycle planning, integrated architecture and technology • Parking facilities
Obstacles	• Lack of adequate and clear order for the project • Lack of competence on user phase • Lack of multidisciplinary understanding in project organization • Insufficient organization of the project	• Technical professions are dominant • Too much emphasis on technic and cost • Insufficient use of digital tools for decisions • Architect profession has a dominant role

1. Clarify project strategy (value aspects) from client. It can be a big difference whether one designs for today's needs or for future needs.
2. Think of building elements / systems in three groups; never seen again (cannot maintain or replace), can see and maintain (but not replace) and can see and do whatever we want with.
3. FM and end users as important players. Ensure that these participants represent competenc for how core business function and on core business strategy. Also competence within design- and construction process.

4. Make premises document for MOME (Management, Operation, Maintenance, Enhancement)
5. Adaptability should be considered if the core business often change demands (hospitals, schools, some offices, terminal buildings at airports etc.).
6. Competence in design group should reflect client's strategy (value) for the project. Project management role is of high importance. It should not only be technical / economical competences involved, but also social, environmental, core business logistics and users need.
7. Project team should work in the same room with the same tools.
8. Core business user representative must have the right competence for being involved (not only because of rang). Important for logistics (local in an department / working team and global between departments).
9. Consequences for core business (efficiency in work processes / logistics) and FM (more operation / maintenance costs) should be clarified before / when cut in investment are done.
10. Good indoor climate and possibility to regulate climate by users.

4.3　　Findings for establishing happiness

"Happy users give happy organizations (core business) and owners" is one of Oscar projects working hypotheses. From all the findings, we can conclude with some main statements about what will contribute to "happiness":

1. Logistics for working processes
2. Adaptable building to upkeep work efficiency when changes in core business is a demand
3. Good indoor climate and individual regulation of temperature, sunscreen and air flow
4. Good communication / response time with FM when assistance is needed.
5. Upkeep quality in workplace surroundings by preventive maintenance.

All stakeholders in strategy, planning, design and construction should:

- **Harvest experiences** from use phase on which effect buildings have for individual persons, working team, an organization's core business and FM activities
- **Bring this harvest into the process** when designing new buildings as well redesign for refurbishments
- **Secure that the crop** is taken care of during the development process from design to end of construction, to ensure that the crop will give happiness.

5　　　　PRACTICAL IMPLICATIONS

Based on our findings so far we suggest some central areas for development of FM competences in the context of contribution to achieve end user happiness:

- Employee's way of working and their activities in connection to the workplace must be clarified regarding what are the needs today and hanging needs in the future. For existing buildings, clarify how suitable the premises are today, and what the main hinders for users happiness caused by the buildings might be.
- Make regular measurement of user satisfaction to follow up and have dialog with users as a base for improvements. If happiness has such a strong causal effect on productivity as indicated by Oswald et al. (2014), Kierulf (2016) and Allen (2010) this is crucial.

- Competence on how the physical environment affects human beings - physiologically and mentally. Hygienic factors (such as indoor climate) have negative influence if they are not adequately present. Too low temperature, draft, noise, lack of daylight e.g causes discontent and therefore may result in negative effect on productivity. Other factors, such as view, aesthetic qualities, natural elements etc. can on the other hand contribute positively to wellbeing if present.
- Knowledge about the premises characteristics to adapt new demands from users, and what potential for further development and improvement they represent. In order to sustain user satisfaction over time the premises might have to be developed and transformed in accordance with the changing demands.

The suggested future role of FM in the happiness perspective should be:

- Search for improvements and identify need and potential for changes in existing building portfolio – measuring user satisfaction and regular dialog with users.
- Consider the potential for adaptations and development of existing premises (adaptability, alternative use etc.) so that user satisfaction can be maintained over time.
- Get involved in early phase planning of projects - transfer of experience from operational phase.
- Demonstrate the cost/benefit and added value (both quantitative and qualitative methods)

Further work in Oscar will be focused on developing methods and tools that can support FM in such a role. In addition, further research, preferably in other countries than Norway is necessary to investigate whether we have stumbled across some general patterns concerning value creation from RE and FM, or if the findings are site and context specific for Norway.

ACKNOWLEDGMENTS

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KEYWORD INDEX   **Chapter**

This publication includes the research papers presented at CFM's Second Nordic FM Conference, which was arranged together with DFM – the Danish Facilities Management Association – on 29-30 August 2016. CFM arranged a first Nordic FM conference with success in August 2011. The ambition was also this time to create a meeting place, which the participants will remember for the intellectual challenge, its practical relevance and as a milestone in the development of an alliance around FM research and practice in the Nordic countries.

The papers were selected after invitation to CFM's research partners in the Nordic countries through a double blind review of abstracts and full papers. All together14 papers are grouped in 7 themes, which constitute the chapters in the publication.

The first theme on "University Campuses of the Future" was also the theme of the opening keynote by professor Tore Haugen, NTNU. Chapter 1 includes a research paper related to the opening keynote. The other 6 themes correspond to the workshops organized as part of the conference. Each workshop included between 1 and 3 research based presentations and the related research papers are included in the respective chapters.