Missed opportunities.

Two case studies of digitalization of FM in hospitals

Structured Abstract

Purpose: Digital practices of facility management (FM) are undergoing transformation. Several Nordic countries have ambitious hospital building projects, driven by large public clients with long-term experience of operating complex building campuses. There is thus an opportunity for creating state-of-the-art digital FM. This paper investigates the role of digital FM in new hospital projects in Scandinavia.

Design/methodology/approach: Based on a literature review, a framework of understanding of digital FM in hospital operation is established. Two longitudinal cases are presented and analysed, one for a greenfield hospital and the other for an extension of an existing hospital.

Findings: The literature highlights the importance of integration between technical digitalization, competences, organisation and management of digital FM. The projects are in different phases and represent quite advanced preparations for digital FM. State-of-the-art computer-aided FM systems are prepared before operation. External consultants are involved, posing a dilemma of in-house/outsourced human resources in the future digital FM operation.

Research limitations/implications: Two case studies provide insights, but they have limited generalizability.

Practical implications: The study underscores the importance of preparation of management, organisation and competences for digitalization.

Originality/value: Documented research on BIM integrations in FM is still scarce. This article adds to the few empirically based studies in the area. The findings illustrate that real estate administrators investing in FM software for new hospital buildings face challenges of aligning BIM models from design and construction to the FM system.

Keywords: Digitalisation, facilities management, hospitals, FM-software, BIM, Scandinavia

Introduction

A new wave of optimism for information and communication technology (ICT) is targeting contemporary organisations and facilities management organisations under the banner of digitization (Atkin & Bildsten, 2017). Yet throughout almost four decades of ICT implementation and use in organisations, unsuccessful, complicated or even scandalous cases have been reported (Flyvbjerg and Budzier, 2011; Hastie and Wojewoda, 2015; Landauer, 1996; Sauer and Willcocks, 2007).. Often ICT implementation has turned into protracted processes of internal excessive consumption of resources, be they financial, or often worse, hours of employees' time spent learning and modifying systems and practices (Hastie and

Wojewoda 2015). From this perspective, a sceptical question mark is well placed as to whether digitalization is a panacea for facilities management organisations (Cordon and Echeveste 2018). An organisation makes an apparently simple purchase of software and ends up spending most on everything else: organisational endorsement, internal processes, responsibility issues, consultancy hours, training, etc. (Flyvbjerg and Budzier, 2011) An implementation of new digital solutions should therefore be done carefully and with proper resources.

Real estate organisations investing in digitalisation, contemporary computer-aided FM (CAFM) software and ICT technologies are no exceptions (Cordon and Echeveste 2018, Jones 2015, May, 2013; Volk et al., 2014, Williams and May 2017). CAFM implementation in existing buildings is limited, according to Volk et al. (2014), who review 184 publications. The barriers for implementation include issues of converting captured as-built building data, updating information and handling of uncertain data, objects and relationships of existing buildings. This is, moreover, probably just a small portion of the issues encountered. Following and extending Volk et al.'s (2014) findings, most BIM integrations in FM have been done in newly built projects. New buildings are therefore opportunities for the clients and their operations and maintenance organisation (O&M) to advance digitalization of FM, especially larger clients operating portfolios of buildings.

Health care is an important part of the Scandinavian welfare state (Rechel et al., 2009). The Scandinavian countries invest the most in health-care infrastructure in Europe (Rechel et al., 2009). Hospital administrators have extensive facilities management competences and experiences. We are witnessing an unprecedented wave of investment in renewal and extension of this infrastructure. Norway invested an estimated 10 billion Euros in new hospitals from 2000 to 2011 (Hågøy, 2013), and Denmark has announced future investment of 5,5 billion Euros (Danske regioner, 2011). Sweden also invests in large projects in its major cities and in general (OECD, 2013). Under these circumstances, one can expect a trailblazing use of digital FM, including the use of building information modelling (BIM), i. e. “ a shared digital representation of physical and functional characteristics of any built object” (Volk et al 2014).

The aim of this research is to investigate the enabling and constraining elements of digital FM in new hospital projects in Scandinavia. Through two cases studies, the digitalization investment, the classification used and the competence developed in the FM organisation are investigated.

A literature review of digitalization of FM is carried out to form a framework of understanding of digital FM in hospital operation and maintenance (O&M). This highlights the importance of integration between technical digitalization, competences, organisation and management of digital FM.

Digitization is the use of information and communication technologies such as BIM, other type of software supporting operation processes, big data technologies, the Internet of Things (IoT), augmented reality, digital twins, block chains (a distributed ledger for value exchange) and building information standards for interoperability (Gartner, 2016).

Two longitudinal cases of hospital design are analysed with a focus on their preparation of the facilities management. One is a greenfield hospital, the other a 22.000 square extension of an existing hospital. While the projects are in different phases, they both represent quite advanced preparations for digital FM.

The term "Computer Aided Facility Management system" (CAFM) denotes digitalization applications in facilities management in a broad sense (May 2013). CAFM has experienced a long historical development, with a number of steps that make present-day CAFM different from earlier systems (May 2013).

The original contribution of the research is to provide in-depth qualitative insights into how digitalization of FM in two hospital projects occur. The opportunities and barriers found add to existing knowledge of current gradual digitalization in FM and contribute to a commencing research strand on digitalization of FM

The paper is organised as follows. It commences with a selective review of literature and material on digitalization in FM. Second, a methods section describes how the paper will pursue its aims. This is followed by a description of the two cases. Next, we discuss each case , identify some common features andrecommendations are made. The paper sums its argument up in the conclusion.

Literature Review

First, digitalization opportunities are identified and then how the literature deals with contributions to digitalization in facilities management is discussed. This together constitute our framework of understanding of digitalization of FM.

Digital transformation opportunities

Below is presented a set of digital transformation opportunities, commencing with big data, internet of things, digital twins, blockchain, augmented reality and ending with standardisation. These technologies and trends are presented in a parallel fashion. Several sources provide elements of understanding of contemporary and future opportunities of digital transformation of the real estate business (Atkin & Bildsten 2017, Barbosa et al 2017, Bilal et al 2016, Cordon and Echeveste 2018, Gartner 2016, Galer 2017, Yalcinkaya and Singh 2015, Volk et al 2015). Bilal et al. (2016) review some 170 literature references of big data opportunities in the construction industry. They point to big data analytics (including retrieval of knowledge from maintenance databases) and big data engineering applications as important. Within FM, existing systems are found having inefficient and time-consuming search interfaces, non-uniform interfaces for the FM system to exchange information and inability to store and process the large volumes of data generated by these systems. The efficiency of many labour-intensive activities could be improved by big data technologies, such as localisation information technology (including location of FM personnel, Bilal et al 2016) and advanced automation and integration to measure, monitor, control and optimise building operations and maintenance. According to Contemporary digitalised facilities "provide adaptive, real-time control over an ever-expanding array of building activities in response to a wide range of internal and external data streams. As investment ramps up and more intelligent systems are brought online, more data will enter the energy management platform at faster speeds" (Bilal et al. 2016, p. 514). However, based on empirical research, Whyte et al. (2017) point to limits of flexibility and the importance of change management when trying to use big data approaches in management of large facilities.

The Internet of Things (IoT) is enabled by a more attractive price/performance ratio, miniaturisation and improved "intelligence" of the sensor devices, and broadband connectivity that is getting cheaper and ubiquitous (Atkin & Bildsten, 2017, Bilal et al., 2016). This implies that an IoT-based framework for building energy monitoring and smart buildings is possible. Data of sensors related to motion, CO2, temperature, airflow, lighting and other acoustics properties are gathered and analysed (Bilal et al., 2016) The applications of IoT are, however, non-trivial and often deploy hundreds or even thousands of sensor devices for data collection. Also, not only generating large volumes of data, but also storing and analysing these data, will be a challenge for FM organisations (Atkin & Bildsten, 2017, Bilal et al., 2016).

Digital twins are a vision that every other psychical thing should have a twin, a dynamic software model of the thing (Gartner, 2016). The software developer and vendor SAP is currently developing a digital twin system for real estate (Galer, 2017). The digital twin should contain unified digital representations of every asset of a physical building collected via sensors across its life cycle (Galer, 2017). Stakeholders involved in a building (such as repair persons) would then receive a digital key to enter the twin and extract the information they need.

Blockchain, according to Galer (2017), provides a neutral collaboration and information-sharing platform that each participant in a real estate management organisation can use to support processes, including ("smart") contracts, regulatory compliance and transactions (Cordon and Echeveste 2018, Risius and Spohrer 2017). Blockchain for real estate is a current development area for SAP for their FM customers (Galer 2017).

Augmented reality is currently being debated among FM-professionals (Atkin & Bildsten, 2017). Gheisari and Irizarry (2016) study mobile augmented reality integrated with BIM. They observe that facility managers are physically mobile in the spaces they manage. However, their survey shows a bit more mixed pattern because the investigated facility managers spend more than half of their working time sitting, 21% of it standing and 21% of it walking around the facility. A portable mobile device integrated with a BIM model could, according to Gheisari and Irizarry (2016), provide on-time and on-place information and geometry of objects in the facility. The data and 3D geometry information extracted from BIM can then be augmented on the facility manager's live view as a "transparent window" (Gheisari and Irizarry, 2016, p. 72).

Information standards are important tools for improving interoperability in a digitalized infrastructure of systems, interfaces and communication technologies (Bilal et al., 2016, Cordon and Echeveste 2018, author reference). Building information standards are currently developed both globally (Building Smart, EU, ISO) and nationally (author reference). Some, but not all, building information standards are prepared to support facilities management and thus are important tools of digitalisation when including transfer of new built information to an O&M organisation, whereas others reconstruct a gap between design, building, and operation.

Finally, digitalisation of facilities management will require integration between technical digitalization, competences, organisation and management of digital FM. As Volk et al. (2014) posits, this is also the comprehension in the BIM in FM literature. Studies of these aspects have proposed the notion of hybrid practices to underscore this important integration (Whyte, 2011).

Facilities management and digital transformation

Although Atkin and Brooks' (2014) is a guidance publication, it contains interesting views of IT in facilities management through a lens of "information management". Atkin and Brooks (2014) point to use in FM of singular systems CAFM, CMMS, ERP, scheduling and design-build BIM, but they do not mention digital transformation, information infrastructure issues or opportunities of "big data" analytics and engineering (Bilal et al., 2016). There is even a tendency of favouring existing proprietary systems (Atkin and Brooks, 2014, p. 328) and problematising the FM benefits of investing in BIM technology (ibid., 302). However, more indirectly, issues of information infrastructure such as interoperability and transfer of data are dealt with through standards and model view definitions for FM. Atkin and Brooks (2014) view such issues as related to the construction of new buildings and point out that facilities management should try to assure that the relevant data and information for FM are produced during design and construction of new buildings.

Similar recommendations for implementation of ICT in facilities management have been made (Levitt, 2013; Madritsch and May, 2009; May, 2013; Teicholz, 2013). Despite these contributions' recent publication, their focus is on CAFM systems implementation and/or use of BIM, but they contribute in a limited manner to contemporary digitalization of FM.

Volk et al. (2014) review 180 journal articles on BIM use in building management. They find that in 2014, BIM is still in limited use in maintenance and facility management. BIM is found mostly in recently constructed buildings. There is growing attention to the need for collaboration, but legal and interoperability issues still need to be tackled. Volk et al. (2014) do not discuss any particular software or technology. They identify a BIM in FM that appreciates the collaboration, organisation and managerial aspects of IT in FM. This will here be understood as important elements of emergent digital practices in FM. For example, one aspect is the transformation of BIM models containing as-built information into reduced and accommodated information models systems (sometimes denoted as asset information models (AIM)).

Summarizing the review and thereby our framework of understanding, a range of technologies are emerging that appear to enable digitalization of FM, including BIM, other type of software supporting operation processes, big data technologies, Internet of Things (IoT), augmented reality, digital twins, block chains and building information standards. However, to commence realizing digitalisations, a process of creating hybrid practices of combined digital technologies, competences, organisation and management has to be developed.

Method

To match the aim of the research an overall interpretive qualitative approach is adopted. A document and literature study is followed by two qualitative case studies of newly built hospitals in Scandinavia have been carried out.

The literature and document study rely on several searches in a library database encompassing the main search engines covering digitalisation, CAFM, IT in FM and hospital

IT. The academic literature has been supplemented with recent consultancy reports and handbooks to assure contemporality, which is important when studying contemporary digitalization.

The first case is a university hospital, where a new building on an existing campus is made. The study includes 18 interviews: two rounds of interviews with the facility manager and one group interview with employees in the facilities management department of the hospital; an interview with other players; the contractor's project manager and design manager, the client's project managers, architects (2) and consulting engineers (3). These interviews focused on the building project, but also involved topics related to future facilities management. The FM system used in this case is a system also from Scandinavia with most customers in the case country. We therefore label it with a pseudonym "STAR FM". Similarly, the building information standards are nationally specific and to some extent even local and specific for the hospital studied, and therefore are renamed "ClassSYS 1, 2, 3". ClassSYS one is relatively old system for coding building components in classes and subclasses. ClassSYS 2 and 3 are variants of ClassSys 1, which are more detailed (deeper trees and longer codes). ClassSYS are loosely integrated in a larger system of standards.

The second case is a greenfield regional hospital project that also hosts research functions and therefore resembles a university hospital. It has not been possible to interview facility managers because the hospital is new. Most of the empirical material therefore focuses on the ongoing design and building project. Here, 34 interviews have been carried out: design managers, the client's project managers, architects (2) and consulting engineers (3). These interviews focused on the building project, but also involved the future facilities management.

The CAFM-software system used in this case is also a system also from the Nordic countries, labelled "BorealFM" here. The building information standards are nationally specific and therefore are renamed "ClassSYS 4". ClassSYS 4 is a new developed classification system consisting of 18 different substandards, including room classification, building component and building system classification, identification, metrics, process standard and more.

The research is carried out within the frame of a Nordic project with Nordic partners (author reference).

It is a condition of possibility to create qualitative insight in two cases, rather than generalizable results. We hope to contribute to an emerging research strand on digitalization of FM by producing qualitative cases, yet this involves limited generalizability.

Case A: Transformation and extension of a university hospital

Case A is a 22.000 m² transformation and extension of an existing university hospital in Scandinavia.. 13.000 m² will house polyclinics, test laboratories, day surgical department including operating rooms and day care centres, an intensive care department, a rehabilitation department and clinical-medical laboratories. Eight thousand square metres will be demolished and reconstructed. In addition, the existing emergency reception will be improved. In connection with the construction, several renovations will be carried out in the adjacent parts of the building to ensure effective functional relationships between the new building and the existing hospital. Total budgeted costs are 170 million Euros.

The client focused on the content of the hospital and did not express a particularly strong focus on digitalisation during design and construction, nor was a classification of the data delivered in the design and construction documentation.

The process started in 2009, developing an early brief without elaboration of IT issues such as classification. The brief was followed by a long pause. The outline proposal was done in 2012, followed up with the functional specifications in 2014–2015 parallel to the design phase. The tendering was done in spring 2015. However, the project changed contract form when moving from the main project to the tender. It was then changed from a design tender build to a design-build contract, which meant restarting some of the design work. The main project was then developed further until 2016. The project will be finalized in 2018.

Classification and objects

The early conceptual phase commenced using dRofus, a commercial standard room programming tool used by the national and many regional health authorities. The module for room classification and unique numbering of rooms and the function program were used. dRofus also offers a module on facilities management handover and a technical information database (TIDA) in which contractors can upload all FM documentation related to their systems and components to provide accurate and consistent FM numbering of all objects using ClassSYS 1. However, ClassSYS 1 does not cover all the components because it only goes down to a certain level of detail. The outline project was done by the architects who decided to build up a classified BIM model on their own initiative. This was not a requirement from the client, which at the start was uninterested in digitalization issues. The design of the project was done with different software programs like Archicad, Revit and Autocad, put together in a portfolio of building information models managed by a BIM coordinator from the architecture company. ClassSYS 1 for the building components and technical installations in construction was used to a certain degree, but the potential of the classification and the BIM model was not fully utilized. The architect's BIM coordinator did a lot regarding classification for the architectural design of building elements and components. The engineering consultants did not do this to the same degree, and their object came to be classified by the standard of their BIM systems (such as Revit). For the engineers, use of classification is a change of practice from marking building components on drawings. This change is hard, and they do not see the opportunities or consequences. After the change to a design-build contract, the focus was on the construction, and the main builder did not want to use extra resources on an advanced BIM model. There was a modification and simplification of the classification for work drawings and components standards to enable craftsmen's work on site. The BIM model was developed just to meet their basic needs without any further attention to the operation and maintenance of the building in use.

As mentioned, the ClassSYS 1 does not cover all the components and is not sufficient for the O&M department, which has its own version based on another national standard ClassSYS 2, a hospital classification system used to classify rooms. However, the O&M representative posits that there should be a common national standard instead of each hospital having its own system. The idea is that ClassSYS 1 should be a common national system that enables hospital organisations to compare apples to apples.

Digitalization: The CAFM system

Until recently, facility management in the hospital was based on 2D and Autodesk software, but data are now entered in StarFM to handle the relevant information. The facilities management system's database, StarFM, is built up in an intersection between two national classifications, ClassSYS 1 for classifying building components and ClassSYS 2 for classifying rooms. These two classification systems are not precise enough to meet local needs, so a third system, ClassSYS 3, is in operation locally. dRofus is not used here.

The main gain of using StarFM is that all the needed information is located in one system. The O&M organisation and especially the FM manager can import data directly into StarFM. However, they have to do it manually to transfer data from the project into their system and then into the national system using Excel. They have a classification already in StarFM, but they have to rename it according to their own system. They have used external consultants to do this, but the project group thinks that the system is a bit cumbersome. They hope to avoid entering all the information manually in the new system. The hospital has a standard for it, but there is a need to find out what level of information and detail is required or appropriate. The version purchased at the hospital is based on PC and cannot be carried around where it is needed. StarFM is not flexible at all and not the most user-friendly. However, it works.

The FM organisation and its competences

As mentioned, the client was at the start uninterested in digitalization issues and had no requirements for the consultants and the contractor regarding use of classification, standards and BIM model beyond ordinary practice. The focus of the consultants and the main contractor is on buildability.

The FM organisation is represented in the project, equipped with a budget for changes in the design to prepare FM. They have good collaboration and communication directly with the head of the hospital. The real estate executive manager is directly under the CEO of the hospital. However, it does not seem that the FM department at the hospital has any strategy to tackle all the data and material that are produced in the project.

The O&M organisation posits that they have not learned about any good examples of use of BIM regarding documentation for operation and facilities management. All the design information on technical rooms, installations, room numbering is based on 2D Autocad software. They have not implemented drawings in BIM yet, but the feeling is that the organisation does not lose that much by not having BIM. The information from one system is supposed to be integrated into the FM system. Different software will communicate, and different clients and the organisation do not necessarily have the same systems. They spend a lot of time collecting information on management and operation. They use Excel to collect data, process the data and put them into TIDA. This is not done in a seamless manner.

StarFM is being prepared before operation. External consultants are involved in this, posing a dilemma of in-house/outsourced human resources in the future digital FM operation. The FM organisation members consider themselves lucky because they are being heard. However, at a time, the FM organisation is clearly in an inferior side-wagon position in need of more influence, continuously placed in a role of accepting others' decisions. The project has given the FM organisation some experience. They want to make a systematic plan in which their experiences on operation and management are described and a plan for training and handover. It is important that their knowledge and experiences are taken into consideration, but it is also certain that this will lead to solutions that are more conservative.

Case B: A greenfield regional hospital in Denmark

Case B is part of a 140.000 m² design of a new regional university hospital in Denmark at 29200 m^2. The total budget is a half billion Euros, and the overall design and construction project was divided into several associated subprojects. This case mainly covers subproject two, which includes design of two buildings: a multi-story rectangular building that will accommodate the somatic departments, including cancer, neurology, day surgery and a two-story building for a service centre, including kitchen and laundry, that will support the entire hospital. The construction of the buildings is on-going until 2020.

At the beginning of the project, the owner made a strategic decision that each subproject would be assigned to different design teams. This decision means that no architect or engineering company was involved in more than one subproject, and therefore the owner had the responsibility to ensure that digital information created in each subproject was coherent and could be integrated with the other subprojects. This was aimed at enabling a well equipped digital FM system, so the future O&M department would have the best foundation for productive and cost-effective operation and maintenance of the hospital.

To obtain this, all digital design and construction information created by the different design teams was required to be uniformly defined and structured through using the same classification system ClassSys 4.
The process commenced in 2014, when a consortium of architectural and engineering firms won the contract. Initial training was carried out in the use of classification, which, however, was not used initially for room programming. The design processes involved complications due to a major estimate overrun, which delayed the process. It was in parallel to this that the client and his FM team commenced improving the database of codified objects. The classification of building components came into use once the main project design of subproject 2 was done. The construction of subproject 1 commenced in 2016, and the two projects are due to be finalised in 2020.

Classification System and Objects

It was decided that the entire hospital project should use a common classification system that could support classification of all types of design and construction objects. A new Danish developed classification system, ClassSYS 4, has been chosen because the developer of the classification system claimed it supports homogeneous object classification during all phases of a building project, from design brief to operation and maintenance. This means that classified objects created in the design brief keep the same classification code in the operation and maintenance phase, even though the object was changing type and properties during the design and construction phases.

The design team in the first subproject had to build a generic object library representing physical building components. The objects in the library were structured in accordance with ClassSYS 4, and the objects contain property information as well as a specification of what information the contractor should supply about the objects when he delivers a constructed building. The object library was central for the type of information the owner could expect to be delivered to the hospital's FM-system.

In the second subproject, the new design team also created its own generic Revit object library structured in accordance with ClassSYS 4. It was built similarly to the object library of the team from the first subproject.

But during the design phase, when the FM-team (see below) tested the structure and content of the object data, it was quite clear that the types of objects and the information level of the objects were total different in the two subprojects, even though most objects represent the same physical type of building components. The cause for the difference was mainly that the teams had different interpretations of the ClassSYS 4 and different ideas about what information was needed to design, tender and construct the two subprojects.

As a result of the test, the owner invested in the creation of one common object library, based on the first subproject object library. All the subprojects' design and construction teams afterwards are to use this owner-specific object library to ensure the same object definitions and information level were correctly structured and delivered.

Digitalization: CAFM system

The hospital client purchased a CAFM system from a Nordic software vendor, called BorealFM here. The system is a state-of-the-art CAFM system. Emphasis was put on the system's ability to import building information models with data classified according to ClassSYS 4. BorealFM could at the time handle BIM with objects classified in the industry foundation class format (IFC). The CAFM vendor therefore extended the import functionality of the software to also encompass ClassSYS 4-formatted BIM objects and models.

This case demonstrates that use of a one common object library was necessary if digital information from the design and construction phase would be the foundation for the future digital operation and maintenance of the hospital.

To ensure that the owner's CAFM system did not contain different object definitions of the same type of physical building component, the owner had to take action and invest in a common project object library for the whole hospital project.

The benefit of a common project object library is that the FM-team was able to import consistent information into their FM-system, even though the information was created by different design teams in different subprojects.

Another major benefit was the re-use of object definitions. In later subprojects, the new design teams will have to use the owner's predefined object library. The design teams will be able to start their design process faster because the owner simply will have eliminated their initial work of defining and structuring objects at the beginning of their design process. In fact, this resulted in an appreciable acceleration of the design process in the last part of the design of subproject 2.

The FM organisation and its competences

Because the hospital is a greenfield establishment, there was initially not any FM organisation or personnel. However, this was established around the time when subproject 2 was designed. The initial relatively small organisation, a FM team, faced a huge task in preparing subproject 1 and part of subproject 2 as they were approaching the final construction phase.

The structuring and ordering of a classified building object library tailored for this hospital building were therefore handed over to a software vendor that possessed classification skills. This consultant went through the entire object database and ordered the classification.

The FM team is to be gradually expanded as the successive subprojects of the hospital are finalized and made ready for operation.

Discussion

Below, the two cases are first discussed separately and then compared.

Case A, the university hospital, is extending a recent FM system investment for the new building, which makes the new system better integrated and supported by hybrid practices. The client organisation in the building project is, however, relatively passive about the digitalization issue, and it is the BIM coordinator from the architecture company who is the driver behind digitalization initiatives such as proactive use of building information standards and BIM.

In the university hospital case, several national systems for standardization and classification are partly used. However, the systems used in the design phase have mainly focused on buildability. The university hospital has recently invested in a PC-based FM system that is not directly integrated or communicating with the other systems. This is in line with Bilal et al. (2016), who state that existing systems lack unified interfaces for FM systems to exchange information.

In the university hospital, FM managers and operatives were understood to be mobile (as in Gheisari and Irizarry, 2016), but the organisation consisted of both more office-based members and mobile members. It should also be noted that the FM organisation was represented in the design and construction phase and exercised influence in preparing the building for future use.

Case B, the regional hospital, has made a new investment in the FM system, but is still predominantly in a waiting position in building hybrid practices in the O&M organisation. Therefore, there has been a predominantly technical focus. Through the building project, the database and its classified objects and information structure have been prepared for future operation, but few of the future O&M have been involved, and those who have been are mainly in a receiver role. In this case, the project manager of the client's building organisation is the main driver.

When comparing the two case findings with the review of digital transformation, it becomes clear that even with very recent investment in ICT, the two hospital cases are quite far from the leading edge of digital transformation. There is even evidence in one case that hospital management constrains this development.

Several of the digitalization opportunities, such as IoT and smart buildings, were actually mentioned in a recent national proposal for digitalization in the country of the university hospital. This involves commencing creating smart buildings at hospitals and equipping the buildings with monitoring sensors. In the country of the regional hospital, however, such common strategy is at present absent. In such absence, one can turn to developing a local strategy and using external partners. From this perspective, it can be speculated that the client’s choice of relatively small Scandinavian/Nordic FM-system suppliers might miss a possible strategic partnership of digitalization between the client and large international FM suppliers.

In addition, it becomes clear that converting BIM to integrate with asset information management (AIM) is a challenge. In both cases, it appears the O&M organisation is going to take over all as-built information without restructuring it to support FM.

The ICT implementation issue described in the introduction has occurred in both cases. Subsequent to investment in the FM system, both hospital organisations needed to use external consultants to help structure and build up the data for the systems. In the university hospital case, on the job learning and training haves been arranged for the O&M personnel. So far, the regional hospital competence development in the building project organisation as a future O&M organisation has still not been established. The Trojan horse phenomenon is likely to continue. Also, in the future, we will witness ICT investments that are accompanied with hundreds of hours of internal hours invested to make the systems work and accommodate routines, not to mention outright failures of adoption (Hastie and Wojewoda 2015). One might therefore adopt the lukewarm approach suggested by Atkin and Brooks (2014), which is to wait for more solid practical business cases of FM software. In contrast, we suggest that the burning issue of FM organisations today is to consider digital transformation of FM. This is a "too early/too late" dilemma in which embarking too early leads to having to handle "children's diseases"/ whereas beginning too late means missing important opportunities of ICT use. Our two cases do seem to be too late compared to opportunities of digital transformation, but they are still on a par with the contemporary Scandinavian FM community. This nicely illustrates the dependence on access to knowledge and experiences, which tends to be limited to national communities.

Recommendations

The most important takeaway from the two cases is that the client must play an active role to succeed. There is a need to prepare management, organisation and competences for digitalization.

The client and future FM operator must have a strategy for using BIM models and digitalization. The strategy should be developed at a sufficiently high level in the client's organisation but also should involve representatives of employees and the FM organisation. The strategy should have a clear focus on the operation and management of the building.

This digitalization strategy should first be operationalized through contractual documents describing deliveries to all consultants and contractors in the project of facilities management information. Second, upskilling through training of personnel, including in topics of classification, should be provided.

The FM organisation must be involved in the planning processes of new builds from an early stage whenever possible. The FM organisation must prepare for future use by having the right resources and competences to do so. Sourcing of external consultants is a possible alternative solution, but it risks being short-sighted because consultants would bring much of their gained knowledge with them when finalizing their contracts.

For the architectural and engineering consultancy companies the cases here indicate that offering more FM services for large clients should be a feasible business, as developing digitalized FM involve competence gaps and other barriers for the large clients.

National standards and classification systems must be developed further to provide better mapping between them and/or to better align with each other. BIM can be used as a platform to handle the information throughout the whole lifespan of a building and to transform data from one standard to another.

Public authorities, including hospitals such as the ones studied, can improve their level of digitization through a long stepwise process, taking advantage of the opportunities offered by contemporary digitalization vendors. Moreover national and international guidelines for implementation can also be used to cover parts of the digitalization agenda, such as GSA (2011).

Conclusions: Missed opportunities

This paper investigates the enabling and constraining elements of digital FM in new hospital projects in Scandinavia. Drawing on recent research, it was observed that creating new buildings appeared to be an important opportunity for hospital operation and maintenance functions to leverage their digitalization level. A framework of understanding was developed through literature study, finding a range of technologies supporting digitalization of FM. This includes state-of-the-art CAFM-systems, BIM, other software that support operations, big data technologies, the Internet of Things (IoT), augmented reality, digital twins, block chains and building information standards. However, there is a strong need to commence realizing digitalisations by creating digitalization strategies and operational hybrid practices in which competences, organisation and management are developed, which together with the technologies can create a digitalization that performs in practice. The two cases show that many opportunities related to new built are not taken up, i.e. the opportunities are missed. BIM models are not integrated sufficiently, and classification is not done fully, even if the development of national standards for classification of building systems, elements and components has progressed over recent years, and the different systems also are more aligned and consistent than previously. One big challenge is that if the systems used in the design and construction phase are not aligned to the CAFM system used in the hospital, all the information collected either will not be used or will have to be imported using unnecessary time and resources. In sum this can be interpreted as a question of lack of structure and coherence. The two cases demonstrated on the one hand the state-of-the-art CAFM system in operation, but on the other hand, a digitalization in the sense of our framework has yet to really commence. The transformation of these solutions into workable support for FM will be a long process.

The implication of our findings is to underscore the importance of managerial, organisational and competence preparation when commencing on a path of digitalization of facilities management. We recommend the client have a strong strategy to obtain that, and use contracts and specifications regarding classification and standardisation as some of the means to achieve that.

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