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Application of BIM in Developing Countries and Implications

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Abstract: Building Information Modelling (BIM) technology can solve construction issues from multiple perspectives, including technical and managerial. While existing research has primarily focused on BIM's benefits and framework development, few studies discussed whether BIM can be successfully applied in developing countries. This paper examines the current status and key obstacles hindering BIM adoption in developing countries, analyzing their underlying causes. Notably, the study reveals that high BIM awareness does not directly lead to high BIM usage. The findings aim to provide theoretical support for enhancing the BIM environment and increasing implementation feasibility in developing countries. Additionally, the research identifies critical barriers for governments to address in promoting BIM adoption, offering a foundation for policy formulation.

Keywords: BIM; Obstacles; Developing Countries

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1. Introduction

The use of BIM technology in the engineering field has been recognized by construction industry in recent years. The construction visualization, collision detection, and other functions are of great significance in reducing design changes and controlling costs. However, implementing BIM requires advanced construction technology, a high level of information technology, computer skills, and open construction culture. BIM may be difficult to implement in developing countries due to limitations such as the overall low level of information technology and the lack of BIM standards. Existing research focused on the benefits of implementing BIM in developing countries and developing new BIM frameworks, with few articles discussing the feasibility of implementing BIM in road construction in developing countries. However, it is necessary to study the feasibility of implementing BIM in developing countries. This is because research in this area can contribute to providing guidance and theoretical support to developing countries in formulating policies to promote BIM development. This paper aims to identify the main obstacles of BIM implementation in the road construction sector in developing countries and provide feasible solutions to improve the feasibility of BIM implementation for the road construction sector in developing countries.

2. Research methodology

This study uses a literature review as the main instrument to reach the research purpose by finding previous research on BIM topics in the road construction industry of developing countries. Some of the articles reviewed are about the implementation of BIM in the field of housing construction in developing countries. Although they do not belong to the field of road construction, the internal logic in terms of investment decisions, design optimization, cost reduction, and operation stage maintenance is similar to the field of road construction. By using a literature review, the author can quickly understand the current state of research on the implementation of BIM in the road construction sector in various developing countries and thus identify research gaps. The literature considered for this study was published between 2007 and 2022 and was mainly in English. Some government reports written in other languages were also referenced because they provided data to understand the local implementation of BIM. The methodology of the literature review for this paper is shown in **Figure 1**.

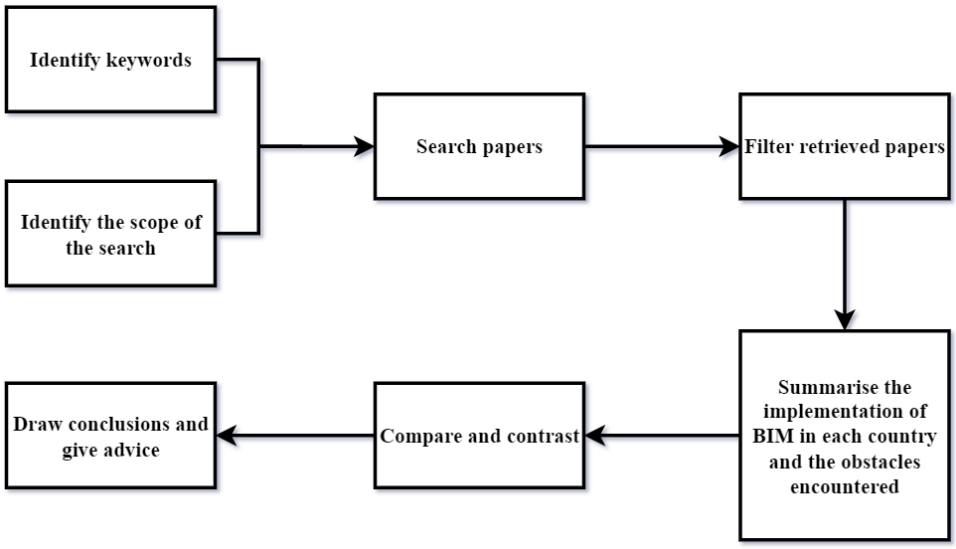

Figure 1. Methodology of literature review

To collect relevant papers for literature review, the following keywords and Boolean phrases were used:([Building information modelling OR BIM] AND [Developing countries] AND [road construction] AND [Obstacles OR Barriers] within [Title/ Abstract/ Keywords]) [1]. The repositories used in this paper include Scopus, ScienceDirect, Institution of Civil Engineers (ICE) virtual library, American Society of Civil Engineers (ASCE) library, and Google Scholar. Scopus is an abstract-only academic search engine, which was used for quick searches of relevant literature in this study. Science Direct provided both abstract and full text; it was used to view the full text of the paper, which was retrieved in Scopus.

3. Findings

In Malaysia, although the relevant government departments have made great efforts to promote BIM and enhance BIM education, the pace of implementation of BIM in Malaysia is still lagging [2, 3]. After the Malaysian government first used BIM for government projects in 2010, the construction industry development board was committed to helping the implementation of BIM to thrive in Malaysia. For example, adding BIM courses in university curricula and promoting the benefits of using BIM at construction industry conferences [4]. However, the result is not satisfactory. A survey finds that only 13% of Malaysian architectural firms used BIM in 2021 [5]. In this survey, the use of BIM technology was significantly higher in the public sector (8.2%) than

in the private sector (4.9%). The reason for this may be that the public sectors desire to lead by example and to drive the implementation of BIM across the industry. The majority of companies in this survey do not use BIM due to a lack of BIM knowledge, insignificant economic benefits, and awareness issues, which have existed since 2013 in Malaysian construction industry. This shows that the policies implemented by the Malaysian government in recent years have not been effective in raising the level of BIM mastery among construction industry practitioners. Another study by Azmi *et al.* also shows that most people have a very limited grasp of BIM, saying they have only experienced it and are still learning [6]. Even though all investigators in this study agree that BIM will bring benefits to the projects, the construction industry is still reluctant to use the technology. Overall, although the Malaysian government has made some efforts to encourage and promote BIM in terms of publicity and education, and the public sector is taking the lead in using BIM, the BIM usage rate is still very low. The lack of a mandatory BIM policy may be one of the reasons for the low usage of BIM in Malaysia.

In India, most construction industry practitioners are willing to use BIM, but the use rate is low. An eight-month survey conducted by Klynveld Peat Marwick Goerdeler (KPMG) and Royal Institution of Chartered Surveyors (RICS) in major Indian cities revealed that approximately 78% of Indian respondents who were aware of BIM expected to start using it, but only 22% of industry players were currently using it [7]. In India, BIM is not implemented throughout the project lifecycle. BIM is mainly used in the pre-project phase and rarely in the operation phase [8–10]. The survey by KPMG and RICS shows that, in Indian projects, BIM was mainly used in the design and development phase (79.9%), followed by the construction phase (59.5%), with only 12.2% continuing to use BIM in the operation phase. The fact that the three most used functions of BIM among the Indian respondents were design coordination, clash detection, and quantity measurement also indicates that the use of BIM in India is still largely focused on the pre-project phases, such as design and tender, but not the whole project lifecycle. Other reasons for the low usage of BIM in India include the lack of BIM talents, lack of mandatory policies, and unclear economics return [8, 9]. There is a lack of structural, mechanical, electrical, and plumbing consultants skilled in the use of BIM in India [7]. So, although clients expect to use BIM, projects may still be unable to use it due to a lack of skilled staff. Moreover, although the construction industry associations in India are encouraging the implementing BIM, the government has not yet introduced mandatory provisions for companies to use it. The lack of regulatory guidance and mandatory provisions from local governments has also slowed down the development of BIM within India.

In China, BIM is widely used but concentrated in public projects [11]. Around 51.27% of companies in the construction industry are using BIM in more than half of their projects [12]. In government projects in tier 1 cities like Beijing and Shanghai, the BIM usage rate reaches 85.15% [13]. The implementation of BIM in China has been largely driven by government guidance and regulations [14]. China Construction Association (2021) also reported that for construction companies, the requirements of clients are the biggest driver for the use of BIM. The Chinese government has introduced both mandatory and incentive policies for the implementation of BIM. The former requires that the government projects with a building area of more than a certain square meter must use BIM, while the latter requires clients to set appropriate bonus points for bidders who commit to using BIM. However, the development of BIM in China is still hampered by insufficient government guidance. Although some policies and regulations have been introduced in China, the construction industry still wants more guiding standards adapted to the Chinese context, such as design standards, document delivery standards, and tariff standards [15]. Lack of policy is still the biggest issue preventing owners from using BIM [16–18].

In Pakistan, the implementation of BIM is slow [19]. A survey of Sindh, the province with the highest BIM usage and the largest population in Pakistan, shows that only 11% of related industries had implemented BIM,

and BIM is limited to 3D modelling for large projects [2, 20]. Several surveys showed that Pakistani professionals are willing to implement BIM, but the major obstacle of lacking skills is hindering the development of BIM in Pakistan [19–22].

In Nigeria, BIM technology is relatively lagging, and the awareness of BIM is low [23, 24]. This is supported by the survey of Anifowose *et al.*, which found that only 40% of construction professionals were aware of BIM [25]. The Nigerian housing development board does not have incentive policies for BIM, but the local educational institutions have undertaken initiatives to add BIM courses to university architecture curricula to enhance graduates' BIM application skills [26]. BIM technology in Nigeria is mainly used in the design phase to produce drawings [27]. Engineers' lack of mastery of BIM technology is the main obstacle to BIM implementation in Nigeria [25, 26].

In Indonesia, BIM was first documented in 2013. Research on BIM was limited at the time and progressed slowly until it came alive in 2018 [28]. After formally introducing BIM in Indonesia in 2017, the Indonesian government developed a roadmap for BIM implementation and formed a BIM team to accommodate the process of BIM adoption in Indonesia [29]. However, the awareness of BIM in Indonesia was still in its infancy. Larasati *et al.* found that, in Indonesia, BIM was still perceived as a technology rather than an integrated system, resulting in the use of BIM not being collaborative among stakeholders [30]. A report by Sopaheluwakan *et al.* also shows that only a small number of survey respondents are able to use BIM. Most people only have a basic understanding of BIM or have only heard about BIM [29].

4. Discussion

The result shows that awareness campaigns can raise awareness of BIM, but they are not effective in increasing the BIM usage rate. In the literature review, all governments are aware of the importance of BIM to the sustainable development of the construction industry and have undertaken activities to promote BIM, such as adding BIM courses to universities and promoting BIM at industry conferences. But the generally low rate of BIM implementation in developing countries suggests that these non-mandatory promotional activities have not been effective in increasing BIM usage. Moreover, high BIM awareness does not directly lead to a high BIM usage rate. From the literature review, it is found that BIM awareness is high in India and Pakistan, but the BIM usage rates in these two countries are not significantly higher than those in Malaysia and Nigeria, two countries with low BIM awareness among construction professionals. This suggests that for developing countries, increasing BIM awareness alone is not effective in increasing the use of BIM. BIM implementers in the road construction sector in developing countries need to consider a comprehensive range of factors such as awareness, skills, education, benefits, and legislation.

Moreover, the development of appropriate BIM policies is a key long-term issue for BIM implementation in developing countries. Even in China, where mandatory policies are in place and BIM usage is high, the survey shows that the main obstacle to BIM implementation is still the lack of adequate policy support [11, 31]. However, there is a need to consider whether relying solely on government support for BIM implementation may make the industry overly dependent on policy support.

Furthermore, it is important to note that the adoption of mandatory policies in developing countries requires a gradual approach based on local realities. Due to differences in construction culture and legal systems, policies in other systems may not be adapted to the local road construction industry, despite their maturity. In China, for example, government-issued policies are very binding and driven, while in more market-oriented countries such as the UK and Malaysia, visible cost-effectiveness may have a greater driving force.

Whereas in India, where the economic system has the nature of both socialism and capitalism, the context of the construction industry will again be different. The BIM implementation sector needs to introduce localized policies to suit local circumstances.

5. Conclusion

This study explored the possibility of applying BIM in road construction within developing countries by reviewing a wide range of existing research. It focused on the main challenges and the reasons behind them. The results show that, although awareness campaigns have increased knowledge of BIM, they have not led to much use in practice. High awareness does not always bring high adoption because of several limits, such as a lack of technical skills, unclear economic gains, and weak policy support.

These findings suggest that developing countries should take a combined approach to encourage BIM adoption. This should include raising awareness, offering targeted training, providing economic support, and creating rules that match local building practices and legal systems. Policy decisions should be gradual and based on local conditions, rather than directly copying other countries' models. By combining technical standards, human resource development, and policy support, developing countries can create a better environment for BIM adoption, improve project efficiency, and promote sustainable growth in the construction sector

Disclosure statement

The authors declare no conflict of interest.

Author contributions

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