Penerbit Akademia Baru

Journal of Advanced Research Design

Journal homepage:
https://akademiabaru.com/submit/index.php/ard
ISSN: 2289-7984

Assessing the BIM-Lean Synergy Adoption Trends in the Malaysian Construction Sector: Benefits and Challenges

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ARTICLE INFO

Article history:
Received 21 February 2025
Received in revised form 23 August 2025
Accepted 23 September 2025
Available online 31 October 2025

Keywords:
Building Information Modelling, Lean Construction, BIM-Lean synergy, benefits, challenges

ABSTRACT

Building Information Modelling (BIM) refers to a detailed digital depiction of a building, including its geometry and information for design and procurement purposes. Meanwhile, Lean Construction (LC) is an approach aiming to improve construction efficiency through waste reduction of time, resources and labour while maximising project potential value. Certainly, the construction industry promotes real, practical solutions over theoretical concepts. Despite previous global adoption of BIM-Lean synergy demonstrating benefits like increased profitability, cost and schedule control and risk reduction, most Malaysian construction sector is mostly unaware of these benefits. Thus, this study aims: i) to assess the level of awareness of lean implementation in Malaysian BIM construction projects and ii) to investigate the feasibility of BIM-Lean synergy in Malaysian construction projects. This research employed qualitative methods, which include semi-structured interviews with 12 industry professionals from Grade 3 to Grade 7 contractors and an engineering solution consultant in Selangor. Findings interpreted that all respondents agreed that the integration of BIM-Lean synergy will substantially impact the construction sector over the next decade. The benefits include better communication and collaboration, more on-site monitoring and fewer inefficient process layouts and errors. However, challenges include a lack of study of synergy functionality, low contractor acceptance and high software expenses. Regardless of this, BIM-Lean synergy is feasible in Malaysia with strong top-down government support and collaboration with industry players.

1. Introduction

The construction industry is unquestionably one of Malaysia's important contributors to economic prosperity. Despite its significance, construction delays have hindered the construction

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https://doi.org/10.37934/ard.146.1.151165

sector. According to Mollasalehi [1], a high percentage of non-value-adding activities is owing to low overall productivity and performance in construction projects.

BIM presents as an intelligent 3D model-based approach that gives AEC professionals the knowledge and tools for better planning, designing, building and managing facilities [2]. In light of this, BIM optimizes construction lifecycle management through a digital information repository. Additionally, Lean approaches with their fundamental concept of maximizing value and minimizing waste are being acknowledged as the key procedures for various BIM utilizations. Some researchers described LC derived from lean thinking ideas as 'revolutionary' since it has a favourable influence on cost, safety, quality and environment [3].

Recognising the benefits, this study will assess the BIM-Lean synergy adoption in Malaysian construction projects. Current studies demonstrate strong synergies between them by reducing project variation and improving the project cycle through improved visualisation and cooperation [4]. BIM and LC are two distinctive yet interconnected initiatives [5]. Even though these approaches come from different initiatives, both offer decent effects towards the industry when adopted [6-7].

To achieve the research goal, two objectives will be prioritized. The first objective was to assess the level of awareness of lean implementation in Malaysian BIM construction projects. Meanwhile, the second objective is to investigate the feasibility of BIM-Lean synergy in Malaysian construction projects. The BIM-Lean synergy positively impacts Malaysia's construction industry, which needs to be comprehended. Hence, encouraging the exploration of BIM-Lean synergy, particularly in the Malaysian context, is crucial as it will accelerate its growing adoption within the industry.

This study focused on the Selangor region and included contractors from Grade 3 to Grade 7 with an engineering solution consultant. Owing to the nature of this understudied concept, semi-structured interviews were deployed, representing the study's qualitative methodology. A list of respondents was obtained from BIM construction companies to some degree consisting of 12 company representatives. It involves 5 respondents in semi-structured email interviews, 3 respondents through virtual meetings and 4 in-person interviews. In Malaysia, the BIM-Lean synergy adoption is uncommon. Thus, this study aims to acquire further insight into how the two concepts complement one another and what benefits they might offer in return to Malaysia's construction sector.

1.1 Building Information Modelling (BIM)

BIM is defined as a collection of interacting policies, processes and technology which provide a methodology for managing building design and project data in a digital format of the building lifecycle [8-9]. The solution supports a cloud-based 3D model visualisation for smoother collaboration and communication among project teams and stakeholders. Unlike conventional approaches, BIM provides an advanced 3D model virtual process, incorporating all disciplines and system facilities for better accuracy and efficiency [10-11]. BIM enables the storage of physical and functional data in several dimensions, namely geometry (3D), schedule (4D), cost (5D), operation (6D), sustainability (7D) and safety (8D) with project-specific analysis and prediction [12].

Numerous benefits could be obtained from BIM adoption in 3 different stages of the construction phase: pre-construction, during construction and post-construction. In pre-construction, BIM improves idea and feasibility, resolves design discrepancies, precise cost estimation and effective design reviews [13-14]. Meanwhile, during the construction process, BIM enhances project cost and scheduling accuracy, fosters real-time decision-making, promotes efficient fabrication and reduces rework, all of which indirectly lead towards sustainability value [15]. Last but not least, BIM is capable

of improving maintenance scheduling in post-construction via offering easy and useful lifecycle data, enabling prompt and accurate operational maintenance.

1.2 Lean Construction (LC)

LC was originally intended to streamline operations, establish the most efficient way to meet client requirements and eliminate waste from construction processes and supplies. The concept was developed by applying lean thinking to the design and construction cycle to boost constructors' profitability and clients' deliverability [16]. Previous research has indicated that adopting LC tools can address ambiguity and challenges, resulting in increased efficiency [17-18]. As a result, this revolutionary movement substitutes conventional management practices with leading-edge project management standards of the current era.

As mentioned by Akanbi *et al.* [16] and Ivina & Olsson [19], five core principles of lean include: (1) Identifying Value – Specifying value from the customer's perspective that fulfils its purpose, necessity and value for money (2) Value Stream Mapping – Designing process mapping applications, suggesting improvements and identifying adequate tools (3) Continuous Flow – Create a continuous flow ambience by standardizing work (4) Allowing Customer Flow – Ability to deliver products to clients instantly (5) Pursuing Perfection – Designing processes for immediate problem detection including continuous learning and improvement.

1.3 BIM and Lean Synergy

Through previous research studies, the construction industry has started to examine and apply collaborative efforts between BIM and LC for effective project management [20]. Currently, BIM adoption solely in construction is poorly adopted, necessitating lean practices for safer, faster and cost-saving while encouraging environmental sustainability through the BIM-Lean synergy. This feasible scenario elevates key values in time, cost, quality and environmental across the entire lifecycle. Their synergy is envisioned to enhance project outcomes and long-term operational efficiency. Al-Adwani [17] and Dave [22] identified three core Lean principles which align with BIM capabilities: waste minimisation, improved production flow and accelerated construction duration, all of which serve to project efficiency.

2. Methodology

This study applied a qualitative research methodology by employing semi-structured interviews as primary data collection. The 5 key stages involved in this study include:

- Stage 1: Preliminary Study
- Stage 2: Literature Review
- Stage 3: Pilot Study
- Stage 4: Execution of Semi-Structured Interview
- Stage 5: Data Analysis and Discussion

The entire research process is illustrated in Figure 1, which presents the methodological framework leading the study.

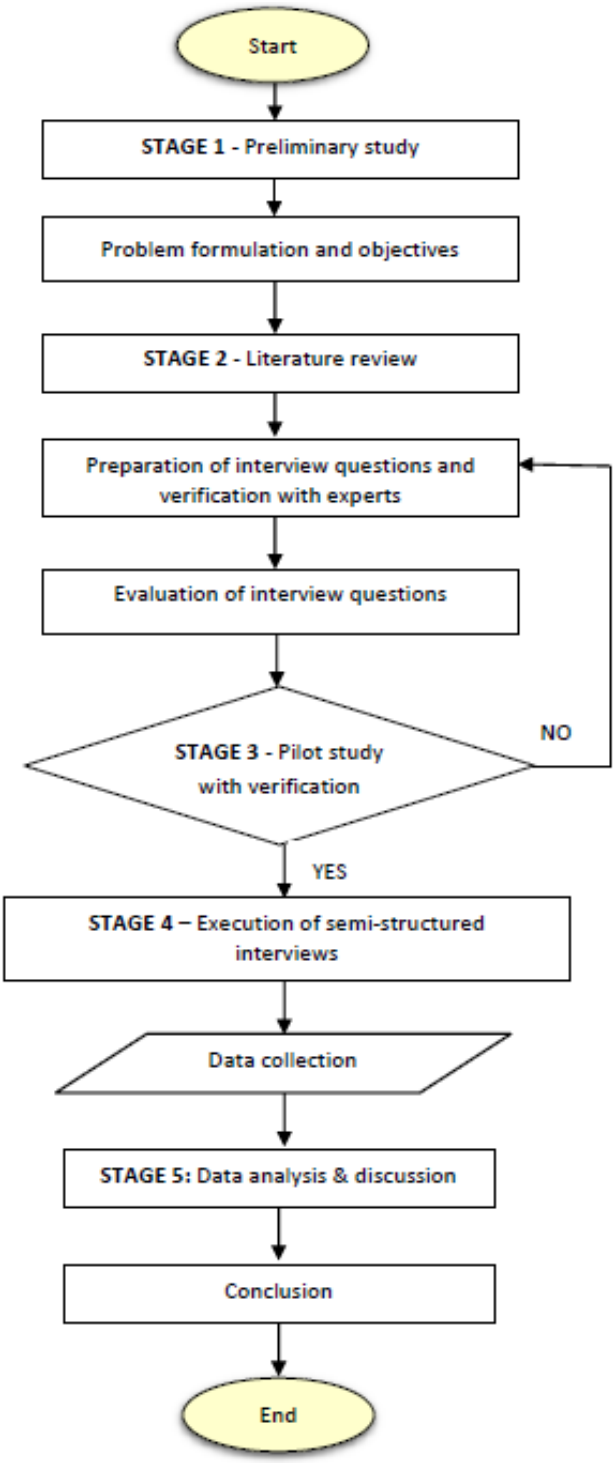

Fig. 1. The methodology flowchart

2.1 Qualitative Method

On behalf of this study, a qualitative method was employed which focuses on the collection and interpretation of non-numerical data to comprehend underlying concepts, perceptions and experiences. Interviews with selected respondents were utilised as the primary data collection instrument to explore the respondents' perspectives from the construction industry.

2.1.1 Instrumentation: Semi-structured interview

A semi-structured interview was employed to assess a contemporary phenomenon within 12 industry professionals, comprising 10 contractors and 2 consultants actively involved with BIM-based projects within Selangor. The interview questions were subjectively crafted to elicit nuanced perspectives on the impact of BIM-Lean synergy on the construction sector, combining empirical data with respondents' professional experiences, individual beliefs and viewpoints. Four respondents were identified via the myBIM official portal, another four from the CIDB CIMS official database and the remaining four were engaged during the KL BIM Day 2023 conference, thereby enriching the study with diverse yet relevant insights.

2.1.2 Population and sampling

The study utilised a purposive sampling strategy to identify and engage respondents with specialised knowledge pertinent to a specific phenomenon, particularly suitable for a targeted and specific small population. Given the limited BIM-Lean synergy among contractors on the study's site, a total of 12 respondents were purposefully chosen to undertake semi-structured interviews. The identification process focused on the registered contractors operating in Selangor who actively utilise BIM in their construction practices. In addition, an engineering solution consultant with expertise in BIM methods was included. The selection of respondents was guided by:

- Involvement in managing complex BIM and Lean processes in a large project;
- Professional experience dealing with BIM/Lean within the industry

This approach was conducted to ensure that all perspectives gathered were contextually relevant and technically informed, resulting in a meaningful contribution to the exploration of BIM-Lean synergy for Malaysia's construction sector.

2.1.3 Data collection

12 representatives from construction companies operating in Selangor were engaged through a series of semi-structured interviews. The mode of engagement involves 4 in-person interviews, 3 virtual interviews and 5 email correspondences. The interview questions were structured into four sections, i.e. respondent's background, assessing the perspectives on BIM-Lean synergy, the benefits of BIM-Lean synergy and the challenges of integrating BIM-Lean synergy. All questions were open-ended with high subjectivity, granting respondents the flexibility to elaborate freely without constraints on response length. Each interview was audio recorded (where applicable) and subsequently verbatim transcribed to ensure in-depth content analysis.

2.1.4 Data analysis

All recorded data from the interview sessions were analysed through a systematic screening process using content analysis, by analysing raw narrative data into thematically categories based on valid interpretation [23]. Following that, the extracted data were tabulated into matrix tables for content classifications to identify the core themes across respondents' inputs. Consequently, the key findings derived from the semi-structured interviews served as the foundation to assess the feasibility of BIM-Lean synergy adoption in Malaysian construction projects.

3. Results and Discussions

3.1 Analytical Themes

The semi-structured interviews were divided into five themes geared to align with the study's objectives, namely: i) To assess the level of awareness of Lean implementation in Malaysian BIM construction projects and ii) To investigate the feasibility of BIM-Lean synergy in Malaysian construction projects. Thus, these thematically structured categories were designed to foster targeted insights that directly support the research aims. Table 1 shows a detailed breakdown of the thematic structure.

Table 1
Analytical themes

No.	Analytical Themes	Focus Area	Contractors representatives (R1 - R10)	Consultant representatives (R11 - R12)
i.	Perspectives on the usage of Lean in BIM projects	To assess the contribution of BIM-Lean synergy adoption	√	√
ii.	Comparison between software performance with conventional methods	To investigate the impact of technology adoption through software versus the conventional method	√	√
iii.	Level of BIM-Lean synergy adoption in Malaysian construction projects	To identify the current adoption of BIM-Lean synergy in the Malaysian context	√	√
iv.	Benefits of BIM-Lean synergy	To determine the benefits of BIM-Lean synergy adoption	√	√
v.	Challenges of BIM-Lean synergy	To determine the challenges to BIM–Lean synergy adoption	√	√

3.2 Section A: Background of the respondents

Table 2 portrays a comprehensive overview of the 12 respondents' professional backgrounds. The purposive sampling method ensures representation across three tiers of organisational hierarchy (top, middle and lower management levels) to cater to diverse managerial perspectives. While all respondents had practical experience with BIM, only R1, R3, R8, R11 and R12 applied BIM and Lean in their project workflows. Conversely, for R2, R4, R5, R6, R7, R9 and R10, it indicated that their involvement was limited solely to BIM practices, excluding the Lean practices.

Table 2
Respondents' background

Respondent	Education Level	Company Roles	Years of BIM Experience	Lean and BIM utilisation	Company Name & Grade
R1	Master in Building Technology	Senior BIM Manager	15 years	BIM and Lean	Gamuda Berhad (G7)
R2	Master Built Environment	Business Development Executive (Construction)	2 years	BIM only	Sc Smart Builders Sdn Bhd (G3)
R3	Bachelor of Multimedia Technology	ICT / BIM Manager	3 years	BIM and Lean	Trans Resources Corporation Sdn Bhd (G7)
R4	Certificate in Mechanical Technology and Design	BIM Coordinator Leader	6 years	BIM only	Geodelta Systems Sdn Bhd (G5)
R5	Bachelor of Civil Engineering	Senior BIM Executive	2 years	BIM only	IJM Construction Sdn Bhd (G7)
R6	Master of Architecture	BIM Coordinator	2 years	BIM only	Jalex Sdn Bhd (G7)
R7	Bachelor Construction Management	Manager Development	1 year	BIM only	WZR Property Sdn Bhd (G7)
R8	Bachelor of Civil and Construction Engineering	BIM Engineer	1 year	BIM and Lean	Alunan Asas Sdn Bhd (G7)
R9	Bachelor of Civil Engineering	BIM Manager	5 years	BIM only	MMC Gamuda KVMRT Sdn Bhd (G7)
R10	Bachelor of Mechanical Engineering	BIM Manager	2 years	BIM only	Gamuda Berhad (G7)
R11	Bachelor of Computer Science	General Manager	9 years	BIM and Lean	Bina Initiatives Sdn Bhd
R12	Bachelor of Architecture	BIM Manager	8 years	BIM and Lean	Bina Initiatives Sdn Bhd

3.3 Section B: Exploring the BIM-Lean Synergy

In this section, respondents were questioned about their perspectives and experiential insights regarding BIM-Lean synergy for construction projects. The inquiries focused on three core questions to assess the level of awareness of Lean practices within the BIM projects in Malaysia.

3.3.1 Perspective on the usage of Lean in BIM construction projects

Table 3 summarizes the data collection of respondents on their perspectives on Lean usage in BIM construction projects. According to respondents of R1, R4, R5, R8, R9, R10 and R12, using Lean in BIM gradually leads to material accuracy, time efficiency, cost saving and waste reduction in building projects. Meanwhile, viewpoints from R2, R5 and R7 indicate Lean in BIM allowing strong potential towards identifying and resolving issues early on.

Additionally, R2, R4 and R6 concur that incorporating Lean into BIM will lead to a smooth and efficient building process. R3 acknowledges that further initiatives must be undertaken to embrace the BIM-Lean synergy concept in the construction sector. In general, R1, R2, R4, R5, R6, R7, R8, R9, R10 and R12 highlighted Lean's contribution to BIM whereas R3 and R11 emphasized on adoption levels.

Table 3
Perspective on the usage of Lean in BIM projects

Transcript/ meaning unit	Sub-category / potential closest meaning	Classification	Theme
R1: Implementing Lean and BIM in construction projects significantly impacts data accuracy, particularly in material quantities, time and cost prediction for LC.	The accuracy of material quantities, time and cost indirectly assists towards LC.	Lean contribution towards BIM	Perspective on the usage of Lean in BIM projects
R2: Facilitate the IBS component and organizing in planning, which is important for a smooth flow in the construction process.	Streamline IBS component planning management for a seamless construction process.	Lean contribution towards BIM	
R3: There is low usage of lean in BIM however, the industry has already started adopting and taking time for its maturity.	Lean in BIM usage is limited despite being slowly adopted in the construction sector.	Adoption level of Lean towards BIM	
R4: Applying techniques that increase construction processes' productivity, profitability and waste elimination.	Lean in BIM helps in productivity, profitability and waste elimination.	Lean contribution towards BIM	
R5: Minimising cost and time usage through problem identification features from an early stage.	Early problem identification features allow cost and time reduction.	Lean contribution towards BIM	
R6: BIM contributes to a leaner construction environment.	BIM helps in keeping construction projects lean.	Lean contribution towards BIM	
R7: Identify and resolve problems before the construction stage takes place.	Identify and fix issues before construction.	Lean contribution towards BIM	
R8: Effective execution in cutting down expenses, waste and misunderstandings.	Good implementation to reduce cost, waste and miscommunication.	Lean contribution towards BIM	

R9: Helps in project planning and scheduling as well as increasing value in construction.	Aids in project planning, scheduling and enhancing construction value.	Lean contribution towards BIM	Perspective on the usage of Lean in BIM projects
R10: Contributes to project planning and scheduling, along with adding value in construction.	Aids in project planning, scheduling and enhancing construction value.	Lean contribution towards BIM	
R11: The idea should have been implemented already.	The concept should have been executed by now.	Adoption level of Lean towards BIM	
R12: Excellent implementation as it will contribute to one-month look-ahead planning.	Good implementation towards one-month look-ahead planning.	Lean contribution towards BIM	

3.3.2 Comparison of the software performance with the conventional method

Table 4 highlights the findings on the comparison of the software performance to the conventional approach. R1, R2, R3, R4 and R6 agreed that the accessible approach's software performance is significantly faster than the conventional method in terms of construction period. Next, R1, R4 and R6 stated that the current method is precise in terms of quantity, quality and job efficiency. R5, R7 and R8 mentioned that despite the current approach being limited in some areas and possibly to prevent some errors, it is still considerably superior to earlier studies, which emphasise visualisation and contribute to better stakeholder communication [24]. In addition, a previous study discovered that visual aids during the design stage can enhance design effectiveness, perform clash identification and analysis while promoting better communication and faster design decisions [25].

Table 4
Comparison of the software performance with the conventional method

Transcript/ meaning unit	Sub-category / potential closest meaning	Classification	Theme
R1: Make the work faster and more accurate by saving time for the engineer and QS in calculating material quantities.	Higher accuracy and time-saving in the quantity take-off process for engineers and QS.	Overview of the software implementation against the conventional method	Comparison of the software performance with the conventional method
R2: It is much better than the traditional method, which is quite lengthy in construction.	Time-saving approach.		
R3: LC allows for an integrated project where everyone can participate in achieving goals and results.	LC results in collaborative participation in achieving goals and results.		
R4: 1. The traditional method needs to be corrected. 2. Lean construction speeds up the process of drawing production with the most accurate location and space required by experts.	LC expedite the drawing production process through precise location and space.		
R5: Traditional methods are very tedious and have certain limitations in capturing more advanced designs.	Conventional methods are time-consuming and limited for basic design.		

R6: It helps to improve work efficiency compared to traditional methods, but it must be consistent with the knowledge of its use.	Improves work efficiency with proper expertise.	Overview of the software implementation against the conventional method	Comparison of the software performance with the conventional method
R7: Good pre-construction visualisation to detect problems early and reduce waste during construction.	Better visualisation in clash detection and offers waste reduction.		
R8: There are significant differences, especially in visualisation, collaboration and communication.	Better visualisation, collaboration and communication.		
R9: It will bring towards better planning smoothly.	Contribution to more efficient planning.		
R10: It will contribute to greater efficient planning.	Contribution to more efficient planning.		
R11: Critical in giving the benefits of time and cost impact.	Critical in time and cost savings.		
R12: Optimising and accelerating project schedules plus cost-saving value.	Optimisation in scheduling and cost-saving.		

3.3.3 Level of BIM-Lean synergy adoption in Malaysian construction projects

Table 5 provides all of the data about respondents' opinions on the level of adoption rate of BIM-Lean synergy in Malaysian building projects. It demonstrates that the majority of respondents understood the necessity of widespread and early adoption of BIM-Lean synergy in Malaysia. R1, R4, R6 and R8 included the rationale for the software expenses. R3 claimed that a higher level of BIM-Lean synergy adoption is necessary owing to barriers. R5 also stated that the BIM-Lean synergy is still in its early phases, which necessitates additional R&D and competence in software management and navigation. In conclusion, the poor BIM-Lean synergy adoption is driven by to variety of technology and human restrictions, such as internal or external, particularly in learning new tools and processes.

Table 5
Adoption level of BIM-Lean synergy in Malaysian construction projects

Transcript/ meaning unit	Sub-category / potential closest meaning	Classification	Theme
R1: It is not widespread because buying software requires a lot of money.	Low adoption due to costly software purchases.	The adoption rate for BIM and Lean in Malaysia construction projects	Adoption level of BIM-Lean synergy in Malaysian construction projects
R2: It has yet to be widely used. Somehow, some people need to realize they are implementing BIM-Lean synergy indirectly.	Low adoption, yet indirectly BIM-Lean synergy is being adopted.		
R3: The Lean and BIM adoption needs to be higher due to barriers.	Greater BIM-Lean adoption is needed to counter barriers.		
R4: It has yet to be very mature due to the high cost of hiring BIM experts and software.	Low adoption due to costly software purchases and expert recruitment.		
R5: It is still in the early stages. Further R&D and expertise are needed to manage and navigate the software.	Low adoption which requires further expertise to handle the software.		

R6: Lean is, but BIM is not. BIM implementation requires upskilling employees and software purchases are expensive.	Wide implementation of Lean but not BIM due to costly software purchases and expert recruitment.	The adoption rate for BIM and Lean in Malaysian construction projects	Adoption level of BIM-Lean synergy in Malaysian construction projects
R7: Still in its infancy phase due to the higher cost needed as capital.	Low adoption due to the higher capital needed.		
R8: It is commonly employed in huge projects, but it is also necessary for smaller ones. This is a result of the software's high initial cost and people's resistance to making new changes.	Limited adoption for huge and small projects since higher initial costs are required and people's negligence of the concept.		
R9: Low level of awareness and adoption in Malaysia.	Low adoption rate due to a lack of awareness.		
R10: It is not widely known by industrial practitioners since it is a new concept.	Low adoption due to the new concept.		
R11: No awareness of Lean principles implementation in construction as compared to BIM.	In comparison to BIM, there is a lack of awareness of Lean principles implementation.		
R12: Low level of adoption due to people's negligence.	Low adoption rates are caused by people's negligence of the concept.		

3.4 Section C: Benefits of BIM-Lean synergy in construction projects in Malaysia

Table 6 highlights the benefits of BIM-Lean synergy adoption. All respondents believed that using BIM-Lean synergy in construction project management will eventually result in higher productivity, notably in cost-saving, time-saving, waste reduction and collaboration across project teams.

Table 6
Benefits of BIM-Lean synergy

Transcript/ meaning unit	Sub-category / potential closest meaning	Classification	Theme
R1: Give a beneficial impact on the construction industry, such as better collaboration, time-saving and reduced wastage.	Enhance collaboration, time-saving and waste reduction.	Impacts of BIM-Lean synergy adoption	Benefits of BIM-Lean synergy
R2: Give benefits to the industry by reducing wastage, cost, manpower and time for construction. Eventually, BIM-Lean is one of the solutions to achieve the productivity of the construction industry.	Lead to waste, cost, manpower and time reduction for better productivity.		
R3: Quality of project - Client knows what and how to expect; contractor knows what to deliver. - Access to information - Straighten communication between the client and contractor, i.e. BIM 360. - Cost efficiency - Enhance value and reduce waste.	Enhanced project quality, collaboration between project teams and cost-effectiveness.		

R4: LC seeks to reduce and eliminate waste in the construction processes, while BIM seeks to improve collaboration between project team members.	Waste elimination during the LC while BIM enhances collaboration between project teams	Impacts of BIM-Lean synergy adoption	Benefits of BIM-Lean synergy
R5: The implementation of BIM-Lean will empower the construction management process itself. It will also enhance and explore new features to benefit construction on-site.	Uplift the construction management overall.		
R6: BIM-Lean would be the future of the construction industry once all stakeholders have the knowledge and utilise it to its full potential.	BIM-Lean synergy is a revolutionary method for the construction industry.		
R7: The new technology of construction will avoid mistakes, reduce cost wastage and shorten the period of development.	Reduce mistakes, cost wastage and time consumption.		
R8: From a coordination perspective, it will probably reduce time in design aspects, while from a planning perspective, it can be found out if the work could be done at the right time or not.	Enhancing accuracy in design and schedule planning.		
R9: With Lean, BIM processes will bring better planning in a much smoother way.	BIM-Lean synergy streamlines schedule planning.		
R10: Better and more accurate planning will be achieved.	BIM-Lean synergy streamlines schedule planning.		
R11: Generally is critical, where unintentionally it benefits in time impact and cost impact.	BIM-Lean synergy critically impacts time and cost aspects.		
R12: By nature, it will optimize and accelerate project schedules, plus provide cost-saving value. Not only that, but it portrays the positive competency of the project team itself.	Enhance the project schedule and cost while portraying positive collaboration between project teams.		

3.5 Section D: Challenges of BIM-Lean synergy

Table 7 summarizes the data from the respondents' experiences with challenges in incorporating BIM-Lean synergy into construction projects. R1, R3, R4, R5 and R8 claimed that the adoption issue was due to strong cultural resistance within their fellow communities. However, R2 and R6 stated that software interoperability technical issues for better integration impede the BIM-Lean synergy in construction projects, similar to research findings by Talib *et al.* [26]. Furthermore, R4 stated that one of the difficult experiences was the project team's low acceptance owing to the high cost of resources compared to the conventional method. Lastly, R4, R5 and R7 believe that the obstacles they frequently face in building projects include excessive software pricing, as well as a lack of expertise and acceptance from other industry practitioners, as according to R3, R11 and R12.

Table 7
Challenges of BIM-Lean synergy

Transcript/ meaning unit	Sub-category / potential closest meaning	Classification	Theme
R1: Willingness to change and human attitude toward the acceptance of new things.	Strong cultural resistance.	Barriers to BIM-Lean synergy adoption	Challenges of BIM-Lean synergy
R2: Compatibility between different types of software.	Software interoperability.		
R3: Lack of awareness about LC, skill techniques, unwillingness to change, lack of client and consultant engagement and expertise in technological knowledge.	Strong cultural resistance, lack of awareness and expertise for LC.		
R4: Less acceptance among the project team due to high-cost resources, tools, and software.	Strong cultural resistance due to the higher adoption costs needed.		
R5: 1. Software & CDE prices - Higher advanced tools have a greater price with different packages and limitations. 2. Expertise - Lack of knowledge and skillset to implement Lean & BIM in construction operations. 3. Acceptance from other construction personnel - BIM is still quite new in the construction industry. Most of the senior team would not tolerate the use of BIM as they were already used to traditional methods. The BIM team requires extra effort to convince them to use and learn BIM basics.	Strong cultural resistance, lack of awareness and expertise and large funding in software and cloud-based data storage.		
R6: Interoperability between the different software.	Software interoperability.		
R7: The cost of implantation in the construction industry is lower for a skilled workforce in this industry.	Low implantation cost for expertise.		
R8: Reluctant to learn new things, certain employees find it very hard to get the same thoughts as each other, and another one is a need for more cooperation among employees.	Strong cultural resistance and cultural misfits.		
R9: People's traditional mindset is to stick with implementing conventional concepts.	Resistance to change culture.		
R10: People are reluctant to change or adopt new trends.	Resistance to change culture.		
R11: There is a lack of awareness of Lean principles implementation in the construction industry as compared to BIM.	Lack of awareness of Lean implementation instead of BIM.		
R12: People's ignorance requires full participation and cooperation of project teams on board and speculation on BIM slowing down progress	Resistance to change culture, lack of support and commitment and misconceptions thought.		

4. Conclusion

The research objectives are to assess awareness of lean implementation in BIM and the feasibility of BIM-Lean synergy in Malaysian construction projects. Most respondents are aware of Lean implementation towards BIM in building projects, despite not all industry professionals use it directly, as it is primarily employed for large-scale projects. This is concerning to industrial practitioners' lack of knowledge of LC concepts, as well as governments' need for more trust in mandating the use of effective project management in the construction industry. Not just that, the majority of the respondents claimed that the benefits of BIM-Lean synergy include improving team communications and collaborations, improved site monitoring and fewer inefficient process layouts and defects. Meanwhile, the resulting challenges include largely undeveloped synergy capabilities, low contractor acceptance and high software costs required. As a result, this study helps to disseminate exploration and feasibility to better comprehend the concept of BIM-Lean synergy in Malaysia's construction industry. It also indicates that while BIM-Lean synergy is achievable for its implementation in Malaysia, it will require top-down government actions and coordination with industry partners to work seamlessly in future.

Acknowledgement
This research was supported by the Ministry of Higher Education (MOHE) through the Fundamental Research Grant Scheme (FRGS/1/2023/SS02/UTHM/02/3).

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