AN EXPLORATORY STUDY ON THE BUILDING INFORMATION MODELING MATURITY LEVEL: A LITERATURE REVIEW

LAMA ABUMOEILAK and SALWA BEHEIRY

College of Engineering, American University of Sharjah, Sharjah, United Arab Emirates

The United Arab Emirates (UAE), Architecture, Engineering, and Construction (AEC) industry has undergone a profound transition and achieved significant progress in embracing technological improvements and transforming the current system. Building information modeling (BIM) is one of the leading forces behind Construction 4.0. The adoption of BIM in the UAE AEC industry has gained significant attention in recent years, with major projects increasingly using BIM due to directives from the Dubai Municipality and Abu Dhabi Municipality. Yet, the effective implementation of fully integrated BIM requires meeting specific criteria and has proven to be a challenge in the sector context. This study analyzes the existing BIM maturity models that could be applied within the UAE AEC industry. A comprehensive literature review was conducted to identify the current BIM maturity model, challenges, and barriers. It was followed by analyzing the selected international BIM maturity models to identify the gap. The main finding showed that the main obstacles to the effective implementation of BIM in the UAE AEC industry identified through the literature review were the need for a clear and comprehensive legal framework and a maturity model, more standardization, and the need for trained professionals. However, despite all the initiatives undertaken by the Emirates of Dubai and Abu Dhabi to support digital transformation in the AEC sector, implementation remains to be confined to BIM Level 2 in the case of Dubai and BIM Level 3 in the case of Abu Dhabi infrastructure projects.

Keywords: Maturity models, BIM, AEC, Dubai, Abu-Dhabi, BIMMM.

1 INTRODUCTION

A building or infrastructure's physical and functional elements are represented digitally in building information modeling (BIM) (Latupeirissa and Arrang 2022). It is a model-based approach that enables the creation, management, and sharing of accurate and up-to-date information about a construction project throughout its lifecycle (Wang et al. 2021). BIM can transform the Architecture, Engineering, and Construction (AEC) industry by providing a platform for collaboration and data exchange among various stakeholders (Dakhil et al. 2016). However, the effective implementation of BIM requires meeting specific criteria and has proven to be a challenge in the AEC sector (Siebelink et al. 2018). The United Arab Emirates (UAE) AEC industry has undergone a profound transition and achieved significant progress in embracing technology improvements and transforming the current system (Leite 2018). The notion of construction 4.0, built on core components such as industrializing construction processes and digitizing the building sector, has inspired this transformation (Ma et al. 2018).
BIM is one of the leading forces behind *Construction* 4.0 (NIBS 2016). Despite the initiatives undertaken by the Emirates of Dubai and Abu Dhabi to support digital transformation in the AEC sector, implementation of BIM remains confined to Level 2 in the case of Dubai and Level 3 in the case of Abu Dhabi infrastructure projects (Alankarage *et al.* 2022). A thorough literature analysis was conducted to determine the present status of BIM deployment, problems, and barriers in the UAE AEC industry (Jung and Joo 2011). An in-depth review of selected international BIM maturity models was also conducted to identify their gaps (Siebelink *et al.* 2018).

BIM adoption in the UAE AEC industry has gained significant attention in recent years, with major projects increasingly using BIM due to directives from the Dubai Municipality and Abu Dhabi Municipality. Despite these initiatives, the implementation of BIM in the UAE remains confined to BIM Level 2 in the case of Dubai and BIM Level 3 in the case of Abu Dhabi infrastructure projects. One of the main challenges to the effective implementation of BIM in the UAE AEC industry is the need for a clear and comprehensive maturity model that measures the level of implementation within an organization (Omar and Dulaimi 2023).

Other challenges to the effective implementation of BIM in the UAE AEC industry include a need for more standardization (Elhendawi 2018). According to Afzal *et al.* (2021), a lack of trained professionals and a lack of understanding of the potential benefits of BIM among stakeholders. The lack of standardization can lead to clarity and understanding among stakeholders, while the lack of trained professionals can hinder the effective implementation of BIM. Additionally, stakeholders may not fully understand the potential benefits of BIM, leading to a lack of support for its implementation (Wang *et al.* 2021).

## 2 RESEARCH METHOD AND MATERIAL

To conduct this study, a comprehensive literature review was conducted to identify the current state of BIM implementation, challenges, and barriers in the UAE AEC industry. Additionally, relevant articles and reports were selected from academic databases such as Google Scholar and Scopus, using a combination of keywords related to BIM, maturity models, construction, and the UAE. The inclusion criteria for articles were that they must be published in English, be relevant to the study topic, and be focused on the BIM maturity models.

Following the literature review, selected international BIM maturity models were selected to identify the gap between these models and the UAE AEC industry. These models were evaluated based on their suitability, their ability to accurately assess the current state of BIM adoption in the UAE, and their comprehensiveness in covering all aspects of BIM implementation.

## 3 REVIEW OF EXISTING MATURITY MODELS ON BIM IMPLEMENTATION AND USE

Many maturity models have been created. To assess the level of BIM implementation and use within an organization. These models provide a framework for evaluating an organization's capabilities and progress in adopting BIM. The Building Research Establishment (BRE) BIM Maturity Level (BML) model is a widely used framework for evaluating an organization's use of Building Information Modeling (BIM). According to Dakhil *et al.* (2016), the BML model consists of five levels of increasing maturity, starting at Level 0 (no BIM capability) and culminating at Level 4 (fully integrated BIM). These levels are based on the processes and practices related to BIM, such as adopting BIM protocols, integrating BIM into project delivery, and using BIM for asset management. Another widely used model is the National BIM Standard-United States
The NBIMS-US BIM Maturity Index (BMI), which was developed by the National Institute of Building Sciences (NI-BS). The BMI consists of four levels of increasing maturity, ranging from Level 0 (no BIM capability) to Level 3 (fully integrated BIM).

The BMI model focuses on BIM adoption's organizational and cultural aspects, including leadership, training, and communication (Banawi et al. 2019). The BIM Maturity Model (BMM) developed by the Dutch Construction Sector (Siebelink et al. 2018) has several advantages. Firstly, it helps organizations identify and prioritize areas for improvement in their BIM processes. Secondly, it provides a clear and structured approach for organizations to achieve higher levels of BIM maturity. Also, it allows organizations to benchmark their BIM capabilities against their peers and competitors. However, the BMM has some disadvantages as well. One disadvantage is that implementing it may be time-consuming and resource-intensive, especially for smaller organizations. Another disadvantage is that it may only apply to some construction projects, mainly geared toward large, complex projects.

The BIM Maturity Model (BMM) developed by the Australian Building Codes Board (Leite 2018) also has several advantages. One advantage is that it is based on a set of well-defined and widely accepted BIM capabilities, which allows organizations to benchmark their BIM capabilities against industry standards. Another advantage is that it provides a clear and structured approach for organizations to achieve higher levels of BIM maturity over time. A third advantage is that it allows organizations to identify and prioritize areas for improvement in their BIM processes.

However, the BMM also has some disadvantages. One disadvantage is that implementing it may be resource-intensive, especially for smaller organizations. Another disadvantage is that it may only apply to some construction projects, mainly geared toward large, complex projects.

Overall, each of these BIM maturity models has its own set of advantages and disadvantages. It is essential for organizations to carefully consider their specific needs and contexts when choosing which model to use. Additionally, it is essential to remember that BIM maturity is a continuous process, and organizations should regularly assess and improve their BIM capabilities to stay competitive and deliver the best possible outcomes for their clients (Dakhil et al. 2016, Ma et al. 2018, Siebelink et al. 2018, Kim et al. 2020, Sabri et al. 2020, Wang et al. 2021). Table 1 summarizes the BIMM key elements, origin, and levels.

4 FINDINGS AND RESULTS

Various BIM maturity models are available in the literature, each with its own set of levels and criteria. Some examples of these models include the BIM Capability Maturity Model (BIM-CMM), the Building Information Modeling Maturity Index (BIMMI), and the BIM Maturity Model (BIM-MM). These models generally define several maturity levels, ranging from essential adoption to advanced use of BIM.

Advantages of the BML model include its focus on practical, industry-specific BIM processes and its clear guidelines for achieving higher levels of BIM maturity. Additionally, the BML model has been validated in the UK construction industry, providing credibility and reliability.

However, one potential disadvantage of the BML model is that it may only fully apply to some organizations or industries. Additionally, some critics argue that the BML model does not adequately consider the potential financial benefits of BIM, which may be an essential factor for some organizations. Finally, the BML model may need to address the full range of potential BIM capabilities and may not be suitable for evaluating more advanced or specialized BIM implementations.
Table 1. Summary of most used BIM Maturity Model globally.

<table>
<thead>
<tr>
<th>Model</th>
<th>Key Elements</th>
<th>Origin</th>
<th>Levels</th>
<th>References</th>
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</thead>
<tbody>
<tr>
<td>BIM-CMM</td>
<td>BIM process, data management, collaboration</td>
<td>UK</td>
<td>5 levels</td>
<td>Giel and Issa (2013)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Sun et al. (2021)</td>
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<tr>
<td>BIM Maturity Model (BMM)</td>
<td>BIM process, data management, collaboration,</td>
<td>Dutch Construction Sector</td>
<td>4 levels</td>
<td>Peralta and Mourguès (2022)</td>
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<td></td>
<td>technology</td>
<td></td>
<td></td>
<td>Lu et al. (2021)</td>
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<td>Sun et al. (2021)</td>
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<tr>
<td>BIM Maturity Indicator (BMI)</td>
<td>BIM process, data management, collaboration,</td>
<td>Korean Ministry of Land,</td>
<td>4 levels</td>
<td>Umar (2022)</td>
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<tr>
<td></td>
<td>technology, sustainability</td>
<td>Infrastructure and Transport</td>
<td></td>
<td>Martin et al. (2019)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Siebelink et al. (2018)</td>
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<tr>
<td>BIM Maturity Model (BMM)</td>
<td>Collaboration, information management,</td>
<td>Netherlands</td>
<td>3 levels</td>
<td>Wan Mohammad (2022)</td>
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<td></td>
<td>process improvement</td>
<td></td>
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<td>Tian et al. (2019)</td>
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<td>Olawumi and Chan (2019)</td>
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<td>Zhang et al. (2017)</td>
</tr>
<tr>
<td>BIM-CMM</td>
<td>Collaboration, information management, process</td>
<td>USA</td>
<td>5 levels</td>
<td>Olawumi and Chan (2019)</td>
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<td></td>
<td>improvement</td>
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<td>Aghimien et al. (2021)</td>
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<td>Dakhil et al. (2016)</td>
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<td></td>
<td>Siebelink et al. (2018)</td>
</tr>
<tr>
<td>BIM Maturity Model</td>
<td>BIM capabilities, industry standards</td>
<td>Australia</td>
<td>5 levels</td>
<td>Jiang et al. (2021)</td>
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<td>Siebelink et al. (2018)</td>
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- **The BIM-CMM**, developed by the National Institute of Building Sciences (NIBS), has five levels of maturity: Level 0 (Awareness), Level 1 (Initial), Level 2 (Standardized), Level 3 (Integrated), and Level 4 (Advanced).
- **The BIMMI**, developed by the Royal Institute of British Architects (RIBA), has four levels of maturity: Level 0 (Awareness), Level 1 (Preparation), Level 2 (Adoption), and Level 3 (Expertise).
- **The BIM-MM**, developed by the Delft University of Technology, has four levels of maturity: Level 0 (Awareness), Level 1 (Introduction), Level 2 (Integration), and Level 3 (Optimization).

The critical elements of BIM maturity models generally include organizational readiness, technical capabilities, project management, and business process improvement. These elements are often grouped into organizational, technical, project management, and business process. Some models consider other factors, such as legal and environmental criteria, as essential elements of BIM maturity.

In summary, BIM maturity models provide a framework for evaluating and improving an organization's use of BIM. These models generally define several maturity levels, each representing an increase in the organization's capabilities and use of BIM. The critical elements of BIM maturity models include organizational readiness, technical capabilities, project management, and business process improvement, which are often grouped into organizational, technical, project management, and business process.

The main challenges to the effective implementation of BIM in the UAE AEC industry identified through the literature review were the need for a clear and comprehensive legal framework and a maturity model, the lack of standardization, and the lack of trained professionals. A legal framework that clearly defines the roles and responsibilities of stakeholders and establishes guidelines for using BIM can hinder its adoption and lead to misunderstandings and disputes. Similarly, the lack of standardization in the use of BIM can create confusion and hinder interoperability, leading to wasted resources and delays. Finally, the need for trained professionals skilled in using BIM can limit its adoption and hinder its effective implementation.
5 CONCLUSION

The previous studies showed that BIM adoption in the UAE AEC industry had increased significantly in recent years, driven by directives from the Dubai Municipality and Abu Dhabi Municipality. However, despite these initiatives, fully integrated BIM implementation remains a challenge in the UAE AEC industry due to the lack of measurement tools or maturity models that can fit the UAE’s construction context.

This study has provided a comprehensive overview of BIM implementation, challenges, and barriers in the UAE AEC industry. An analysis of selected international BIM maturity models has been conducted to identify the gap between these models and the UAE AEC industry. The findings of this study have implications for developing a BIM maturity model for the UAE AEC industry, which various stakeholders can use to assess the level of BIM adoption in the industry and identify areas for improvement.

Overall, the results of this study suggest that despite the initiatives undertaken by the Emirates of Dubai and Abu Dhabi to support digital transformation in the AEC sector, implementation of BIM remains confined to BIM Level 2 in the case of Dubai and BIM Level 3 in the case of Abu Dhabi infrastructure projects. To facilitate the effective adoption of BIM in the UAE AEC industry, it is necessary to address the challenges and barriers identified in this study, including the lack of a clear and comprehensive framework, the lack of standardization, and the lack of trained professionals. Future research should focus on developing and testing a BIM maturity model for the UAE AEC industry, as well as exploring challenges and barriers to BIM adoption in the industry. Additionally, further research is needed to understand the potential benefits of BIM in the UAE AEC industry and how these benefits can be effectively communicated to stakeholders.

References


