

Implementation Strategies of Building Information Modelling towards Sustainable Residential Construction Project in Malaysia

Nur Syafika Artika Rahim^{1,*}, Syuhaida Ismail¹, Aminah md Yusof²

¹Razak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, 54100 Kuala Lumpur, Malaysia

²School of Civil Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 Johor Bahru, Malaysia

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Abstract There are major challenges in regards to building information implementation strategies in achieving sustainable residential construction projects in Malaysia, namely project management team's lack of knowledge, the high cost in training, lack of technology infrastructure and software readiness, no support for the management to change from conventional method to BIM application. Therefore, this paper is aimed to appraise the BIM implementation in achieving sustainable residential construction in Malaysia in terms of its challenges and implementation strategies. This paper is undertaken based on data gathering via literature review, which is then analysed and validated by an expert focus group inclusive of 2 developers, 2 consultants, and 1 contractor with more than 20 years of experience in the BIM application. It is found that the challenges in BIM to achieve sustainable residential construction projects in Malaysia are lack of BIM technical knowledge, difficulties in accessing BIM technology and its framework, absence of appropriate BIM guidelines, and insufficient government support for BIM regulation and its implementation. Hence, it is important to propose good implementation strategies in implementing BIM to achieve sustainable residential construction projects in Malaysia, which include proper governments support for BIM initiatives and awareness within the Architectural, Engineering, and Construction (AEC) industry players, and provide an incentive for the relevant

parties utilising BIM in their project and implement BIM in all government and private projects. The proposed BIM implementation strategies can serve as a guide for the industry player who is involved in the construction project in Malaysia to drive the Public Work Department Strategic Plan 2021-2025 and to support the green building initiatives by The Malaysia Green Building Council (MGBC) and the United Nations Sustainable Development Goal (UN SDG).

Keywords Building Information Modelling (BIM), Implementation Strategies, Sustainability, Residential, Construction, Project, Malaysia

1. Introduction

The construction industry is a significant industry that contributes to socio-economic growth worldwide. Construction is also one of the industries that are contributing to major problems that will lead to unsustainable action, such as stakeholder miscommunication, uncontrollable construction wastage, major project dispute within stakeholders, human errors and inaccuracy, project cost overrun, and project delays [1]. In addition to that, in terms of environmental, the

construction industry also contributed 24 percent of carbon emission from the total industry sectors in Malaysia [2].

The construction project is also prone to project stakeholder miscommunication and other project disputes that will lead to cost overrun and project delays [3]. Furthermore, other problems such as the inability to detect early constructability issues and conflict were also amongst the major issue in residential construction projects [4]. Besides, building information modelling (BIM) implementation has also not been generally embraced by the architectural, consultancy, and construction (AEC) industrial players hence, its lead to its slow growth in both developing and developed countries [5]. Although, BIM was initiated to solve the construction project inefficiencies and improve its existing implementation strategies in ensuring the Malaysian national agenda concerning sustainable and residential development can be achieved; its implementation by the industry in Malaysia is still minimal. This is because although BIM was widely known for its function that can anticipate changes in the construction project and ascertain successful delivery of the project [6], the project management team (PMT) is reluctant to practice BIM because of its high cost in training and technology infrastructure [5].

Even so, BIM is starting to gain its implementation in other advanced countries, such as Australia, Denmark, Finland, Netherlands, Norway, Singapore, the United Kingdom (UK), United States of America (USA) [8]. BIM is critically important to solve decision-making problems and to integrate all data, especially during the planning and design stage. However, the level of implementation in Malaysia is very low despite its advantages [9]. Therefore, this paper aims to appraise the BIM implementation strategies through its challenges to achieve sustainable residential construction in Malaysia and to be served as a guideline for the AEC industry players.

2. Literature Review

Overview of Building Information Modelling (BIM) in Sustainable Residential Construction Project in Malaysia

Building Information Modelling (BIM) may greatly influence the evolution of the construction industry that is now a global phenomenon. Based on the national Construction Policy 2030 by the Ministry of work Malaysia that was launched in the year 2021, the construction industry is moving towards digitalisation [31]. With the implementation of BIM-based digitalization initiatives, it can help the residential construction industry

to become more sustainable and it is a collaborative way of working, with a more efficient method of designing [10]. BIM is capable of producing its 2dimensional models from the design stage, which can be used respectively by all stakeholders including project architects, consultants' engineers, contractors, and facility management (FM) managers, at all stages of the lifecycle of preliminary planning until the operation of the building [11]. However, it is can be seen that despite the relevance of BIM to achieve sustainable residential construction projects in Malaysia, the rate of its implementation is still slow due to its challenges.

It is important to highlight that there is increasing demand and awareness within the public for sustainable building facilities with minimal environmental impact [6]. The most critical phase to achieve sustainability in residential construction projects' decision-making is at the preliminary design and pre-construction stage of a building [6]. Also, [12] stated that building orientation, daylighting analysis, water harvesting, energy modeling, and sustainable materials selection are some of the BIM's aids in residential construction project sustainable design. Hence, this paper observes that BIM and sustainability are the two emerging subjects in the construction industry, that are in the need to ensure more affordable sustainable residential projects can be developed for the communities in Malaysia.

Table 1 shows how BIM can contribute towards achieving sustainable residential construction projects in Malaysia.

Based on Table 1, it is observed that the most cited BIM functions that can help the sustainability effort for the residential construction project are, BIM can optimise the construction cost throughout the project life cycle [32],[34],[35],[36], and [37]. With this function, it is easy to monitor the residential construction project costing throughout the project lifecycle to ensure there will be no cost overrun, and hence achieve its sustainable efforts.

Additionally, the other BIM function with the most cited by the authors is BIM which can be used as a tool to reduce environmental impact in sustainable residential construction projects [32],[33],[35],[36], and [37]. By using the right software, BIM can help to reduce environmental impact such as waste reduction which can be planned from the beginning of the residential construction project [36] and [37]. Therefore, it can be seen that the implementation of BIM will be the major contributor to ensure the environmental impact can be minimised, and hence, the sustainability of the residential construction projects in Malaysia can be achieved.

Table 1. BIM functions toward sustainable residential construction projects in Malaysia.

BIM Function towards Sustainable Residential Construction Project in Malaysia	[32]	[33]	[34]	[35]	[36]	[37]	Frequency of Citation
1	X		X	X	X	X	5
2	X	X					2
3	X	X					2
4	X	X	X		X		4
5	X	X		X	X	X	5
6					X	X	2

Indicators:

1. BIM can optimise its construction costs throughout the residential construction project life cycle
2. BIM can enhance the technical resilience of the sustainable residential construction project phase by enabling simulation on the structural performance for disaster risk forecasting
3. BIM can facilitate various green building performances in the sustainable residential construction project
4. BIM can minimise building maintenance cost of sustainable residential construction project
5. BIM can be used as a tool to reduce environmental impact in sustainable residential construction project
6. BIM can help in reducing waste in construction

Table 2. Challenges in adapting BIM to achieve sustainable residential construction project. Summarised from authors ([13], [14], [15], [16], [17], [6], and [18])

Causes	[13]	[14]	[15]	[16]	[17]	[6]	[18]	Frequency of Citation
1	X	X		X		X		3
2	X		X					2
3					X	X		2
4	X		X					2
5							X	1
6						X		1
7	X							1
8	X			X				2
9						X		1
10							X	1
11					X			1
12		X						1

Indicators:

- 1 – Lack of BIM Technical knowledge in construction project
- 2 – Difficulties to access BIM technology and its framework
- 3 – Higher capital investment in BIM technologies
- 4 – Absence of appropriate BIM guidelines
- 5 – Insufficient government support for BIM regulation and its implementation
- 6 – High cost of staff training, software, and infrastructure
- 7 – Lack of management support due to unclear vision
- 8 – Difficulties to change/individual perception
- 9 – Legal and contractual limitation
- 10 – Lack of demand from clients
- 11 – Inadequate vision of BIM benefits
- 12 – No support from clients/government for BIM adoption in projects

Challenges in Adapting Building Information Modelling to Achieve Sustainable Residential Construction Project in Malaysia

Construction project by their nature is complicated, fragmented, high risk, and uncertain [6]. Hence, the usual problems in the construction industry such as project communication, coordination, and management especially when the project stakeholders are all located in discrete locations or different locations [39]. Additionally, the extensive physical distance between stakeholders, who are all located in different regions or places, is the primary reason for slow decision-making in the construction project [14]. BIM can easily help the project stakeholder by smoothening the project delivery. However, to successfully implement BIM in the project, several major challenges need to be addressed. The challenges were identified and shown in Table 2.

Based on Table 2, it is observed that the most cited challenges in BIM implementation are the Lack of BIM technical knowledge in construction projects and its awareness [13],[14], and [16]. It can be seen that without proper knowledge and understanding of the BIM process, it is difficult to implement it in the construction project. Hence, it is important to address these critical challenges by initiating the right awareness to the residential construction project stakeholders in Malaysia.

Similarly, the other challenges cited by the authors are accessibility to the BIM framework and technology. This no doubt had a significant effect on BIM implementation. For instance, [13] asserted that even if the company embraces the changes from an existing process to a new one without access to suitable technology and its framework, the change will not be lasting. Moreover, [17] argued that the transition from traditional processes to conventional processes, such as BIM, has high-cost implications. Business owners are reluctant to implement it, unless they can associate it with long-term gain concerning their respective firms as well as a substantial reduction in the cost of training. Therefore, it is agreed that the difficulties to gain access to adapt BIM and its framework, as well as difficulties to change, are also a critical challenge to the BIM implementation in most developing nations, especially in Malaysia.

In addition to that, [15] argued that BIM technologies are mostly high cost to procure and difficult to set up. This is because the implementation of BIM involves high initial capital investment, which includes BIM computer hardware and software packages purchase, its infrastructure, and high cost in staff training among others [17]. Thus, project stakeholders might incur excessive

expenses, which will affect their profit [19]. Therefore, many construction industry players were not confident to implement BIM in their project without adequate support from the government in terms of finances, especially under the current BIM implementation initiatives. The BIM implementation will continuously remain at a slow rate because the construction industry players were still not interested in fully implementing BIM in their projects.

3. Methodology

The paper is based on a thorough review of the literature and expert focus group validation through a structured interview. The document review generally provides useful information to support or supplement data collection based on the understanding of the challenges in implementing BIM to achieve sustainability in the residential construction project in Malaysia.

The proposed implementation strategies that have been initiated based on the literature review findings will then be validated by the expert focus group inclusive of 5 experts amongst 2 developers, 2 consultants, and 1 contractor having vast experience in residential construction projects in Malaysia. The experts interviewed in this study were well experienced in managing residential construction projects in the private and public sectors in Malaysia.

The interview findings will be then analyses based on the expert focus group agreement on the proposed implementation strategies for the construction industry players.

4. Findings and Discussion

BIM is slowly dominating the construction industry depending on the nation's strategies [20]. The experts, researchers, and government authorities have also started to discuss several BIM implementation strategies that have to take place in the sustainable residential construction project.

Ten proposed implementation strategies were discussed during the interview. The results of the expert focus group structured interview are based on the expert agreement on the implementation strategies. Hence, their point of view findings and impact relationship will demonstrate how important are the strategies to be implemented in the future.

Table 3 shows the BIM implementation strategies that were discussed with the expert focus group.

Table 3. Proposed BIM implementation strategies to achieve sustainable residential construction projects in Malaysia

No	BIM Implementation Strategy	Frequency	Impact	Importance
1	The government helps to promote BIM awareness to the AEC industry players in the sustainable residential construction project in Malaysia	4	5	20
2	Proper selection of BIM tools according to the sustainable residential construction project needs in Malaysia	2	3	6
3	Ability to involve all project stakeholders in the BIM dynamics and facilitate the transition change in the sustainable residential construction project in Malaysia	2	3	6
4	Introduction of BIM standards and guidelines to help better users understanding of sustainable residential construction projects in Malaysia	3	4	12
5	Initiate BIM workflow that helps management to understand the process better and thus get their support for complete implementation in the sustainable residential construction project in Malaysia	4	4	16
6	Incorporate BIM syllabus in the academic curriculum especially in the sustainable residential construction project in Malaysia	5	2	10
7	The government helps to subsidies BIM initial investment cost to encourage the AEC players to implement them in the sustainable residential construction project in Malaysia	5	5	25
8	Sufficient BIM training and seminar to equip relevant stakeholders in the sustainable residential construction project in Malaysia	5	5	25
9	The government have to improve technology infrastructure to accommodate the BIM process and implementation in the sustainable residential construction project in Malaysia	3	3	9
10	100 percent BIM usage requirement for all government projects to encourage AEC players to start to implement it within the team especially in the sustainable residential construction project in Malaysia	2	5	10

Impact Indicator

1. Very Low Impact
2. Low Impact
3. Medium Impact
4. High Impact
5. Very High Impact

Table 3 shows that it is suggested by most of the experts via the structured interview that as a part of improving the BIM implementation in achieving sustainable residential construction projects in Malaysia, the most important implementation strategies are the government needs to help in subsidising BIM initial cost to encourage more construction industry players to fully implementing BIM in their projects. This strategy can be seen as an important effort because based on the challenges findings via literature review; many authors cited their most common challenges that affect the BIM implementation in the project as its high cost of investment for its tools and infrastructure. Therefore, it is important if the construction industry player can get financial assistance from the government to fully implement BIM in their projects, and hence, the BIM implementation strategy will be fully accepted by the construction industry players to achieve residential construction project sustainability in Malaysia.

Managing and sustaining the sustainability of the residential construction project is one of the most challenging tasks [23]. One of the experts claimed that the residential construction project in Malaysia is having difficulties in achieving its sustainable initiatives, such as effective cost management, accurate design planning, good

communication, and fewer project disputes during design planning. Moreover, insufficient support from the government authorities for the BIM implementation is one of the major factors that affect the construction industry players to achieve its full implementation strategies [18]. It is often that a residential construction project experiences a significant inaccurate design planning and a huge amount of construction wastage that often causes the project cost to exceed the budget, and thus leading to an unsustainable project. Therefore, the expert focus group suggested that the government authorities establish the government policy that requires 100% BIM implementation in all government and private projects to ensure its demands in the construction industry.

Apart from these, the other implementation strategy on how to implement BIM in a sustainable residential construction project in Malaysia, is the government authorities should be able to help to promote BIM to construction industry players. The expert agrees that these initiatives also have a high impact on the industry due to the ability of the government to increase construction industry players' awareness.

Subsequently, most of the experts also agree that the other important strategy is to ensure sufficient BIM

training and seminar to equip the relevant stakeholders in the project so that everyone is in better understanding of the BIM usage, and hence making the project more efficient and sustainable in the future.

These proposed implementation strategies can help the construction industry players to achieve sustainability in implementing BIM in the residential construction project in Malaysia. The use of BIM in the project will reduce major critical challenges in the sustainable residential construction project in Malaysia, such as design clash, cost overrun, project delays, and disputes between the stakeholders.

5. Conclusions

Many challenges hinder BIM implementation to be fully implemented in the sustainable residential construction project. The outcomes of a thorough review of this literature would have to classify the challenges in implementing BIM to achieve sustainability in the residential construction project in Malaysia and propose BIM implementation strategies to achieve sustainable residential construction projects in Malaysia.

Also, it is found that the most important challenges in adapting BIM in the residential construction project in Malaysia based on the findings are lack of BIM technical knowledge and its awareness, difficulties to access BIM framework and technology, a high initial investment in BIM technology, absence of appropriate BIM guideline and difficulties to change especially in the organisation.

Based on the proposed BIM implementation strategies to achieve sustainable residential construction projects in Malaysia, the most important strategies are the subsidies from the government on BIM initial investment cost including its software and infrastructure, sufficient seminar, and training for relevant project stakeholders, sufficient promotion and awareness initiated by the government for AEC industry players and ensuring the management level understand BIM before making a big transition of change from the conventional method.

This paper is expected to become a guideline for project stakeholders related to sustainable residential construction projects, such as developers, project consultants, government bodies, contractors on how to implement BIM to achieve sustainable development, especially in Malaysia. With the implementation of BIM in the residential construction project in Malaysia, it will also support the Public Work Department Strategic Plan 2021-2025 to reach 50% of BIM implementation by 2021 and 80% by 2025 [30].

This guideline will also reduce the environmental impact and hence support the 2030 agenda of sustainable development goal 11 (SDG 11) agenda by The United Nations (UN) through green building initiatives by The Malaysia Green Building Council (MGBC).

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