

Shaping tomorrow's facilities management

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Abstract

Purpose - Against the background of earlier publications on the future of FM and acknowledging digitalization and sustainability as two major shaping forces, the purpose of this paper is to place contributions to the special issue in a perspective of current opportunities for FM research.

Design/methodology/approach – After a review of publications since the 1980s dealing with the future of FM, there is an analysis of how the forces of digitalization and sustainability have emerged over five decades. The articles of this Special Issue are introduced against this background. Opportunities for future FM research are identified, and the relation between research, education and practice is discussed.

Findings – Megatrends outlined in the 1980s still shape how FM develops. Digitalization supports sustainability through workplace change and building design, but also by performance measurement, certification schemes and an awareness of the wider urban context.

Research limitations/implications - Opportunities for FM research are created by digitalization and concerns with sustainability, combining environmental and social aspects. Relations between organizations studied in an FM context are important. Within organizations, employee issues and risk management are emphasized.

Practical implications – Policies and schemes for sustainable buildings should be linked to sustainable FM more clearly. The relation between research, education and practice needs to be consolidated as a basis for research and development, as illustrated by a number of the studies belonging to this Special Issue. To reach the goals of sustainable development, we need to develop the knowledge and theoretical frameworks that can be applied to and used by practice. The recent ISO FM definition appears as narrow and should be extended to recognize facilities life cycle issues as well as broader urban and social concerns.

Originality/value - This paper highlights the importance of basing FM research on an understanding of the fundamental forces that shape change.

Keywords Facilities management, Digitalization, Sustainability, Research/Education/Practice

Paper type Conceptual paper

Introduction

Predicting the future of facilities management has been the focus of a wealth of studies since the early 1980s. In this special issue of Facilities, we begin by looking back at how researchers have approached

the future of FM. Today, we see digitalization and sustainability as the two forces that generate development trends for FM for the future. These could also be claimed to be driving forces during the last decades, but there are now major steps in technology and process development that are expected to transform many FM activities.

What is shaping tomorrow's facilities management? The recent ISO 41011:2017 definition of facility management as an "organizational function which integrates people, place and process within the built environment with the purpose of improving the quality of life of people and the productivity of the core business" offers a starting point.

Any organizational function is changed over time by forces that are external to the organization as well as by internal forces. Integration is a key concept in the definition, and this immediately leads to a concern with the future development of technologies that support integration in organizations. Although the built environment is comparatively stable over time, it is being added to through new construction and slowly transformed by refurbishment of existing structures. People also change: management attitudes are subject to trends, increasing educational levels and arising cultural issues. This is probably tied to changing interpretations of quality of life. What is understood as the core business of an organization is influenced by technologies and markets and, thereby, also the links between the core and the facilities management.

Against the background of earlier publications on the future of FM and acknowledging digitalization and sustainability as shaping forces, the aim is to place contributions to the special issue in a perspective of current opportunities for FM research.

The University of Salford International Research Conference, held in conjunction with CIB in September 2017, was entitled Shaping Tomorrow's Built Environment. The highest number of papers presented there was under the auspices of the CIB Working Commission W70 Facilities Maintenance and Management. Contributions were not limited to only authors from W70, other authors were also invited to contribute to the present Special Issue of Facilities.

Earlier studies of the future of facilities management

Interest in the future of FM is as old as the concept itself. An early question in the history of the field was "What's Next for Facility Management?" (Facility Management Institute, 1986). Already in his proposed strategy for FM, Alexander (1994) identified four 'key facilities issues for the future': (i) increasing adaptability to changing business needs, (ii) providing a healthy workplace for creative people, (iii) assimilating the potential of new technologies, and (iv) ensuring full use of diminishing resources while minimizing environmental impact. Although the new ISO definition of FM includes productivity, which is not far from 'use of diminishing resources', it is noteworthy that environmental impact is highlighted as one of the four issues. This was published before web-based digitalization had made its impact, but here we find both 'new technologies' (today mostly thought of as digitalization) and 'environmental impact' (today more often treated as sustainability).

We concentrate here initially on writers and publications that have chosen to express an ambition to think about the future of FM as a whole and what drives change. A succession of authors explicitly addressing the future of FM have refined Alexander's four issues while adding other themes. In an article on linking practice and research, Nutt (1999) identified the need for a basis for "the next generation of property and facility performance criteria, management methods, operational procedures and decision techniques". He also pointed out the need for new approaches to investment and risk. Not least, he emphasized international FM knowledge exchange: "research results and data, practical theory, ideas and concepts, methods and techniques". A subsequent contribution outlined four competing futures for FM (Nutt, 2000), with four FM trails to the future: the financial resource trail (business), the human resource trail (people), the physical resource trail (property) and the knowledge resource trail (information). Here again, Nutt reasoned in terms of opportunities and risks.

Price (2001) raised the need for facilities and property providers to demonstrate the addition of value to their clients: “If it is not to be seen by clients as a commodity — and purchased/ budgeted as such — it has to demonstrate its operational and perhaps strategic impact.” Similarly, when discussing the future of FM, de Valence *et al.* (2003) expected the industry to “change the role it performs for clients and become a strategic rather than operational function” by following a long-term approach “focused on value-adding rather than cost saving”. Therefore, they recommended a focus on performance measurement and strategic relevance, while wishing to develop FM professionalism with a use of analytical tools for locational decisions, space use and work patterns.

Summarizing for the 2002 Salford EuroFM Symposium, after looking back at how the 2000 millennium had prompted several studies of the future of FM, Alexander *et al.* (2004) concentrated on workplace changes and the relation between FM and corporate real estate issues. As a case, the recently completed Telenor headquarters outside Oslo was presented at the Symposium, acknowledging how the facilities reflected ambitions to contribute to sustainable development.

An even more fundamental approach to predicting the future of FM is to start from trends in society. Two of Naisbitt’s (1982) original ten megatrends appear to remain of crucial importance for FM: the “transition from an industrial, blue-collar society to an information, clerical, white-collar society. Information is now mass-produced and globally disseminated instantly” and “business management will shift from short-term planning to long-term perspectives, motivated both by concern for the environment and by economic necessity”. Naisbitt thus recognized the sustainability megatrend, without using the term. Not many FM authors have based their views of the future on megatrends, although they were mentioned by Becker (1991) and when Lunn and Stephenson (2000) discussed the future of FM automation. Saurin *et al.* (2008) created scenarios for the future of workplaces, starting from a list of ‘critical challenges’ of a global nature. They identified “the power of information technology, market pressures, changing demographics and employee expectations”.

In their scenarios for the “future of the Global Facility Management Industry” two dimensions of uncertainties were identified by a major provider of facilities management services (ISS, 2011): the technology dimension (labour-saving technologies, knowledge-based advisory services, incremental innovations in knowledge services) and the sustainability dimension (green, health issues, social, economic). Four megatrends were explored: Factor Megatrends (Economic growth, Globalization); Demographic Megatrends (Aging and urbanization, Sustainability); Knowledge-based Megatrends (Technological development, The growth of a knowledge society); and Social Megatrends (Individualization, Commercialization). Trends and tendencies specific to the FM industry were seen as new ways of working as well as preparedness and populations at risk in densely populated urban areas.

An FM foresight project had been initiated in 2010 aiming at identifying the possible futures of the facilities management sector in the Nordic countries (Denmark, Finland, Norway, and Sweden) and, based on the findings, to establish a proposal for a common Nordic facilities management research agenda (Andersen *et al.*, 2014). Here, nine megatrends emerged, and four of these trends can be said to be new compared to earlier identified FM trends:

1. Mix of cultures – from homogenous to multicultural and multi-ethnic societies.
2. Area and urban development.
3. New materials.
4. Changes in the public sector – political initiatives on outsourcing.

How facility owners will relate to disruptive innovations associated with the Internet-of-Things and artificial intelligence is a strategic question raised by Atkin and Bildsten (2017). They also foresee a need to bring improvement to the operational performance of facilities “from a more disciplined approach to briefing, design and construction”. Not all recent views of the future concern technology; when ISS (2018) returns with a survey of the “future of service management”, it is claimed that the workplace is “becoming a place of shared experiences just as much as it is an environment where work

is performed”. As a consequence, it is said that the future facility manager will manage “user experiences and transformations”.

Shaping forces: digitalization, sustainability

Assuming the two main forces that have shaped facilities management since the 1970s are digitalization and concerns with sustainability, an overview of developments during five decades is presented in Table I. Here, three effects of digitalization are further distinguished between: information and communication technologies as support for work in workplaces, radically new ways of designing buildings and the spread of support for new methods of performance measurement.

Decade	Digitalization			Sustainability
	Work support	Building design	Performance measurement	
1970s	Microprocessors Word processing Internet <i>Office of the Future</i> <i>Paperless Office</i> <i>Telecommuting</i>	2D CAD		<i>Limits to Growth</i> Oil embargo
1980s	Personal computers Fax Email <i>Virtual reality</i>	<i>Intelligent Buildings</i> 3D CAD	Spreadsheet software	<i>Brundtland report</i> <i>Global warming</i>
1990s	Mobile/cellular WWW	<i>Artificial intelligence</i> BIM IFC file format 4D CAD	Balanced Scorecard Key Performance Indicators	BREEAM <i>Social sustainability</i> <i>Circular economy</i> <i>Carbon footprint</i>
2000s	<i>Internet of Things</i> Wireless LAN	<i>Smart buildings</i> <i>Virtual reality</i>	Condition based surveillance	LEED <i>Smart cities</i>
2010s	<i>Big Data</i> Drones	<i>Activity-based workplaces</i> <i>Smart hospitals</i>	Big data from real time condition surveillance <i>PropTech</i>	<i>Sharing economy</i>

Table I.

Emerging forces of digitalization and sustainability, shaping FM since 1970 (*concepts in italics*)

Digitalization

How facilities management has developed is tied closely to advances in information and communication technologies. Already when the Office of the Future and the Paperless Office were launched as concepts in the 1970s (van Meel, 2011), it was obvious how subsequent changes in office design and office support services would take place. The advent of ubiquitous computing based on wireless communications supported the idea and reality of activity-based workplaces. Today, the technology-driven changes in office work are comparatively small, although the full effects of modern ICT on (reduction of) office employment remain to be seen (Frey and Osborne, 2017).

Digitalization has had many consequences for the support of FM operations in practice. Already in the 1970s, there was digital space planning with stacking and blocking (Liggett, 2000), followed in the 1980s by FM systems and Building Management Systems (BMS). A decade later, there was CAFM – 2D and a wider use of data bases and electronic data archives in general for FM purposes. The early 2000s experienced a growth in the field of Building Automation Systems (BAS) (Kastner *et al.*, 2005), partly supported by Building Information Models (BIM). The growing application of building information modelling to new construction projects has led to many studies of the relation between Building Information Modelling (BIM) and FM (Becerik-Gerber *et al.*, 2011). More recently, in the current decade, we have seen beacons with sensors (Li and Becerik-Gerber, 2011) and a fuller understanding of the concept of Digital(ized) FM.

Performance measurement in organizations left its earlier focus on accounting and was developed further based on spreadsheet software; it did not take long before the potential for multidimensional performance indicators was packaged as the Balanced Scorecard, which gave rise to FM development of specialized KPIs (Bröchner, 2017). Given the importance of energy management in both cold and hot climates, considerable effort has gone into monitoring of energy use, ultimately improved by the emergence of wireless sensors, something that at the same time is directly relevant for sustainability efforts.

The use of digitalization for optimizing FM and in particular devising strategies for sustainable energy management is getting more sophisticated, applying artificial intelligence to big data, and is something that is increasingly referred to as PropTech in business media. The importance of facility user behaviour leads to new approaches where more data on employees are collected, but with barriers ultimately imposed on Big Data derived from people by concerns with personal integrity (The Economist, 2017). This concern is reflected by the new European General Data Protection Regulation (GDPR) which also implies new restrictions for those who carry out FM studies of e.g. satisfaction among office workers. There is a parallel with medical research here (Rumbold and Pierscionek, 2017).

Sustainability

Facilities managers have many responsibilities related to the sustainability of their organizations. A survey by Elmualim *et al.* (2010) identified three areas where a majority of respondents were active: energy management, waste management & recycling and health & safety. Published research on sustainable facilities management can be assigned to eight categories: building performance; sustainability tools and standards; user perception, satisfaction and productivity; sustainability management; construction and sustainable building materials; building design and sustainability; urban development; and benefit of green buildings (Nielsen *et al.*, 2016). The growing concern with sustainable facilities management implies that the ISO 41001:2017 Vocabulary definition of FM appears as limited and outdated because it concentrates exclusively on the organizational impact FM services have and also fails to acknowledge the environmental impact. The ISO 41001:2018 FM Management systems does mention ‘sustainability’ explicitly, but then only when deriving FM system requirements for an organization that “aims to be sustainable in a globally-competitive environment”.

Another outcome of the performance measurement evolution can also be said to be the development of (building) certification schemes such as BREEAM and LEED and their corresponding systems in various countries. This also means that BIM based FM can be a question of how certified sustainable buildings can support certified sustainable FM.

One established field of facilities management is workplace and workspace management where approaches to adaptability in facilities can meet shifting organizational demands without requiring physical changes to the building (Geraedts *et al.*, 2017). Circular economy is a concept where efficient management of assets has the potential of financial gains by reusing raw materials that are currently disposed of in the linear “take, make, dispose” system, as well as by extending the value generating life cycle of products (Circle Economy, 2014). Facilities managers are at a central position to uphold the values within circular economy as custodians of the built environment and influencing material choice, use and reuse in an organization. The development of circular economy in FM may require increased record keeping on assets and novel ways for making assets last longer.

Articles in this issue

In this special issue, the two main themes explored by contributors are digitalization and sustainable FM, and then concerning environmental sustainability. The types of facilities represented in this issue are hospitals, office buildings, public buildings in general and housing. The geographical origin of the contributors is global, including countries of four continents: Europe, Asia, US and Australia.

Digitalization themes are present in six of the articles collected in this issue. A broad overview of how FM functions can be integrated in BIM is provided by Dixit *et al.* (a), and Halmetoja describes a particular solution, implemented in practice and based on a conditions data model. Not all BIM implementation projects are equally successful, as analysed by Koch *et al.* in two cases of FM digitalization in hospitals. Another contribution to our understanding of BIM used for maintenance management in healthcare facilities is given by Wanigarathna *et al.* Visual approaches to FM digitalization is found in two articles included in this issue: a BIM integrated visual search and information management platform for COBie extension (Singh and Yalcinkaya) while Ge *et al.* display how the housing inspection-repair process can be supported by BIM combined with image classification. Comparing with the digitalization categories in Table II, it is easy to see that this special issue lacks articles on *feedback from FM to the design stage* (a theme investigated by many earlier researchers) and *analysis of Big Data* (a theme little explored yet other than in energy management). *Analysis of space use* relying on digital tools is largely absent here, although subject to investigation by many researchers today; digital aspects of *contract management* are less explored and also not present in this issue. *Security and privacy* remain as topics for the future.

Facilities management digitalization category	Special issue article	Topic(s) addressed
BIM integration into FM	Dixit <i>et al.</i> (a) Halmetoja Koch <i>et al.</i> Wanigarathna <i>et al.</i>	Impeding factors Public buildings Hospitals Hospital maintenance
FM feedback to BIM design		
BIM creation for existing facilities	Ge <i>et al.</i>	Housing repair process
Inspection of physical conditions	Ge <i>et al.</i>	Housing repair process
Visual interfaces for FM operations	Ge <i>et al.</i> Singh and Yalcinkaya	Housing repair process General issues
Resource planning	Wanigarathna <i>et al.</i>	Hospital maintenance
Generation of Big Data	Halmetoja	Public buildings
Analysis of Big Data		
Performance measurement / KPIs	Wanigarathna <i>et al.</i>	Hospital maintenance
Analysis of space use		
Contract management		
Security and privacy		

Table II.

Facilities management digitalization categories and articles in this special issue

In Table III we link articles dealing with sustainability in this special issue to the eight categories of sustainable facilities management defined by Nielsen *et al.* (2016). The article by Collins *et al.* connects to the three categories of *building performance, building design and sustainability and benefit of green buildings* in exploring how to close the gap between sustainable buildings and sustainable facilities management. Within these three categories, there is always a risk of suboptimal solutions if important issues related to environmental sustainability are restricted to an individual facility, just as in corporate real estate management which usually needs to take into account more than a single building. Both energy management and waste handling are obvious examples of activities that need a larger perspective than that of the isolated facility.

Table III.

Sustainable facilities management categories (Nielsen *et al.*, 2016) and articles in this special issue

Sustainable facilities management category	Special issue article	Topic(s) addressed
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Building performance	Collins <i>et al.</i>	Closing the energy performance gap
Sustainability tools and standards	Haugbølle and Raffnsøe Ploeger <i>et al.</i>	LCC Legal aspects of operational leasing for circular economy
User perception, satisfaction and productivity	Tezel and Giritli	Workplace behaviour
Sustainability management in the built environment	Rameezdeen <i>et al.</i> Støre-Valen and Buser	Facilities managers in green leases Implementing sustainable approaches into FM
Construction and sustainable building materials		
Building design and sustainability	Collins <i>et al.</i>	Linking SFM to design sustainable building to close the performance gap
Urban development		
Benefit of green buildings	Collins <i>et al.</i>	Green buildings

Tezel and Giritli examine workplace behaviour within the category of *user perception, satisfaction and productivity*. The category of *sustainability tools and standards* is represented by articles on LCC by Haugbølle and Raffnsøe and by Ploeger *et al.* in terms of legal aspects of FM operational leasing of fixtures and fittings. Still after almost half a century of studies, further work is needed for analysing how policies work, and how they can be designed, in order to promote energy efficiency in existing buildings through regulation and standards. As is well known, there is a substantial existing building stock, not least in Europe, with inefficient energy usage. While all of the above articles deal with *sustainable management* to various degrees, Støre-Valen and Buser emphasize the challenges and barriers FM practitioners face in implementation.

That there are many obstacles to the implementation of sustainable FM is clarified by Støre-Valen and Buser (2018) who rely on Scandinavian examples. How to bridge the gap between sustainable buildings and sustainable FM is explored by Collins *et al.* (2018) for six public buildings in Norway. A comparison of pro-environmental workplace behaviour in certified and uncertified office buildings in Turkey has been made by Tezel and Giritli (2018), whose survey shows how eco-centric value, belief and awareness are important. Green leases are studied in two contributions: Rameezdeen *et al.* (2018) have highlighted the role of facilities managers for environmental performance, while Ploeger *et al.* (2018) have penetrated the legal issues that complicate the implementation of the concepts of a circular economy. Haugbølle and Raffnsøe (2018) have rethought how to deal with life cycle cost drivers for sustainable office buildings in Denmark.

Much of what has been learned from the transformations of workplace design has now moved into studies of healthcare facilities, where there are many challenges: numerous stakeholders with non-market relationships and different competencies, not least what follows from developments in medical technologies. The shift to healthcare reflects a growth of resources coming to the sector. The reason why healthcare facilities have gained in importance is not just a reflection of ageing societies, the demographic factor. It is not least a consequence of economic growth where rising incomes translate into greater demand for healthcare services. There are three articles here in healthcare settings: Gola *et al.* (2018) analyse how to monitor chemical pollution in inpatient rooms, and Dixit *et al.* (2018b) have surveyed how facilities managers reason when they select floor finishes for healthcare facilities. More generally, Jensen and Prugsiganont (2018) have considered space management problems in Thai hospitals.

Future research opportunities

A first cluster of digitalization topics that offer opportunities for FM research concerns BIM in FM, where there remains a gap between model thinking and practical realities; practitioners in FM may still fail to see the difference between their own in-house specialized digital systems and BIM (Lindkvist, 2015). How can FM operations benefit from filtering and reusing data emanating from BIM based building design, and how are barriers overcome? Recently, there has been a number of 'BIM in FM'

studies concentrating on systems and classification approaches, as well as technical aspects and potential use, but with limited real testing. Going further, applications of augmented reality and virtual reality technologies may enhance FM operations. Model based information flows from design to operations to demolition should reduce current problems of inaccurate and incomplete data when information is handed over from construction projects for use in operations (Whyte *et al.*, 2016).

Here, multi-actor innovation is a promising theme for research and in particular when private and public actors collaborate, often in conjunction with public procurement. In 2013, in the UK, the Construction 2025 industrial strategy promoted BIM in public construction projects and mentioned the BIM potential for FM, but studies continue suggesting that practices must change in FM to adapt to BIM (Carbonari *et al.*, 2018). How information concerning the vast stock of older buildings not designed originally with BIM support can be collected and used in parallel with BIM designed new buildings (Volk *et al.*, 2014) remains as a rich field for research.

If digitalization transforms office work by automating more routines performed today by individual employees, earlier studies of perceived effects of FM and workplace design on individual productivity successively lose their relevance. New studies of FM effects on knowledge sharing within firms and in coworking spaces are beginning to appear, and more needs to be done here.

Turning to sustainability research, we find again that separation from design and construction hinders FM from meeting the challenges of sustainability which require information continuity throughout the building life-cycle (Whyte *et al.*, 2016). Moreover, defects inherited from construction will surface in operations, resulting in a performance gap between design expectations of energy performance and actual energy performance of the building (Forcada *et al.*, 2016; Fedoruk *et al.*, 2015). The bridge between sustainable buildings and sustainable FM could be strengthened through improved coordination of information managed through handover manuals, not only through full-fledged dependence on BIM. The UK Soft Landings process aims to ensure that decisions of the building project improve the operational performance of the building (BSRIA, 2018). The BREEAM In-Use international standard for commercial buildings enables owners to track the performance of their assets, supporting operational efficiency and sustainability (BREEAM, 2016). Both BSRIA and BREEAM In-Use take their starting point from construction or refurbishment projects, however, and a broader coverage of sustainability in facilities services would be useful.

The primary activities of any organization influence energy use levels, and tensions emerge when sustainable technical systems do not align with expectations of practitioners and building users (Pettersen *et al.*, 2017). Despite many decades of research into user effects on energy consumption in buildings, we lack dependable tools for prediction. Building Energy Management systems are obviously important for sustainability, although a naïve focus on reducing energy use may create inefficiency if impacts on user comfort and total cost of the workplace are underestimated. It is desirable to see more studies of how users in non-residential buildings may engage in and contribute to energy efficiencies (Bull and Janda, 2018).

The usability factor needs consideration when designing buildings so that specified users can use buildings to achieve their primary organizational activities and identified goals (Boge *et al.*, 2018). Buildings that are not developed for specified users may soon need adapting through alterations that generate waste. A topic for analysis is how to balance this principle against the view that tailor-made inflexible solutions may give rise to unexpected waste as users and uses change over time, thus creating a need for alterations in the longer time perspective. The need to recognize a range of user needs and capabilities is underlined by the shift to more research on FM in healthcare settings.

Studies of sustainable FM have been dominated by environmental sustainability. Social sustainability is a growing field of research, including social welfare and non-profit service organizations. There is a potential clash between environmental and social sustainability when producing Big Data for the analysis and control of energy use in buildings, as the collection of data on user behaviour raises issues concerning personal integrity and privacy. What is acceptable in the workplace is likely to depend on

local cultures if not on explicit legislation in various countries, and this is clearly a new field of FM research.

That this special issue does not report any research concerning urban development, but this does not reduce its importance for sustainable FM. After 2000, the ideas of Digital Cities and Sustainable Cities have merged into Smart Cities (Moir *et al.*, 2014). The idea of Smart Cities combines big data and governance. Cities have gained prominence in national objectives to reduce climate change and meet targets based on the 2015 Paris Agreement, and this raises the question of what role FM as well as FM research should play within the urban perspective. While the FM discipline is established at the organizational level, it is far from obvious how skills of maintaining and delivering services to individual organizations are transferable to the city scale. The relation between the concepts of Smart (or Intelligent) Buildings and Smart Cities is complicated (Ghaffarianhoseini *et al.*, 2018), indicating the challenges raised by upscaling to the city perspective. This transition is no easy feat, as acknowledged in the urban sustainability literature (Dixon *et al.*, 2014; Turcu, 2013). However, FM does have a tradition of linking strategic goals of an organization to its needs for operational maintenance and services, and early papers by Roberts (2004) and Alexander and Brown (2006) refer to the concept of Urban FM. Grass roots initiatives exist within the Smart Cities movement (Angelidou, 2015), and ideas related to community vitality (Dale *et al.*, 2010) may tie in to current trends for developing and expanding the FM field to contribute to more sustainable urban management.

Even if digitalization and sustainability are accepted as two main shaping forces for FM in itself, new research opportunities emerge against a range of related or different background factors. Several topics concern relations between organizations. While there has been a number of earlier studies of FM innovation, the sales and delivery stages can hardly be said to have been prominent. With relation to risk analysis, there are questions concerning FM service demand management, with an extension into studies of FM service supply chain coordination, taking into account both demand and supply. A related effect on FM is in the context of outsourcing: IT developments have lowered transaction costs because of greater ease of writing contracts and monitoring outcomes. This has lowered the barriers to outsourcing of FM services, but despite many years of research on this topic, there are no hard and fast rules concerning what FM services should be kept in-house and what should be contracted out (Haugen and Klungseth, 2017). Turning to other themes that evoke the external relations of FM providers, there is clearly a fruitful opportunity for analysing jointly the capabilities of both clients and providers, emphasizing the co-production nature of services. How FM clients are supported by advice from FM consultants is also well worth investigating. Although the wider issue of how relational and contractual governance interact in FM contexts has not been left unexplored by FM researchers, it seems that there remain issues that should be approached, inspired by studies of relationships for other business services. One such issue is how pricing models are—and should be—designed for FM services.

On the other hand, there are research themes concerning operational issues inside the organization that coordinates and produces FM services. It is striking how few studies have been devoted to FM employee satisfaction and its links to performance and building user satisfaction. Issues of operational risk in the delivery of FM services, as well as the corresponding hedging mechanisms, need more attention. Which are the proper risk treatment strategies under the headings of prevention, monitoring and mitigation if risks happen to materialize? The diverse nature of FM risks in different regions is a strong argument for global comparisons; an increasing number of single-country studies could now be followed by more efforts to compare across national boundaries and systematically assess the importance of various levels of economic development, education, climate and disaster risks in a range of countries.

Research/Education/Practice

Who is shaping tomorrow's facilities management? There are those who manage and perform facilities services as employed by an organization, there are external providers of facilities management and particular services, there are both international and national associations within the field, and finally

there is the community of FM researchers (Junghans and Olsson, 2014). Shaping tomorrow's FM has been on the agenda for education, research and practice development from the early 1980s. In an academic perspective, it must be regarded as an applied field of knowledge with a strong focus on the professional development of FM. The introduction and development of models, systems and methods for understanding FM, both as an overall concept and for management of the many different activities within FM, have been the outcome of a combination of theoretical work and practice (Jensen, 2018). The ISO definition of FM as an "organizational function which integrates people, place and process" implies the need for a close cooperation between theory and practice-based knowledge development. There is also a close link to improving FM education on various levels, and altogether this reflects the need for continued development of FM based on the knowledge triangle (Soriano and Mulateiro, 2010). The evolution of FM over the years has been based on a close cooperation in many countries between education, research and practice as reflected by the profile of EuroFM, IFMA and other FM networks, national and international.

Looking forward, in shaping tomorrow's FM we should continue to develop stronger theoretical frameworks for sustainable FM, creating a deeper understanding of the knowledge area based on a multidisciplinary approach. The FM knowledge field is based on theories, understanding and academic traditions from on the one hand behavioural and social sciences, not least economics, as well as the humanities, all reflecting the softer parts of FM and on the other hand, architecture, engineering and technology in general for hard FM related to buildings and the wider built environment.

The FM conferences arranged by IFMA and EuroFM in the early 1990s established a platform for close collaboration between practice and academia. In the knowledge triangle of FM research, practice and education, students, educators and researchers cooperate with professionals and work with real problems and cases from practice. The learning process is based on this interaction, giving the possibilities for developing and testing new models and solutions for tomorrow's FM activities. This creates new business opportunities and allows developing skills and gaining insights in new theories, models and applied solutions. In developing FM as a professional discipline and as an academic field, we need research and development at master and doctoral levels. Research linked to real problems and challenges for FM, as well as projects based on collaboration with the FM industry (Roper, 2017) will remain important tomorrow. Practice and the professionals, as the third leg in the knowledge triangle, will also have a broader perspective for innovation and societal development and value. Today, the knowledge triangle described here is mainly visible in highly developed countries where you can establish a joint development of FM in research, practice and education. But we believe that the triangular approach is important to adapt and spread to other countries and regions.

Conclusions

The two main shaping forces today are clearly digitalization and sustainability. They go hand in hand. They point to the need for going beyond the individual facility. That is why the recent ISO definition of FM can be criticized for being inward looking, not taking into account the need for a broader perspective and solutions for environmental sustainability in the long perspective from cradle to grave. Environmental sustainability cannot be a separate issue, as social and economic sustainability will be basis for joint solutions for the future focusing on people, place and processes.

FM for tomorrow will be based on a new wave of digitalization with intelligent data solutions for planning, design, monitoring, control and management in general. Low cost sensor technology gives us the possibility to develop a wider use of real time condition monitoring and automated solutions for buildings and infrastructure, and access to data for key performance FM indicators for services and their coordination. Use of big data solutions and robotics offers FM future possibilities for improving efficiency, increased flexibility and better quality of FM services. At the same time, it will also challenge the FM of tomorrow in focusing on—and reaching—the overall goals for an organization, as well as to require more understanding and a clearer focus on the needs of users, clients and society at large.

Digitalization in both FM and the architecture, engineering and construction industries will also drive new models and processes as data become more accessible and the FM use of building information models proceeds. This will give new possibilities for asset data and documentation for operations and maintenance by use of shared intelligent models sitting on structured data. How far FM will be influenced by practical applications of augmented reality and virtual reality technologies remains as an intriguing question.

Technology innovation and sustainability will also continue as the driving forces for the development of tomorrow's work patterns, workspaces and workplaces. This will add to the situation we face already today when employees can work in the office with different workspace settings, or from home or from cafés, during travel or in any space with access to digital networks.

Digitalization and sustainability are obviously not mutually exclusive forces that shape tomorrow's FM. Both of these background forces emphasize the position of facilities management as an integral part of a long-term perspective, underlining the connection that FM has with the other stages of the building life cycle.

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