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Sustainable Development in The Healthcare Enterprises Management Through BIM And FM Interaction Based on a Holistic Aspect Structure

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1 ABSTRACT

Sustainability stands out as a widespread topic that cannot be neglected in the field of the healthcare management. Building Information Modelling (BIM) can potentially act on every aspect of the enterprise. This can lead to the feasibility of BIM programs to implement the criteria of facility management (FM) in the real estate sector. The progression of sustainable management measures in healthcare industry requires effective, clear and integrated interaction systems in a holistic organizational aspect structure during the entire building life cycle. BIM implementation in the life cycle of a building project incorporates and merges precise and reliable data for building management and offers outstanding business value in the operating period. Hence, digital interaction paradigm for all types of documents and properties through all building phases is a necessity that leads to life cycle BIM based on FM. This concept is called enterprise BIM (EBIM) that is targeted to focus on integration, information exchange and openness across the core business structures. This paper is aimed to discuss the potential of BIM and FM interaction in EBIM systems that can lead to a sustainable approach in the healthcare enterprises management. In this regard, the literature review/case study discussion as a methodology for conducting research is chosen. This can be an overview of the different types of reviews of BIM, FM and EBIM, as well as some guidelines for how to perform and evaluate. Collaboration and interactivity are the most important factors in a sustainable system. EBIM by having the ability and potential to access of all stakeholders, users and operational organizations to the virtual building in all phases of the enterprise activities will have a major impact on the quality, knowledge transfer and user interaction and it allows owners to make unique decisions about the optimal and efficient use of building stock.

Keywords: Building Information Modeling (BIM), Facility management (FM), Enterprise BIM (EBIM), Health care industry, Sustainability

2 INTRODUCTION

Health is an issue of paramount importance and an inescapable part of struggling for one's livelihood together with the fusion of food and dwellings (Morgon 2015). Healthcare institutions as social and economic organization that preserve value and wealth for people and communities in society need to find a way to create public value by Gaining legitimacy to build and maintain public trust for all stakeholders. Therefore, it is very important for the sustainable healthcare industry to consider the importance of management at all stages and discover development of policies with the aim of effective communication improvement with all users and building trust-based relationships. Hence, the advancement and operation of healthcare institutions systems which are based on strengthening sustainability as a core concept drives the healthcare sector to success in development and helps to survive and create public value and benefits to promote health and wealth for people and communities in society. In this regard, healthcare systems must move forward towards sustainability by utilizing and enhancement of business management, knowledge sharing, collaboration and implementation of sustainable practices and processes in a holistic aspect structure that authorize to ensure quality of healthcare services and enable all stakeholders to interact positively within the technology (Romanelli 2017).

The structure and provision of healthcare services have changed rapidly in the recent years (Patry, Morris, and Leatherman 2010). In fact, the forward-thinking framework and structure of human society has resulted in an organization that contributes to a healthy society through more efficient care coupled with education and other public utilities. In such circumstances, FM in healthcare industry has incrementally shifted from Evidence-based experience to systematic and scientific, and simultaneously the bioscience industry has gradually shifted from the bourgeois and materialistic efforts to developed and logical innovations. Hence, the dynamics and go-getting of sustainable outreach in the healthcare industry needs to cover all principal

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and significant aspects of the industry, including research and development, processing, production, administration, market access along with trading opportunities, and public management (Morgon 2015).

In fact, innovation is the key factor in healthcare management, and it can lead the sustainability approach to any health-care system. Throughout the years, innovation has been a motive power in ameliorating treatment outcomes, lab results, and functional efficiency in healthcare system services. It is certainly true that pursuing real innovation requires a significant investment of time, energy and money and in this regard, the expense of innovation is the overriding consideration to decision-makers and health system managers. Therefore, one way to ensure and guarantee the sustainability of health care systems is to use the suitable "business model" for these systems. This will drive innovation and optimize the management throughout the industry (Barei 2015).

Over the last few years, breakthrough technological innovation has disrupted traditional research in the field of real estate. Hence, invigorating the technology-based in real estate sector is heavily influenced by computer-assisted facility management (Wills, Ponnewitz, and Smarsly 2018b). In fact, in an overall view, if firms want real estate resources to add value to the company, they should harmonize companies' real estate strategies and intentions with core business strategies (Gibler and Lindholm 2012). In this regard, supporting the incorporation of BIM which is used extensively in the architecture, engineering, and construction (AEC) sectors has the possibility to carry out FM procedures and allocate FM activities to different stakeholders in accordance with BIM standards. BIM is a digital representation of geometric and functional features of a center that can serve as a common source of knowledge for FM. Despite the obvious correlation between FM and BIM, BIM applications are not included in the FM sustainable Guidelines(Wills, Ponnewitz, and Smarsly 2018b). This is practically, the point of absence of a holistic organizational aspect structure that can support important functions in the core business. In this regard, in 2012, St. Olav's University Hospital, together with the Central Norway Regional Health Authority (HMN), started a project called Life Cycle BIM in reliance on FM. In fact, EBIM is founded on the understanding that the world is three-dimensional (3D), comprehensive, object-oriented and process-oriented. This implies that, both the actual and the digital built environments with all objects and interconnected objects and processes are joint in an interrelated complex network which are accomplished as an Authoritative Data Source (ADS) in a model server (Evjen, Hosseini Raviz, and Petersen 2020). This paper examines how EBIM can be an advantageous and sustainable platform for supplementing BIM and FM interactions. Hence, the synergistic highlighting between BIM and FM in EBIM system show how the concept of EBIM, is aimed to extend a process-driven approach with a holistic business perspective. In this regard, the St. Olavs Hospital as a pioneer of using EBIM system is considered as an evaluation to provide a deeper insight into effective network collaboration between various actors involved and their interaction. The goal is to implement a comprehensive approach in the light of a holistic organizational aspect structure by using effective tools in the various processes and management of existing buildings, as well as the implementation of technologies to enhance cooperation between all actors and stakeholders in the healthcare industry.

3 RESEARCH METHODOLOGY

This paper is based on the sustainable development approach in the healthcare industry by focusing on interaction between BIM and FM in a holistic organizational aspect structure throughout the lifecycle of a building. the importance of improving business management, knowledge sharing, digital interaction and connection in the different phases of the building life cycle as key components in defining and understanding could be considered. Therefore, in the first step, it should be understood the definitions and keywords terms in the field of sustainable development in healthcare enterprises through BIM and FM interaction in EBIM system. In the following, the paper considers the relevant literature review/case study and introduces the EBIM concept and the performance of BIM and FM in the EBIM system. The main source of information for the present study is scientific reports at St. Olvas Hospital. During the study, the authors held several meetings in the real estate department at St. Olvas Hospital with leading technicians and specialists. Emphasizing on EBIM capabilities means that upcoming investigation will be able to address more solutions for FM developing and meet sustainability demands from the initial phases to involving end users

4 LITERATURE REVIEW - FM DEFINITION AND EVOLUTION

Sustainability is generally and extensively accepted as a factor with ability of enhancing the quality of human life while we live in the supportive capacity of ecosystems. In FM field, sustainability issues encompass considering the enhancement phase of building planning, design, construction, reconstruction, operation and demolition, and how the building adapts to fit its users' goals, maximizing its resources over its lifetime. Despite the fact that, there is widespread debate among FM professionals about the necessity of sustainable solutions performance, this sector is still undeveloped in terms of execution (Støre-Valen and Buser 2019). FM is a functional organization consisting of diverse and several processes, activities, and maintenance services used to support the core functions of a building or facility. In this regard, due to the capabilities of BIM in visualization and coordination and its background that has been used for many years for design and construction, the interest of experts in using BIM in FM processes has increased (Yalcinkaya and Singh 2014).

FM seems to have expanded into the industry in a short period of time, over the last 40 years. Today, many literatures know FM as a developing discipline that is increasingly recognized in every corner of the globe. The divergence in its definitions has been so fast that it may not have strong roots, or it may have been defined in line with the taste, environment and demographics of the inventor at that time. The description, field of application and scope of FM remains a controversial subject, and definitions rely on local customs, organizational and personal interests. The basic hypothesis of the various literature is that the definition of FM truly is influenced by the purpose and motivation of the observer. However, after examining the various definitions of FM, it is entirely obvious that the definitions of FM, although quite diverse and multifarious, still have a joint perspective and mission. In today's world, it can be found that FM practically revolves around the main axes of financial resource management, physical resources, human resources and information and knowledge resource management. The main role of FM is management of resources, at the grade of strategic and operational support. General types of resource management to the core functions of FM are financial resource management, manpower resources, physical resources, and information and knowledge resource management (Mohamat Nor, Mohammed, and Alias 2014).

From the late 1980s, FM incrementally found its place as a profession in the real estate and construction industry. The foundation of professional FM enterprises throughout the world (e.g. IFMA in the USA, JFMA in Japan, BIFM in the UK, FMA in Australia, etc.) testify to its growing significance. However, several years later, the profession is still suffering from an serious identity crisis. In fact, the role and scope of tasks of one facility manager probably different from another. Such confusion does not seem to exist in other occupations in the real estate and construction industries, such as architecture, project management, and urban planning. Although it may be claimed that FM is a quite new functional organization and therefore still in development, it is essential to assess the core competency of FM as a discipline and occupation at this stage of formation (Tay and Ooi 2001). Developing an accurate comprehension and awareness of the evolution of FM is very significant, so that when the FM theme is varied, the original theme is fixed in order for the next result does not fade with the newer components and elements of FM knowledge, which can obscure the main areas of the issue. In Europe, for example, many stakeholders use FM terms to affect customers, but do not offer professional FM services (Mohamat Nor, Mohammed, and Alias 2014). Hence, it should be noted that despite the fast expansion and growth of FM over the past decade, its definition and domain are still controversial. FM definitions assessment during the past indicates that FM is clearly focused on the workplace and in this regard, location, type, quantity, quality, content and allocation of workspace are the most important factors (Tay and Ooi 2001).

5 THE ROLE OF BIM IN EBIM SYSTEM

BIM is transition of methods and technology from a single traditional consecutive form to a modern multiple parallel form of data combination (Kouch, Illikainena, and Peräläa 2018). It is fundamentally a digital platform for establishment and development of virtual buildings. If BIM is used, a model can provide all the information needed to collaborate, predict, and decide on the design, construction, operation, cost, and maintenance of pre-construction facilities (Tjell 2010). In this regard, it acts as a procedure of information exchange and distribution with the capability to use the data through abundant applications for managing various multidimensional assignments and activities in architecture, engineering, construction, maintenance and different types of operation all along the building life cycle. The era of automation, artificial intelligence,

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robotics and three-dimensional printing is coming faster on account of the remarkable advancement and new features in the digitalization and according to the lack of productivity and efficiency in the building industry, BIM can play an efficient role to provide and offer the required and detailed information and also precise data to be employed for model simulation in different phases of the building industry (Kouch, Illikainena, and Peräläa 2018). Hence, BIM enables the way to more effective multidisciplinary collaborations with a total lifecycle and supply chain integration perspective which means that it is the process of creation and managing data and information about the built environment during its lifetime. BIM brought the most transformative power into architecture and engineering especially in the field construction and facility management during the last decade with regard to its fundamental lifecycle and digital collaboration (Evjen, Hosseini Raviz, and Petersen 2020).

Therefore, in this regard, proper implementation of digitalization and BIM will contribute to efficiency improvements at all stages, reduced costs and better quality. As a virtual and digital tool, BIM provides the space for analysis, understanding, support for acceptance and decision, as well as necessary support for realization and management. In this regard, BIM acts as project-centric and focus on project data, technical subject solutions and real estate operations from a business perspective where building is one of many business structures. By considering BIM as a digital interaction paradigm for all types of properties through all phases, where everyone can initially share and gain insight through different digital interfaces, the focus is shifted from the project-centric to see BIM in a business perspective. In this regard, St. Olavs Hospital, together with Helse-Midt-Norge (HMN) initiated a project entitled Life-Cycle BIM based on facility management. This concept is called Enterprise BIM (EBIM or Business BIM) that the main emphasis is on integration, information sharing and openness across business structures (Evjen, Hosseini Raviz, and Petersen 2020). EBIM philosophy was adapted where all buildings are an integral part in the entire portfolio of buildings, as well as the aspect structure defined in the hospital business structure (Evjen et al. 2020).

Figure 1 shows digitization of building documentation. Technology and process development is defined as follow:

Level 0: Computer-aided design (CAD) consisted of strength-based visualization with or without visible surfaces, to produce drawings.

Level 1: object-oriented representation in 2D / 3D and assembly of 3D CAD models.

Level 2: virtual building elements representing doors, windows and walls.

Level 3: the introduction of IFC and integrated server-based data models with support for compiling professional models with a view to operation as well.

Level 4: involves a development where one does not see the BIM models detached from the organization, but as an integral part of the company's systems, the model has relationships with and communicates with processes in the company.

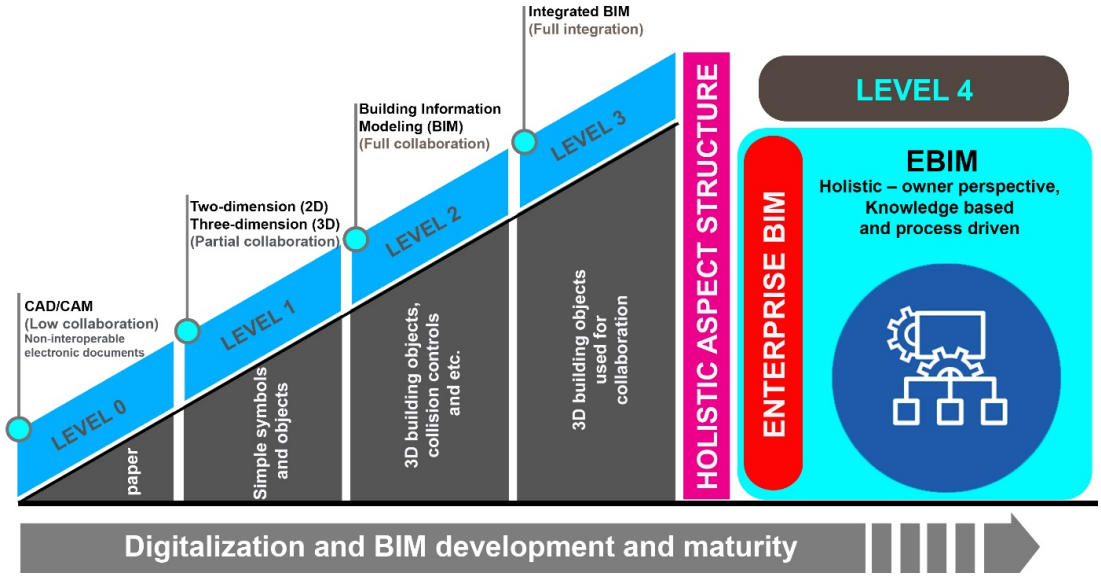

Figure 1: digitalization and BIM development (Bew and Richards 2008)

In this regard, St. Olav Hospital has been at the forefront of using BIM models and data usage in BIM models and scrutinizing the concept of EBIM. St. Olav's delineates EBIM as a discrete database intended to sustain and strengthen many organizational aspects and empower the consolidation of core business and different healthcare activities in a holistic organizational aspect structure (Øgård Aksnes 2016). The information accumulated by way of the EBIM system process and stored in its database leads to a functional efficiency for a variety of FM practices, such as operationalization, quality control and guarantee, cleaning, maintenance and repair, and spatial management.

6 BIM ON THE PATH OF SUSTAINABILITY

BIM is a revolutionary way in designing, development and construction management by creating digital representations of buildings and simplifying the exchange of information digitally. The most important main features of BIM include database, reusability, change management. (Hussain, 2020). Today, the integration of BIM technology and sustainable development is more and more absorbed attention in the AEC industry (L. Zhang et al., 2019). Hence, the necessity to realize and recognize the significance of sustainable development has become a major concern. The emerging and state-of-the-art technologies around the building industry can be a great help in achieving the goal of sustainable development. There are a variety of frameworks for ranking sustainability around the world, each built with the goal of enhancing the performance of the entire building to achieve the establishment objectives of a healthy environment. In this regard, data integration is the key to sustainable development that requires a change from traditional procedures of information interchange between different stakeholders. Accordingly, today, BIM is rising and developing as the predominant and influential technology with the gradual integration of more and more people in the AEC industry (Khattra et al., 2020). The Innovation in BIM technology is a new tool for predicting, managing and monitoring the environmental repercussions of the construction and development stages of a project via a one-stop-shop. BIM plays an important role in supervision and management environmental sustainability throughout the full life cycle of a building. In addition, BIM provides a possibility to expand its scope in sustainability through information embedded in a building project. In fact, it can be claimed that without the development of BIM aptitude, no real advancement and development can be made towards AEC sustainability. BIM is inherently a sustainable system and helps to design and measure the environmental performance of a building (J. Zhang et al., 2016). Sustainability in construction is not only low-consumption mechanical devices installation. In fact, sustainability is a point of view that affects all parts of the related programs and the development process, just as ongoing support and structural activity continue (Khattra et al., 2020). The benefits of BIM at this stage is obvious, but with this concept of sustainability, its capability for realizing buildings and structures with less environmental impact becomes with continual acceleration apparent. In this regard, sustainable development is a measure of the potential of the AEC industry, technical capacity and portability, along with social responsibilities and environmental performance, which is becoming frequently common today (InterFocus, n.d.) (InterFocus, n.d.) and in this regard, BIM can assist in the analysis of various functions in the building sector to ensure a maximized sustainable building design. (Azhar & Brown, 2009)

7 INTERACTION BIM AND FM IN EBIM SYSTEM AS A SUSTAINABLE PERFORMANCE

FM is defined as a vocation that includes several disciplines to guarantee the performance, security, comfort, effectiveness and productivity of the built environment by integrating place, people, processes and technologies (Tezel and Giritli 2019). In other terms, FM acts as a functional organization to ensure the performance of the built environment covered by numerous activities such as property management and maintenance, air condition, cleaning and safety, and the social integration, places and technologies. Sustainability is one of the most significant challenges in the Architecture, Engineering and Construction (AEC) industry and is one of the considerable factors in FM. Sustainability is defined as the potency of management to guarantee that the ongoing functional needs of the facilities take place without compromising the capabilities to meet future operational needs. One of the important factors in the AEC sector is cooperation between project participants (Wills, Ponnewitz, and Smarsly 2018a). In this regard, BIM is recognized as a promising tool for establishing, saving and managing all sorts of information and details throughout the project lifecycle (Tezel and Giritli 2019). The life cycle of a building represents the greatest investment in time and resources in the course of the occupation, various operating processes and maintenance periods (Figure 2). BIM acts as a repository for digital three-dimensional (3D) information and

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data generated by the design and simulation process. All construction information, installation instructions and project management logistics are collected in a one database. There is a data model for the building lifecycle, and it can be applied to conduct and handle stakeholders assets. The use of technologies such as BIM also sets out possibilities for savings during related activities and processes. Obviously, pre-set deliveries can prevent interruptions in the program, therefore, it can be planned for the most convenient time and often reduce on-site storage difficulties (Cotts, Roper, and Payant 2010). (Cotts, Roper, and Payant 2010). If the actors involved work together in a project, mistakes, differences and duplication of work in the AEC industry can be avoided. AEC industry stakeholders use BIM methods to handle pertinent documents in models, design documents, technical drawings, and reports. Accordingly, BIM can be defined in three branches. The first part encompasses the building models, which is a structural data set that characterize the building and fundamentally forms an intelligent digital demonstration of building-related data. The second part is the cooperative operations of connecting various building-related data and building information models creation. The last part is the BIM management system, which includes the coordination of operations and processes (Wills, Ponnewitz, and Smarsly 2018a).

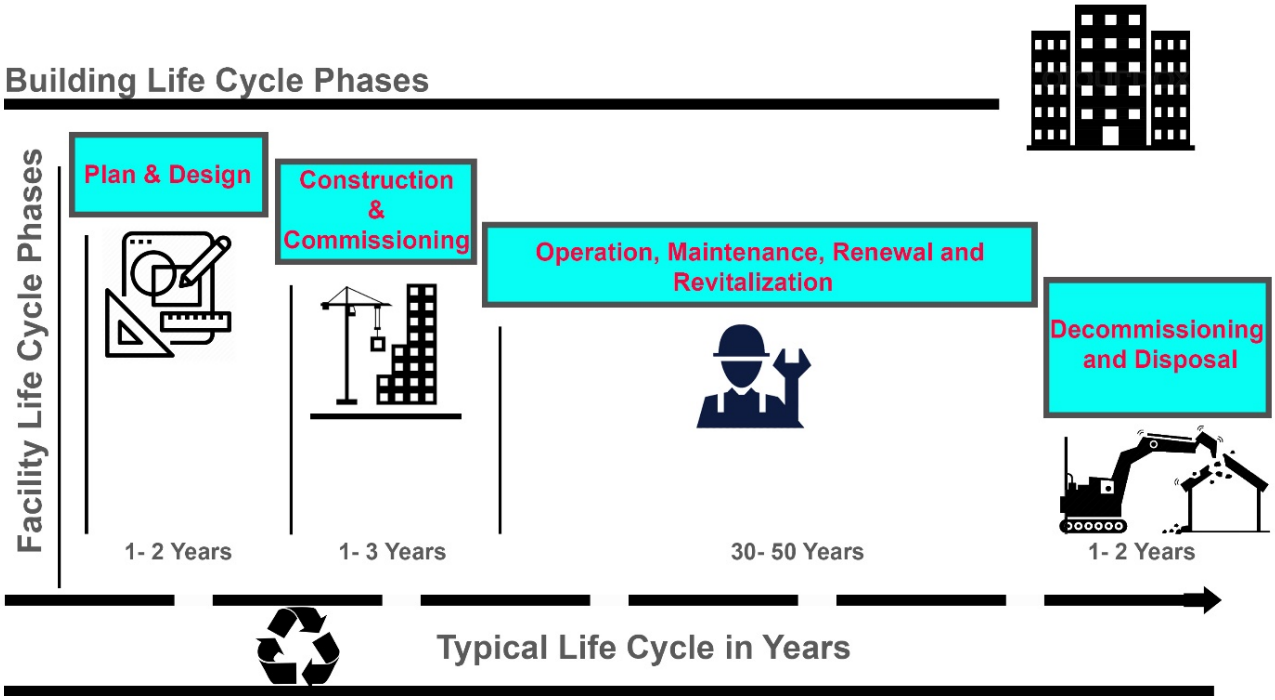

Figure 2: Relative timeline for each stage of a typical building life cycle, and sustainable operations that are considered throughout the operational phase (Cotts, Roper, and Payant 2010).

On the other hand, FM includes and needs multidisciplinary proceedings and therefore it has a wide range of information needs. While some of these requirements are met by numerous available FM information systems, BIM with its features of visualization, analysis, control and given that it is extensively accepted by the building industry, has underdeveloped opportunities to offer and support FM methods (Becerik-Gerber et al. 2012). In fact, FM applies to an overall and integrated approach to the operation, maintenance, improvement and compatibility of an organization's buildings and infrastructure with the aim of establishing an environment that vigorously supports and assists the initial goals of the organizations and covers the longest period in the buildings life cycle (Tezel and Giritli 2019). Buildings are designed to meet the requirements of organizations, but in the course of the operational phases when the building are occupied, they require special FM measures. Since FM processes produce and need a lot of information, the efficient use of BIM in the implementation phase to obtain a greater quality-built environment becomes very important factor for all stakeholders (Tezel and Giritli 2019).

As mentioned previously, EBIM is a method based on the concept of cooperation between all stakeholders and is based on the process-oriented and object-oriented nature of a three-dimensional and comprehensive world. This means that both real and digital settings are built with all interconnected objects and processes in an interconnected intricate network, which is realized as an Authoritative Data Source (ADS) on a model server (Evjen, Hosseini Raviz, and Petersen 2020). The model server has the duty to visualize and

management of St. Olavs University Hospitals EBIM. the application is called MSM (Model Server Manager) (Øgård Aksnes 2016). In MSM, all old, new and future buildings are an integral unit in all building portfolios. (Van der zwart and Evjen 2018). Thus, EBIM facilitates and elucidates the inherent complexity by creating an enterprise specific aspect structure that is linked to other organizational and all stakeholders' structures. This indicates that EBIM includes 3D geometric data and other building information, which in turn is related to other aspects such as economics and facility management. one of the most significant aspects of EBIM is the focus on integration, data exchange and transparency in business structures that avoid the vendor lock-in. This happens when a company is restricted due to reliance on the services provided by a vendor or manufacturer. Figure 3 shows the concept and the connection between the actual building, EBIM and the structural processes, which means that all information is shared and EBIM consider the actual building complex as much as possible, irrespective of the phase (Evjen, Hosseini Raviz, and Petersen 2020).

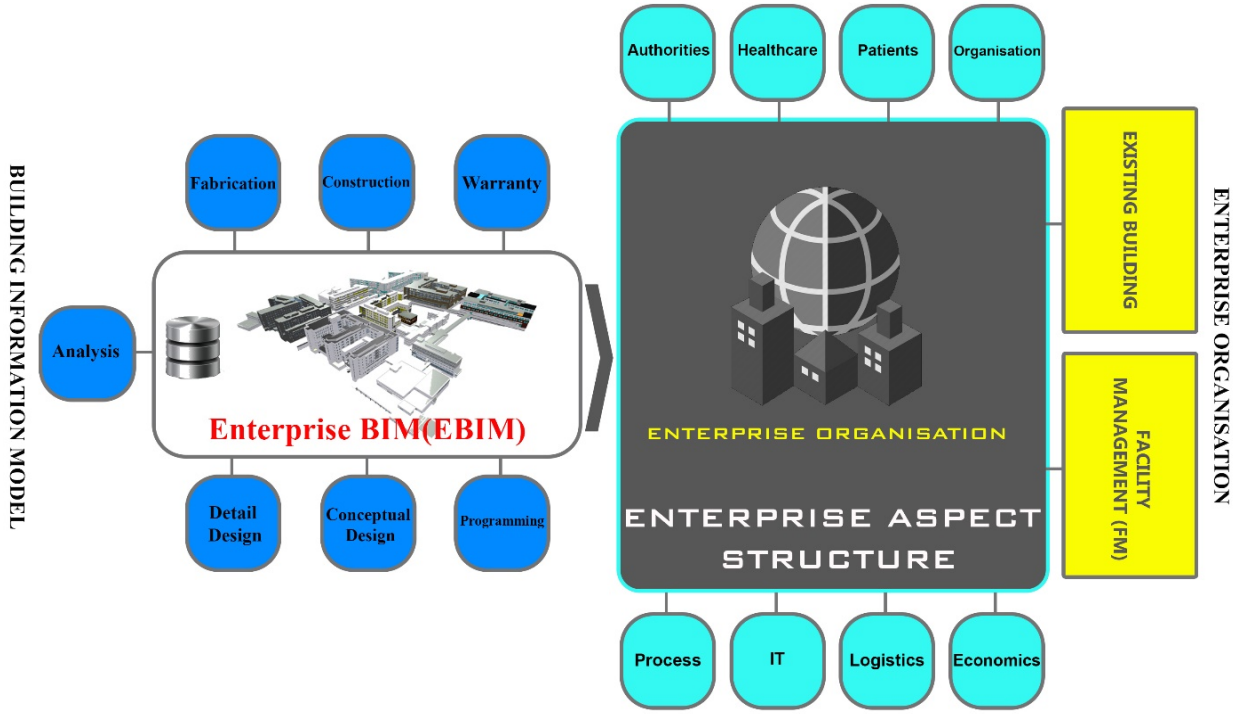

Figure 3: Enterprise BIM as an aspect structure

As it is shown FM is not dedicated or separate system. It uses the same data as rest of the building project. By creating EBIM as an independent structure instead of a part of the FM system, gives the BIM a more prominent position in the company. Adapted from (Evjen et al. 2020).

Hence, St. Olav Hospital is currently using EBIM to achieve better and cheaper construction project goals and to manage real estate operations with the goal of using resources more efficiently. Buildings used during the EBIM process have better performance and maintenance quality and provide higher services to employees and visitors than traditionally designed and constructed buildings. In this regard, other benefits include good performance, easy benchmarking against other projects, faster implementation, fewer construction faults, reduced costs, reduced energy intake and carbon footprint, coordination and simplification of operations (Evjen, Hosseini Raviz, and Petersen 2020). Hence, EBIM can be a new vision and concept in FM that uses digital representation of the building process to facilitate the exchange and collaboration of information in digital template and acts as a shared source of knowledge for decision making process throughout the buildings lifespan and can also be a dependable basis for FM. EBIM creates an environment based on reproducible, verifiable, transparent and sustainable information.

8 DISCUSSION - EBIM AND SUSTAINABLE DEVELOPMENT

The modern age has promised a transformation in the industrial society in which the sustainability of knowledge, especially digital systems, is mainly used as a tool to achieve sustainable development (Stuermer, Abu-Tayeh, and Myrach 2016). In this regard, the principle of digital sustainability has been defined in researches on digital preservation together with openness platform in which the technical durability of digital information from data storage on suitable hardware devices to standardization of file

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formats and continuous identification schemes for data structures are the main factors (Stuermer 2014). The capability to perform BIM and obtain data well determines which consultants or resources we use and with which building automation system we get ahead (Cotts, Roper, and Payant 2010). Although BIM can serve as a powerful management tool, we also need a holistic organizational structure to interact efficiently with FM and to optimize and improve business management. In this regard, EBIM plays an important role in new marketing, management and operational tools (figure 4) in the core business which are the most important factors in sustainable performance. EBIM forms the basis for the strategic property management of the future through the use of virtual models and open standards. In fact, EBIM is the concept where 3D and other building data are used throughout the building's lifetime and are combined with sensors and the companies' own work processes. Thus, building owners will have a unique decision basis for optimizing the use and operation of the building stock. To make the EBIM system work, St. Olavs University Hospitals uses a model server manager (MSM). Hence, the building owners can gain security and ownership of their own data, which in turn makes it possible the integration of other systems and processes such as FM or finance in business. Today, St. Olavs Hospital manages all its areas in BIM on MSM. Indoor positioning system (IPS) is an example of the use of sensors which are installed on hospital equipment that provide extremely accurate locational tracking (Jotne EPM Technology 2017).

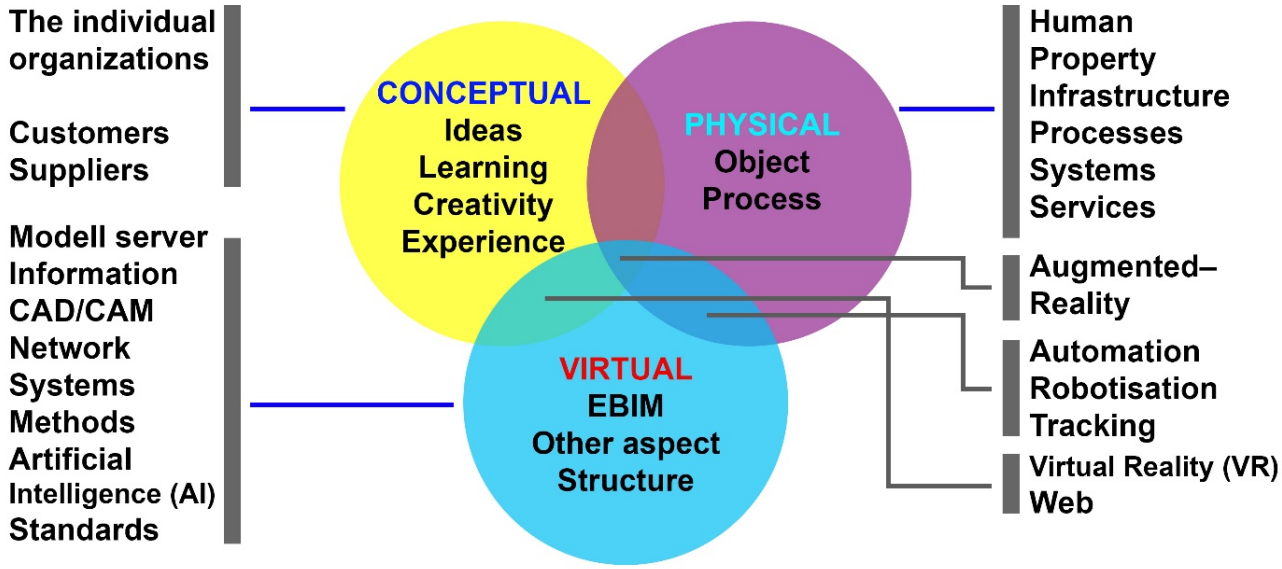

Figure 4: Digital interaction and interfaces with EBIM

One of the most important aspects of sustainability in EBIM system is that it allows all stakeholders to use the same BIM throughout the buildings lifetime based on open data standards. Stakeholders of this solution include the building sector chain (AEC, managers, owners) and other groups such as patients, logistics, authorities, marketers, etc. EBIM implements new sets of rules and models for the building industry. This innovation is a unique approach in the global market and has a great possibility and ability for fast market uptake. (Jotne EPM Technology 2017). EBIM underlines the necessity for integrated and participatory strategies and organizational processes during the whole building's lifecycle that are specifically tailored to the requirements of professionals and stakeholders. Hence, the role of FM in the EBIM system becomes a powerful functional organization for achieving sustainable objectives. In this regard, FM professionals have the greatest opportunity to add value to their establishment and customers through effective governance of sustainability issues and methods (Støre-Valen and Buser 2019)

9 CONCLUSION

Designing sustainable health care systems is emerging as a strategic goal for developing new functionality and applications with the aim of more efficient use of resources over time. This article hopes to provide a platform on which the joint interaction between BIM and FM in the light of EBIM as sustainable system can stand and thrive. BIM undertakes to deliver primary data to FM systems and supports and improve other FM functions by providing forward-thinking visualization and analysis abilities. Cooperative design should support data exchange as knowledge and not just data transfer as information in documents related to business processes. Such cooperation can be seen as a response to industry integration. As a result, this

collaboration can lead to the support of good services and increase performance and reach to a stage of significant changes. Hence, EBIM can provide the valuable judgments needed to make a more sustainable infrastructure for the satisfaction of owners and all stakeholders in a holistic aspect structure. EBIM is a system for using digital models to manage data possession throughout the buildings lifecycle and to support the core businesses.

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