International Journal of Digital Civil Engineering and Building Information Modeling
Volume 1 Issue 1, 2025

Application of Building Information Modeling (BIM) in the Construction Sector in Malaysia

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Research Article
Received:27-01-2025 **Revised:02-02-2025** **Accepted:10-02-2025** **Published:25-02-2025**

Abstract A collection of digital technologies called Building Information Modeling (BIM) may control the efficiency of building projects. Malaysia's Architecture, Engineering, and Construction (AEC) sectors have adopted BIM. The Director of the Public Works Department (PWD) first proposed the use of BIM in Malaysia in 2007. This article aims to explore the use of BIM in the Malaysian construction sector. The definitions and history of BIM, construction-related challenges, the use of BIM and BIM tools in construction projects, and the advantages of BIM were all covered in a study of the literature. The Malaysian government promotes the use of BIM in building projects because it may solve issues including delays, conflicting professional designs, and cost overruns. The government has recommended Autodesk technologies as a platform for BIM tools. Navisworks, Cost-X, Revit Architecture, Revit Structural, and Revit MEP are further tools. It is imperative that those involved in construction understand the significance of using BIM in building projects. This is due to the fact that, as in many other nations, BIM may be one of the requirements a business must meet in order to be eligible for government and private projects. Additionally, BIM enhances the efficacy and efficiency of building projects. Additionally, it may be used to enhance cooperation and communication among construction industry participants. Because of the government's efforts to promote BIM, it is anticipated that BIM technology would be used more widely in Malaysia's building sector.

Keywords Building Information Modeling (BIM), Application, Construction Project, Effectiveness, Malaysia

1. Introduction

The architectural, engineering, and construction (AEC) sectors employ Building Information Modeling (BIM), a collaborative technology built on many software programs [1]. It is a method and a system for managing building projects [2]. Infrastructure design, analysis, construction, and management have all changed as a result of BIM, a collection of technological advancements and procedures [3]. Project design, construction, and planning may all be improved by BIM. Professor Charles M. Eastman first presented the BIM idea in 1970 [4][5]. AEC companies began using BIM in building projects in the middle of 2000 [2]. The first nation to use BIM was the United States of America (USA) [6].

These days, a number of nations have adopted BIM, including the UK, Australia, Hong Kong, Denmark, Norway, Finland, and Singapore [6][7]. The Director of the Public Works Department (PW D) in Malaysia first proposed the use of BIM in 2007 [8]. The government took this action after seeing how BIM may lower building costs and prevent design issues during the planning stage. Additionally, BIM has been seen as a coordinated effort to guarantee cooperation amongst construction industry participants, including contractors, engineers, architects, and project managers [7][8].

The government formed the PW D committee on August 27, 2007, to choose the best BIM platform to guarantee interoperability [8]. The group was formed with the intention of identifying the BIM

implementation procedures involved in building projects. Additionally, as a guide for construction industry participants, the group created a BIM standard handbook documentation for PWD. Additionally, the committee offers project teams BIM training and guidance on how to use BIM technologies [8].
The Multipurpose Hall at Universiti Tun Hussein Onn Malaysia (UTHM) in the country's southern area is the first project in Malaysia to use BIM [9]. Other BIM projects in Malaysia include the Ancasa Hotel in Pekan, Pahang, the Educity Sports Complex in Nusajaya, Johor, and the National Cancer Institute of Malaysia, which is scheduled to be finished on August 31, 2013 [9, 10, 11].

The following upcoming projects in Malaysia will use BIM: [8][12].

i. Sri Jaya Maran, Pahang's Healthcare Center Type 5.
ii. The Suruhanjaya Pencegah Rasuah Malaysia (SPRM) Administration Complex Project in Shah Alam, Selangor.
iii. Meru Raya Ipoh Primary School, Pe Rak.
iv. Tanjung Minyak Second Primary School, Melaka Tengah, Melaka.

These initiatives are referred to as pilot programs. The Malaysian government's initiative to introduce government officials to BIM includes pilot initiatives [8]. There are now twelve (12) BIM-based projects in Malaysia [8, 9, 10].
Because BIM has a great deal of potential to help solve construction project challenges, the government encourages construction players to utilize it in their projects. For example, BIM can manage the proper amount for each building, eliminate project delays, reduce construction costs, and prevent disagreements amongst construction participants [8][13].
These days, complicated and high-risk projects are seen to be better suited for BIM implementation in Malaysia [13]. Local contractors from Grade 1 (G1) to Grade 6 (G6) are not prepared to use BIM, which is a barrier to its deployment in building projects. This is due to the fact that the contractors in the aforementioned categories seldom utilize information technology (IT) and need a significant amount of money to buy BIM tools like Revit Architectural, Revit Structural, and Navisworks, as well as to attend BIM-related training [13]. Multimedia Super Corridor (MSC) Malaysia has awarded a grant to undergraduate students and any businesses or people to undergo BIM training in order to address these problems [11]. MSC Malaysia is a national information and communications technology (ICT) initiative in Malaysia that aims to develop the local ICT sector while luring top-tier technology firms [11]. MSC Malaysia offers training in the use of BIM tools and explains BIM standards. Additionally, all attendees get BIM professional credentials [11].
Small construction firms would benefit from the Malaysian government's efforts to use BIM in the AEC sectors since they will be able to investigate and use BIM in projects [12]. With BIM applications, small construction companies can increase staff efficiency, productivity and job satisfaction, which will lead to reduction in operating cost[12]. These benefits allow businesses to participate in major building projects [12]. Thus, the benefits of BIM for the Malaysian construction sector are discussed in this study.

2. BIM and the Construction Industry Issues

One of the main sectors that supports the Malaysian economy is the building sector. By providing fundamental infrastructure, the sector continues to promote social development [14]. In order to meet the financial demands of commercial buildings and infrastructure, the government and private construction industries demanded construction projects in 2005 [14].
In building projects, a number of issues arose. Delays, unclean building sites, challenging and hazardous site conditions, subpar work, and accidents on construction sites, like the collapse of Jaya Supermarket in Petaling Jaya, Selangor, are among the issues [14] [15]. The industry was negatively

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impacted by these issues. These are indicators of the Malaysian building industry's shortcomings. ICT solutions, however, may address these issues. ICT application in building projects facilitates efficient and successful project management [16]. BIM has been introduced by ICT as a tool for efficient construction project management [14]. Potential issues may be avoided throughout the pre-construction, construction, and post-construction phases with careful planning [17]. BIM has become a cutting-edge approach to managing the planning of construction projects [18]. Although using BIM helps solve issues in building projects, its use is still in its early stages [8]. Players in the construction industry must understand how BIM might assist them better execute construction procedures. It should be emphasized that the Malaysian building sector is still relatively new to BIM. Although BIM is thought to be an expensive technology to use, it has been shown to provide answers for the construction issues listed above. This paper's next part will address the use of BIM at various stages of building projects. These three stages are pre-construction, construction, and post-construction.

3. BIM Application in Construction

Construction participants benefit greatly from BIM applications in projects, including enhanced collaboration and quicker design decisions [3]. Additionally, the simplicity of use of BIM's tools is one of its strengths; as a result, using BIM may cut down on design time as well as construction costs and length [8].

All three stages of a construction project—pre-construction, construction, and post-construction—can use BIM [7][13][9].

Table 1 illustrates the use of BIM in a construction project at each stage, including the pre-construction, construction, and post-construction phases. It is evident that using BIM in a building project aids in more efficient project management. Decision-making in the design process is made easier by BIM's capacity to promote cooperation among construction industry participants [2]. Additionally, time and construction costs may be decreased by identifying and analyzing conflicts during the design phase. Because BIM helps with planning, it also guarantees the completion of a high-quality building project. activities and phasing throughout a project's planning phase [2].

Table 1. BIM applications in a construction project[7][13][9]

Phase	Stage	Uses of BIM
Pre-construction	Existing conditions modeling	Enhances accuracy of existing conditions documentation.
	Planning	Identifies schedule sequencing o phasing issues.
	Design	Facilitates better communication a faster design decision. Perform clash detection and a analysis. Increases design effectiveness.
	Scheduling	Enables project manager and contractor to see construction work sequence, equipment, materials and track progress against logistics and timelines established.
	Estimate	Enables generation of takeoffs, co and measurements directly from a 3-Dimensional (3D) project model.
	Site analysis	Decreases costs of utility demand a demolition.

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Construction	Construction	Enables demonstration of construction process, including access and exit roads, traffic flows, site materials and machineries. Provides better tracking of cost control and cash flow. Enables tracking of work in realtime, faster flow of resources and better site management.
Post-construction	Operation / Facilities management	Keeps track of built asset. Manages facilities proactively. Enables scheduled maintenance and provides review of maintenance history.

The application of BIM in pre-construction phase is more evident than during the construction and post-construction phases. This is because there are many activities done in this phase such as design, scheduling and estimating; these activities generally involve the use of BIM technology. BIM tools such as Revit Architectural, Revit Structure, Revit MEP, Navisworks and Cost-X aredeveloped to assist construction players in all phases in construction process. Discussion on BIM tools applicable to the industry is discussed in the next section of this paper.

4. BIM Tools

Numerous kinds and functionality of BIM tools have been developed. Revit, Tekla, Bentley, Autodesk, Vico, and Cost X are a few of the tools. Every tool has a specific purpose and is used to oversee various tasks in building projects [8][19]. Four (4) criteria are used to choose BIM tools: data exchange dependability, correctness, usability, and communication reliability [8]. By forming a project team, outlining important procedures and dependencies throughout a project, and allocating roles and duties to each project team, the BIM process demonstrates communication reliability [12]. The precision of BIM throughout the taking-off process is shown by its implementation in the estimation phase. During the estimating phase, BIM may lower the quantity of measurement estimate errors [20].

In terms of usefulness, 4-dimensional (4D) simulation and conflict detection allow BIM systems like RevitArchitectural and RevitStructural to depict building processes [21]. Additionally, successful projects handled in other nations including the USA, the UK, Hong Kong, and Australia have shown the effectiveness of BIM [7]. One Island East in Hong Kong, the Hilton Aquarium in Atlanta, Georgia, the Freedom Tower in New York, and the Sydney Opera House in Australia are a few examples of successful projects [7][22]. Additionally, before creating a model that may support additional procedures like mechanical and electrical design, estimates, and the building phase process, the dependability of data transmission between architects and structural engineers must be confirmed [23].

The PWD recognized that BIM tools from Autodesk and Exactal Cost-X were relevant to the industry based on the aforementioned qualities. The Malaysian government uses the tools as an application platform. The PWD formally announced this on February 25, 2010 [8]. Autodesk includes all four (4) BIM selection options, as was previously noted. Autodesk is a global software company based in the United States. 3D design software for AEC sectors is its main emphasis [24]. For those involved in construction, Autodesk has created a number of tools, including Revit Architectural, Revit Structural, and Revit MEP.

Exactel was founded in October 2003 with the goal of creating Cost-X, an estimate tool for the construction sector. It is specifically used to combine the estimating process with CAD design files and concentrates on the estimating process [25].

Five (5) BIM tool types that the government recommends for use in building projects are shown in Figure 1. These include Navisworks, Cost-X, Revit architectural, Revit structural, and Revit MEP [8].

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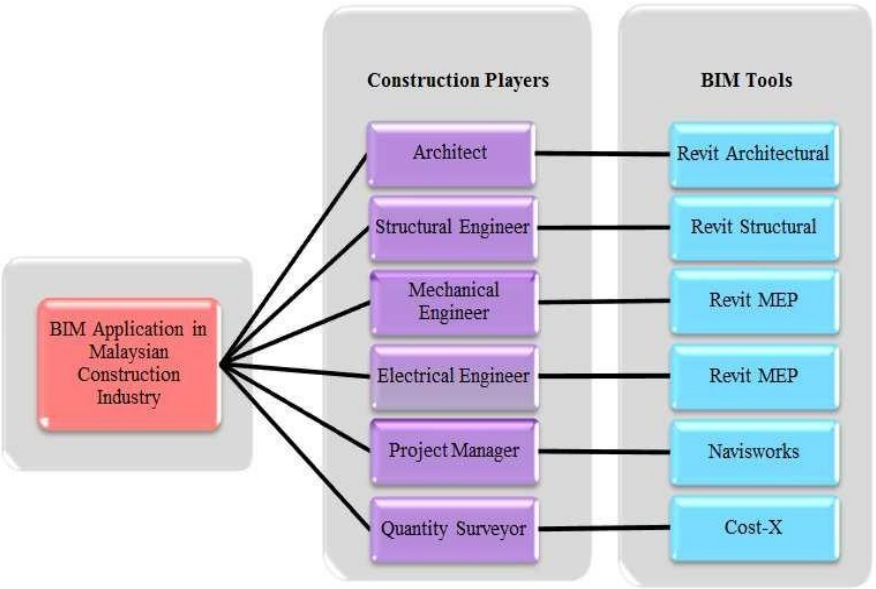


Figure 1. BIM tools suggested by PWD[8]

Every part of a structure, including the walls, stairwells, doors, and roof, may be designed by an architect using Revit Architecture [25]. By modeling buildings using the fundamental elements of walls and a base, Revit Structural enables structural engineers to carry out structural design and analysis [26]. In the meanwhile, mechanical engineers may utilize Revit MEP to create a model of pipes and ducts and to better comprehend HVAC zones [26]. Electrical engineers can also model light fixture placement and design circuits and wiring with Revit MEP. Drawings in two dimensions (2D) and three dimensions (3D) may be produced using all of these tools [26]. Additionally, project managers can use Autodesk Navisworks to build a multidisciplinary model that simulates and optimizes scheduling, identifies and coordinates conflicts, and fosters cooperation between contractors and the design team, which is made up of structural engineers, architects, and mechanical, electrical, and plumbing (MEP) engineers. This cooperation allows the team to gain insight into potential issues [26]. Additionally, the Cost-X tool may be used to estimate building costs. It has several extra capabilities, including a special revision tool to speed up the takeoff process and a sophisticated viewing tool [25]. The transparent and filter modes are used by advanced viewing tools to speed up and simplify model browsing. In the meanwhile, a special revision tool can recognize design modifications and automatically update the amounts [25]. Numerous businesses in Malaysia are involved in BIM by offering training, consulting services, and BIM technologies to help the construction sector adopt BIM [10][27][28]. The businesses are Sunway Berhad in Petaling Jaya, Selangor [28], Precision Design Solution Sdn. Bhd. (PDSSB) in Petaling Jaya, Selangor [27], and Integrated Project Management Solution Sdn. Bhd. (IPMS) in Johor Bahru, Johor [10].

5. Benefits of BIM

Implementing BIM in construction projects can overcome construction problems such as delay, clash of design and disputes between construction players.

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Figure 2. Benefits of BIM implementation[3][7][8]

Five (5) key advantages of using BIM in building projects are shown in Figure 2. Every stage of the building process demonstrates the advantages of using BIM. The following are explanations of the advantages [3][7][8]:
i. BIM helps with built asset design, scheduling, and budgeting.
ii. BIM gives architects a platform to start the evolutionary design process.
iii. Using the database that BIM systems give helps speed up design since it requires less collaboration with engineers.
iv. An illustration of the building process using .
The 4D model significantly improves process comprehension and aids in identifying construction-related difficulties as well as potential concerns with the building assets process.
v. The 4D BIM models make it possible to show how a construction project might impact traffic patterns, access and exit roads, public transportation, on-site material storage, and staff and equipment scheduling.
vi. BIM offers a practical means of greatly enhancing the quality of design and documentation.
vii. BIM uses clash detection to save 10% of contract value.
viii. BIM contributes to a 3% accuracy rate in cost estimate.
ix. Drawing coordination problems and conflict mistakes are decreased by BIM.
x. By including all important systems into the model, BIM reduces design conflict problems.
xi. Internal conflicts may be identified by design BIM systems, while conflicts between models and other data input into the viewer can be identified and highlighted by model viewing systems.
There are several advantages to using BIM in building projects, and doing so may improve project quality [7]. It is evident from the advantages mentioned that BIM helps construction industry participants build modest or high-risk projects successfully [7]. Additionally, BIM may lessen issues like building site accidents, delays, rising construction costs, and disagreements among construction participants [2].

6. Conclusions

Successful building projects may result from the use of BIM. The Malaysian government does find BIM to be very valuable [8]. The government must be an early user of BIM technology as a significant customer [19].
The use of BIM in building projects may minimize waste and safety issues, resulting in the completion of high-quality projects. The Malaysian construction sector has used a number of BIM technologies to enhance construction procedures. Construction projects benefit from BIM in a number of ways, including better project scheduling, conflict detection during the design phase, lower construction costs, and more participant communication.
Using BIM in the construction sector may improve project quality overall and enhance the sector's reputation. Furthermore, it is anticipated that BIM technology would be used more extensively in Malaysian building projects as a result of government initiatives.

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