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BIM UTILIZATION IN FACILITIES MANAGEMENT PRACTICE: A STATUS STUDY IN SOUTH AFRICA

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Facilities Management is the most extended phase in the life cycle of a facility. To effectively manage facilities' electronic information is needed. An integrated information management system such as Building Information Modelling (BIM) can be utilised to support data at any given phase of a building life cycle. Literature review shows that there are benefits to using BIM in Facilities Management. However, there is insufficient research regarding the use of BIM in Facilities Management in South Africa. The purpose of this research was to investigate the extent to which BIM is utilised in the South African Facilities Management sector. The findings reveal that majority of Facilities Management practitioners are not utilising BIM, due to factors relating to cost and week support organisations. Those who use BIM believe that the model does not have enough information to carry out all Facilities Management activities.

Keywords: BIM, buildings, facilities, ICT, management

INTRODUCTION

Facilities Management (FM) encompasses multiple roles for the purpose of ensuring the functionality of the built environment through the integration of people, places, processes and technology (International Facility Management Association, (IFMA), 2015). FM's primary focus and function are to manage changes that occur in the relationship between organisations, their employees, and their facilities (Chotipanich, 2004). According to Nutt (2004), the relationship involves an extensive range of activities including but not limited to the;

1. Physical use of built space, use of technology, provision of services, ensuring maintenance as well as modification and adaptation where necessary;

2. Human and business component of facility purpose, its use and function, provision of security, ensuring safety, comfort, and environmental health; and

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3. Financial issues of property investment, asset value, and the costs and benefits of occupancy.

One significant challenge that can be experienced in FM is information collection, storage and sharing (Eastman, Teicholz, Sacks and Liston, 2011). The main reason that hampers information management is that most of the FM information is documented in paper formats, which are not easy to locate and maintain (Mendez, 2006).

The use of information in FM is no longer limited to the maintenance records for routine, reactive or compliance purposes, but rather it involves operational and strategic elements where data and information are captured, processed, shared, applied and reported (Achoru, 2015). With technological advancements in the digital age, FM teams are encouraged to transfer and store building information in digital formats that are readily available (Teicholz, 2013). Therefore, effective FM requires an integrated information management system that provides practitioners with adequate information to control maintenance functions to support day-to-day operations and decision making (Graddy, 2010; Chen and Wang, 2009).

Information management systems such as Computerised Maintenance Management System (CMMS), Computer-Aided Facility Management (CAFM), Integrated Workplace Management Systems (IWMS), Enterprise Asset Management (EAM) and Building Information Modelling (BIM) can be used for storing and sharing FM information. BIM is a model for defining a facility's physical and functional characteristics in a digital form (Gardezi, Shafiq, Nurudin, Farhan and Umar, 2014).

BIM emerged as a technological information management process and product that tackles interoperability and information integration issues in early 2000 (Motamedi, 2013). BIM involves spatial relationships, light analysis, geographic information, and building components' quantities and properties (Eastman et al., 2011). Current BIM software is therefore used by individuals, businesses and government agencies in infrastructure planning, design, construction and FM (Azhar, 2011). The use of BIM in FM can have numerous benefits, including but not limited to faster and more effective information sharing and cost control (Arayici, Onyenobi and Egbu, 2012). With the advancement of BIM, there has been evidence of BIM adoption and its use in developed countries such as the United Kingdom (UK) and the United States of America (USA). The use of BIM in the UK (Succar, Sher and Williams, 2012; Sabol, 2008; Arayici et al., 2012). Unfortunately, the use of BIM is mainly focused on design, preconstruction and construction phases (Hilal, Maqsood, and Abdekhodaee, 2019). Hence, the use of BIM in FM has been noted as generally lagging behind relative to other AEC sub-sectors (Sabol, 2008). Despite the potential and significant benefits, BIM in FM is still relatively in its infancy (Korpela and Miettinen 2013: Lui and Issa, 2013); the situation has also been highlighted in the context of South Africa (Kotze, 2013).

BACKGROUND TO THE STUDY

FM, as a growing profession in the built environment, has evolved over time. FM is the process needed to support and enhance an organisation's core business by

ensuring that its buildings, systems and services provide a quality, cost-effective environment for people and processes (Chotipanich, 2004). FM coordinates all efforts related to planning, designing and managing buildings and their systems, equipment and furniture (Becker, 1990).

It is an integrated approach to operating, maintaining, improving, and adapting the buildings and infrastructure of an organisation to create an environment that strongly supports that organisation's primary objectives (Rondeau et al., 2012). In addition, FM can be seen as the application of the total quality techniques used for improving quality, adding value and reducing the risk associated with building occupation and support services delivery (Alexandra, 2001), with the primary function of the process being resource management at strategic and operational levels of support (Liu and Su, 2013). The South African Facilities Management Association (SAFMA) ascertains that FM enables sustainable enterprise performance through the whole life management of productive workplaces and effective business support services (Atkin and Brooks, 2015).

FM's scope is broad; FM is no longer limited to the maintenance records for routine, reactive or compliance purposes. Instead, it involves operational and strategic elements where data and information are captured, processed, shared, applied and reported (Achoru, 2015). Effective information management is the cornerstone of successful FM, which enables forward planning to support the core business (Atkin and Brooks, 2015). In its electronic form, information can be easily stored, collected, analysed, and shared (Teicholz, 2013).

BIM offers an integrated digital platform to store, manage and share information obtained from the planning to FM stage (BIFM, 2012). BIM has functions and tools that can be used to support FM functions for both new and existing buildings (Volk et al., 2014). FM enabled BIM model contains FM data which can be used to support FM tasks involving space analysis, retrofitting and preventative maintenance (Pishdad-Bozorgi, Gao, Eastman and Self, 2018). Arguably the importance of information management cannot be overemphasised.

The Sydney Opera House case study (Sabol, 2008) successfully demonstrated the potential benefits of BIM in FM. Other case studies include a renovation project at the University of Chicago, where BIM was linked to existing CMMS and CAFM systems during the administration building's renovation (Teicholz, 2013). According to Temmink and Ritter (2020), BIM is the first half of a Digital Twin that considers people and their potential actions within the building. The study of, Becerik-Gerber et al. (2012) interviewed FM practitioners on the role of BIM and found that using BIM decreases the chances of errors and increases efficiency. Korpela and Miettinen (2013) also found that in FM, BIM can be used for space management, planning and scheduling maintenance tasks, operations data such as energy use, allocating and managing assets, and facilitating maintenance.

Furthermore, BIM can be used as a tool to track the types and quantities of materials, equipment and spaces of a facility. When integrated with the CAFM system, BIM provides notable benefits such as utility cost reductions, comfort management, space optimisation, improved inventory management and energy simulation and conservation (Love et al., 2014).) Furthermore, when BIM is utilised in FM, there is an improvement in the quality of life (QOL) in the workplace that

encompasses multiple disciplines to ensure higher functionality of the built environment (Aziz, Nawawi and Ariff, 2016). Research on the utilisation of BIM in FM focuses mainly on its implementation in refurbishment and maintenance, energy efficiency, knowledge management and existing building (Matarneh et al., (2019).

Even though the AECO industry has recognised the potential benefits of BIM for FM (Lui et al., 2015), there is an increase in BIM uptake in the UK due to the Government mandated BIM Level 2 for public-funded projects (Carbonari, Stravoravdis and Gausden, 2018). There is a perception that the industry has been slow to participate in the developments of BIM and that facility managers are not precisely sure about how BIM can be utilised effectively. Several researchers have cited the critical factor of successful BIM implementation as seamless information management exchange between various BIM-FM systems and data exchange standards and regulations (Chan, 2014; Mehran, 2016; Matarneh et al., 2019;), Government support and pressure (Willis and Regmi, 2016: McPartland, 2017: Succar et al.,2013) and BIM awareness and education (Azhar, 2011; Almutiri, 2016)In South Africa, there is evidence that BIM usage is growing amongst architects relative to contractors and other construction professionals (Froise and Shakantu, 2014). Most architects implement 3D BIM compliant software such as ArchiCAD and Revit (Booyen et al., 2013), while a small percentage work exclusively in a BIM environment (Froise and Shakantu, 2014). Architects use BIM for drawing, visualisation, conceptual design functions scheduling, programming, costing and collaboration with other consultants (Froise and Shakantu, 2014). Even though some architecture companies are using BIM tools, Kipprotich (2014) asserts that most of them do not realise the extent to which BIM should be used and what BIM can do.

In construction, BIM compliant software has been implemented increasingly for cost management, construction management and project management (Kekana et al., 2015). While, in quantity surveying, a BIM compliant system, Dimension X, is commonly used for cost estimating and quantity take-off (Booyens et al., 2013). BIM has been used in South Africa on projects such as Kusile Power Station, Medupi Power Station and the 2010 FIFA World Cup stadiums (Booyens, Bouwman and Burger, 2013; Kipprotich, 2014).

Although there is awareness of BIM in South Africa, the rate of BIM adoption in the country is very low (Kekana et al., 2015). According to Froise and Shakantu (2014), less than 10% of South African contractors are familiar with BIM. Some of the factors identified in the literature that contributes to the slow uptake of BIM in South Africa are:

- Lack of communication between various stakeholders, whereby architects are not designing with quantity surveyors, contractors and facility managers in mind (Booyens et al., 2013). This non-systemic approach results in further fragmentation of the sector as it causes hindrances in design collaboration and design data losses, leading to wasteful iterative design processes (Wortmann, Root and Venkatachalam, 2016).

- Lack of mandated or best practice BIM standards, specifications or protocols in South Africa (Wortmann et al., 2016). The lack of BIM regulation affects the rate of BIM adoption in South Africa (Froise and Shakantu, 2014).

There is, therefore, a scarcity of literature exploring the actual use of BIM in Facilities Management within South Africa. This research aims to determine the levels and extent of BIM utilisation in FM practice, focusing on FM practitioners in South Africa. The pertinent question was derived as; what is the nature of BIM utilisation in FM practice among FM practitioners in South Africa? A fieldwork approach was adopted to address the research question through a research design detailed in the following section.

RESEARCH DESIGN

To answer the research question, two data-collection tools were developed for data collection. The first was a qualitative interview guide, and the second, a mixed open- and close-ended self-administered questionnaire. Using both methods in the same study is a viable option to obtain complementary findings and strengthen the findings (Thurmond, 2001). The two methods are different in approach; Interviews are more exploratory, while a questionnaire is more confirmatory (Harris and Brown, 2010)

Identification of items for the research and preparation of the interview guide as well as the questionnaire was a crucial step for the success of the research. A significant amount of work has already been done on items of BIM functions and the use of BIM. In addition, there is a well-documented and peer-reviewed set of those available items in the literature review. Using the latter, the two data-collection tools were developed for the study.

Data collection

A semi-structured interview method was used. The interview guide had two sections—the first section aimed at collecting demographic and background information. The second section constituted of five questions gathering information about operations at facility management companies. The interview took 30 minutes. Interviews were crucial in collecting information used to develop the questionnaire.

The questionnaire was administered to the respondents through an online platform, Qualtrics©, which is used for data collection and management. Thereafter a link was generated through Qualtrics© and sent to 123 participants via email. However, the link was only sent to members of SAFMA, whose core business is FM.

Data analysis

The data were analysed using grounded theory and descriptive statics. The data was collected in 2016. The research population included facilities management professionals registered with the SAFMA. The population from which a sample was drawn for this research comprised 950 FM practitioners registered with SAFMA, amongst which 360 are based in Gauteng Province, which is the study's geographical scope. However, only 30 surveys were found useful for analysis.

Sampling

This research used purposive sampling. The chosen method allowed the researcher to select a sample of people who would give the most accurate information. A small number of practitioners who provided in-depth information about the topic were selected from a sample of FM practitioners registered with SAFMA to participate in the interview and questionnaire survey

RESULTS

Interview Data

Industry Experts Interview

Four industry experts from FM organisations were identified and interviewed in Gauteng Province. Three were male and one female. The age range was between 35 and 55 years of age. In terms of education, two had bachelor's degrees whilst the other two had Masters degrees. See Table 1.

Table 1: Position, age, gender and qualification of the interviewee

Interviewee	Position	Age	Gender	Qualification
A	FM consultant	Over 55	Male	Degree
B	FM manager	35-46	Female	Masters
C	FM director	Over 55	Male	Degree
D	FM director	35-46	Male	Masters

FM functions

Both respondents C and D work within organisations that focus on all areas of FM. These organisations manage over 100 facilities. Respondent B is only involved in facility planning and real estate, while Respondent A, functions in building operation and management, strategic planning, outsourcing and insourcing.

Table 2: FM functions which the respondents are involved

Organisational functions	Interviewee
Facilities planning	C, D
Building operations and maintenance	A, C, D
Real estate and building construction	B, C, D
General office services	C, D
Outsourcing and insourcing	A, C, D
Green building	A, C
Strategic planning	A, C, D
Other. Specify	

Information management in FM

Sections of the questions asked concerning this theme are presented below in Table 3. The results indicate that the respondents are digital-ready, as all four of them receive, store and manage information digitally.

Table 3: Information management

Interviewee	Receive	Store	Manage	Share
A	Digital and paper	Digital	Digital	Digital
B	Digital	Digital	Digital	Digital
C	Paper and Digital	Digital	Digital	Digital
D	Paper and Digital	Paper and Digital	Paper and Digital	Paper and Digital

BIM utilisation

The interviews revealed that only respondent, A had used BIM previously as an employee, but he was not using BIM currently. Respondents B, C and D have never used BIM even though they are aware of it. They all suggested that the directive to use BIM must come from the designers and contractors, and they will follow suit.

In addition, Respondent A believed that BIM would only be fully considered in FM if the Government imposes specific rules, such as in the UK, where a level 2 of BIM is required for public projects. Respondent C further suggested that their organisation is willing to explore BIM for FM. Furthermore, Respondent C proposed a public sector driven BIM adoption for FM in South Africa.

Survey data

FM information management

For the question, in which format do you usually require FM information? Respondents could choose any format, and the question also allowed for multiple selections. Some of the respondents chose more than one response. Therefore, the total number of responses were more than those of the participants. Table 4. shows that 36% of FM information is received in paper formats, 44% in a digital copy on CD/DVD, 17% in BIM, 22% through BIM integrated into CMMS, and 19% through other means. Those who specified other means mentioned emails with a PDF attachment.

Table 4: FM information formats

Information format	Percentage of responses
Physical paper copy	36.11%
Digital copy on CD/ DVD	44.44%
BIM	16.67%
BIM integrated into CMMS	22.22%
Other. Specify PDF, MS Excel, Cherwell	19.44%

FM information formats

The respondents were asked how they store, share and manage FM information. The respondents indicated that most information is stored and managed digitally on a server via MS Excel, PDF and Cherwell. However, significant amounts of paper are involved, such as service records, invoices, and equipment manuals stored physically on-site and off-site. In addition, FM information is shared via emails, SharePoint and Dropbox.

BIM utilisation

To ascertain the level of BIM utilisation in FM, the respondents were asked if they use BIM or have used BIM for FM. The data from questionnaires shows that a small amount (20%) of FM practitioners use or have used BIM for FM, while 80% responded no, as shown in Table 5.

Table 5: Use of BIM model for Facility Management

	Answer	Percentage
1	Yes	20.%
2	No	80.%
	Total	100%

Further analysis of the respondents that use BIM for FM indicated that of the 20% who have used BIM or are currently using BIM, 50% consider themselves as intermediate users, 25% as beginners and 25% are experts. These results suggest that most BIM users are at ease with utilising BIM to support their FM functions. See figure 1 below

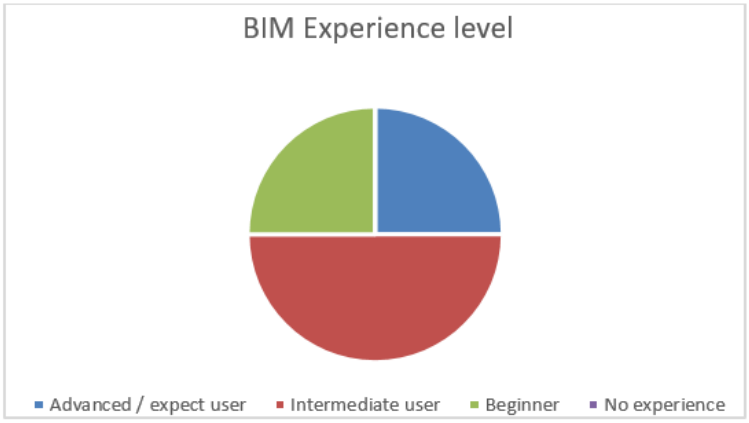


Figure1: BIM experience level

Figure 2 illustrate that 37.5% of BIM users use BIM in facility planning and building operations and maintenance, while 25% use BIM general office services. Findings also indicate that 75% of BIM users believe the system carries part of the information they require for FM and that manual inputs are still required.

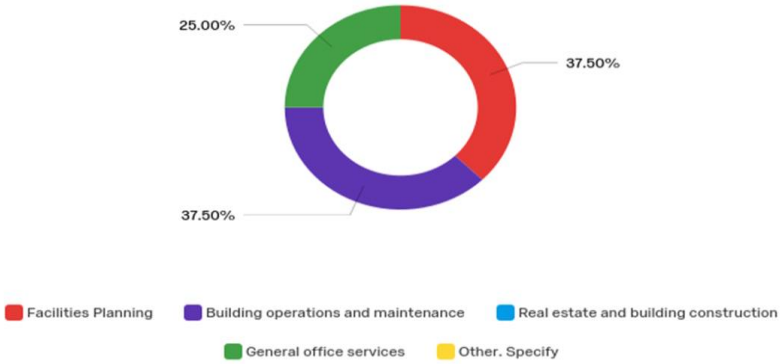


Figure 2: Area of FM where BIM is utilised

FINDING AND DISCUSSIONS

The data collected contains very diverse opinions and information from experienced FM practitioners. In analysing the data, the answers to all questions were linked to three thematic areas, namely FM functions, Information Management, Utilisation of BIM in South Africa.

According to the literature, FM functions include facility planning, Real Estate, building operations and maintenance management and general premises management. Figure 1 illustrates that approximately 38% of FM organisations within South Africa focus on building operation and maintenance management. These findings are similar to Kiprotich (2004), who suggested that FM

organisations' primary focus is building operations and maintenance. FM information is better stored and received in a digital format (Teicholz, 2013), but most buildings store their documentation in paper formats (Sabol, 2008). To further ascertain the level of digitalisation, the survey confirms that 44% of the respondents receive FM information in digital formats, while 36% receive information in paper format Table 4. These results suggest that the South African FM industry is transforming and is moving towards total digitalisation.

Moreno, Olbina, and Issa (2019) found that regardless of the participants' discipline, they indicated less frequent use of BIM in FM. Similarly, the data from this study show that a small amount (20%) of FM practitioners use or have used BIM for FM, as shown in Table 5. This finding corroborates with Becerik-Gerber et al. (2012) 's statement, which states that globally, some organisations push for BIM use in AEC while industry-wide adoption of BIM in FM has not been embraced. And the findings of, Kekana et al. (2015) indicate that only 38% of AEC practitioners are currently using BIM in South Africa, which means that the use of BIM in FM in South Africa is lagging behind its use AEC. This reveals that there is a gap in the use of BIM in FM. And Further analysis shows that organisations are not propelling adoption and awareness of BIM to support their FM functions.

Lastly, the findings show that BIM users use BIM to store, share and manage information and that some of the required information is still received and stored in paper format. This finding is supported by Bjork (2010) and Becerik-Geber et al. (2012); they believe that FM information is still received, stored and shared in paper format. This hinders the use of BIM in FM as Practitioners are of the option that information received in paper format takes too much effort and time to input FM information into BIM. This can be justified by considering that in developed countries, BIM is mandated, whereas BIM is not mandated, and there are no regulatory initiatives towards BIM implementation in developing countries.

CONCLUSION

This research aimed to determine the levels and extent of BIM utilisation in FM practice among FM practitioners in South Africa. As such, it is essential to note that FM practitioners in South Africa are still receiving, sharing and storing FM information in paper format. Those who use BIM find that BIM for FM does not have enough information for FM. Some of the information they require for FM must be captured manually into the system. It is costly and time-consuming to capture/input all the necessary data into a BIM model. These findings suggest that there is a low level of BIM utilisation in FM.

Whereas complexity and skill requirements heavily as challenges to BIM adoption by FM practitioners, findings from this current study also highlight a lack of appreciation of the extent to which BIM could improve their work. For FM practitioners to start using BIM, there is a need for the industry to educate the practitioners on the benefits of BIM in FM, for the Government to develop BIM adoption strategies and mandatory initiatives and for FM organisations to invest in BIM and collaborate with other stakeholders continuously. It is evident there is a scarcity of information regarding the utilisation of BIM-FM in practice in South Africa. The lack of evidence creates a knowledge gap in terms of best practice and

case study examples to prove the level and extent of BIM utilisation in FM in the context of South Africa. As such, the level of BIM utilisation in FM is not known.

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