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Impacts of Quality Design BIM Towards the Malaysian Construction Industry

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Abstract

Building Information Modelling (BIM) is the recent technology in the construction industry and makes an impact towards building quality design. BIM helps the construction industry to manage design quality all through the construction project tends to boost buildings performance by ensuring that all phases of the project meet the customer's criteria and are secure for consumers. The traditional construction industry had faced challenges in quality design like drawing 2D plan by hand, it costs a lot of time to complete. Thus, the objectives were to determine the challenges before using BIM technology on quality design for the construction industry and impact of after using BIM technology on quality design, and implementation strategies of BIM in quality design. The qualitative research used in this study, which is semi-structural interview, had been conducted with architects that had experience using BIM in construction projects in Johor Bahru area. The data had been collected and transferred to transcribe; the content analysis matrix table was using to analyse the data The research findings and the results had meet with the three objectives of the study which is drawing skill with hand sketching is the main challenges before using BIM technology on quality design, BIM produce better model quality and improve quality and lifespan of building are the main impact of after using BIM technology for quality design. The implementation strategies for BIM in quality design are also indicated by respondents which are employing competent staff to operate BIM software.

1. Introduction

Building Information Modelling (BIM) is a method for producing and managing information about a building project across its entire life cycle. This digital description is expected to consist of a variety of data rich Three Dimensional (3D) graphic models and semantic information like product, performance and transfer data and others (Hamil, 2016). BIM is the modern trend technology to manage construction projects and those building design in digital form that is a way that allows for information interchange and accessibility across stakeholders. BIM is significant cost and time saving that can help construction companies to improve productivity and be more effectiveness. Besides, it also has prompted construction companies to embrace and deploy it in a variety of contexts (Othman *et al*., 2020). Nowadays, the construction industry in Malaysia has risen significantly, and it has

become a major sector that already has a significant influence on the Malaysia economy and contributes to social development. BIM has provided substantial benefits such as cost and time savings, improved design quality, and many others. These advantages influenced construction plans for the development of building design, construction, and facility administration.

1.1 Research Background

Construction industry is the most important part for many countries economy includes Malaysia. Nowadays, the construction industry in Malaysia has risen significantly, and it has become a major sector that already has a significant influence on the Malaysia economy and contributes to social development. Building Information Modeling (BIM) seems to as an organized method that enhances information flow depending on the speed of technological advancements throughout the construction sector, as all BIM enabled plans are implemented in an integrated environment relating to information sharing capability (ISC) and collaborative decision capability (CDC). Transmission of data and evaluation of construction drawings from drawings and documentation are difficult and time-consuming procedures (Sebastian, 2011). These advantages influenced construction plans for the development of building design, construction, and facility administration. Traditional organisational structures lack the capacity to combine work teams under superiors, and to permit efficient communication, coordinating, and monitoring. Furthermore, as the different stakeholders in construction projects have grown, so have the difficulties of product development. Due to the merging of digital and visual environments and the incorporation of sophisticated digital technologies in projects, modernism is dynamic and adaptable (Rochegova and Barchugova, 2016), and the designer's role has started growing in importance. Therefore, BIM technologies are important in construction industry nowadays. The purpose of this study is to determine the impact of BIM on quality building design in the Malaysian construction sector.

1.2 Problem Statements

Building Information Modelling seems to have the ability to transform the constructions industry's design quality and construction processes. While BIM is expected to help enhance design by removing disagreements and reducing remodeling, previous research has been done on its use in projects for construct quality design and data management. According to Khan (2021), construction projects require improvement in quality at a lesser cost also in a shorter time, making achieving an equilibrium between both the quality-cost-time relationship problematic. The contractors are under pressure to complete the project at the lowest possible cost. Building layout and project detail issues were discovered, such as unclear drawings and drafting errors, which resulted in major construction issues. The framework for building is becoming harder due to insufficient detailing on documents and drawings. Some minor details are lacking from the architect, which will be a huge impediment during implementation. There are many businesses and individuals participating in building construction, therefore many comprehensive plans and drawings are involved in implementation. If the information on the drawings is insufficient or user friendly, the job will not be completed as expected. It will eventually have an impact on the quality of performance (Holkar, *et al*., 2021).

1.3 Research Questions

The following are the three major questions:

i. What are the challenges to employing BIM technology for quality design in the building industry?
ii. What is the impact of BIM technology on quality design in the construction industry?
iii. What are the strategies for BIM deployment in quality design?

1.4 Research Objectives

There are three objectives that are identified based on the research question. The objectives are:

i. To determine the challenges before using BIM technology on quality design for the construction industry.
ii. To identify the impact of after using BIM technology for quality design in construction industry in Malaysia.
iii. To determine the implementation strategies for BIM in quality design.

1.5 Scope of the Study

This study focused on Malaysia construction industries that concentrated the industry workers that is architects that had experience in BIM for construction project. In my opinion, most of the architects would use BIM technology for designing the building and have the experience of using BIM like Revit. The limitation of this study is only in

1.6 Significance of Study

This research focuses on the Malaysian construction industry that use of Building Information Modelling (BIM) technology for their building projects. Through this study, it would identify the impacts of BIM and can be a reference for traditional construction companies to transform adopting the BIM technology for their construction projects to be more effective and improve design process. The result of this study will be useful for assisting BIM gaining new ideal to improve their own system and bring benefits for the construction companies.

2. Literature Review

2.1 Building Information Modelling (BIM)

Building Information Modelling (BIM) is a new idea, and it has the potential to alter the construction industry world at large. It has the potential to significantly influence the way projects are conceived, implemented, and operated (Doan *et al.,* 2019). In the architectural, engineering, and constructions (AEC) business, BIM combines organized, multi-disciplinary data to build a digital representation of an asset across its lifespan, from planning and management to construction and installation, using an intelligent model and a cloud platform (AutoDesk, 2021). BIM does have its own tools which are used to plan, develop, build, and operate BIM models in order to model and optimise projects. BIM Software is 3D design and modelling software for architectural, construction, plant, civil, and mechanical, electrical, and plumbing (MEP) projects which can assist optimise detailed design work. It helps to assist in the development of high-performance design changes and the enhancement of building performance. integrating data from construction via transfer through digitising the worksite, organizing pipe, structural, including process construction and operation. Besides, operations consistency, efficiency, and profitability are all being improved and improving design quality and cooperation to aid overall project successfully (Pluralsight, 2013).

2.2 BIM Process

The BIM process has 4 processes which are Planning, Design, Build and Operate. These four processes have different collaborative purposes and are important to construction projects (RMJM, 2019).

2.2.1 Planning

The capacity of BIM to gather actual information and produce authorized pre-existing settings is critical for planning. This allows construction companies to show building design in 3D view, calculating the expected costs and materials that will be used for the project. This can give clients clear information and a big picture of the building (RMJM, 2019).

2.2.2 Design

The building design, analysis, detailing, and documentation are being started in this process. For the age of 2D drawings, it takes a lot of time and huge task that to draw all the possibilities and elements in the drawing sketch. While BIM developed, it is able for giving designs and materials that reveal details about actual real-life equivalents, simplifying either estimation or planning (Ocean, 2021).

2.2.3 Build

This process in which the manufacturing process begins with BIM requirements. It also for controlling schedule and efficiency, building project details are communicated with trades and contractors (RMJM, 2019).

2.2.4 Operate

Which is the source of the information is carried into the completed asset maintenance and support. BIM data may also be utilised for cost-effective refurbishment or efficient deconstruction in the future.

2.3 BIM Tools

According to BIM Report 2019 that conducted by CIDB, the figure above depicts the most often utilised tools among respondents. Autodesk Revit remains the most popular programme for creating models or drawings, with over 46 percent of respondents utilising it. multi - discipline collaboration is cited as two of the primary explanations for the increased number of responders who use Autodesk Revit in their everyday work and research (Shah, 2020). BIM systems perform more than simply computer-aided design (CAD). If used correctly, it may assist to save expenses, detect, and correct faults while issues occur during development, and speed building project timetables. BIM architecture software provides engineers and designers with the necessary tools and insights for more effective building and infrastructure assessment, development, construction, and management (Johannes, 2019).

2.3.1 Autodesk
Revit Revit is a BIM application for Mechanical, Electrical and Plumbing (MEP) engineering, architecture design and construction. It is also one of its most prevalent software applications upon that market, being used by MEP engineers, architects, designers, contractors, and landscape architects, among others (Johannes, 2019).

2.3.2 ArchiCAD
(Graphisoft) ArchiCAD (Graphisoft) is a 3d rendering BIM design and application software. This software is the favourite application of developers and designers for improving their building design and its workflow processes of construction projects. ARCHICAD is known as one of the first BIM applications that pioneer of CAD tools technically competent of constructing in 2D and 3D geometry (Johannes, 2019).

2.3.3 Digital Project (Gehry Technologies)
Digital Project (Gehry Technologies) is a programme that allows the designers and architects to create BIM and CAD models of any complex geometry (Johannes, 2019).

2.4 Challenges of Implementing BIM

2.4.1 Construction companies are resistant to change
According to Sardroud *et al.* (2018), he stated that only a tiny percentage of construction companies are conscious of BIM and then use it to enhance their own construction projects. Other organisations lack experience in this sector and conduct their own projects in a conventional manner because they are hesitant to employ BIM technology.

2.4.2 Lack of skilled workers
While confronted with a scarcity of qualified staff in the construction industry, traditional training techniques have limitations; the introduction of new teaching interventions, such as introductory video and BIM-based learning environments. This will lead top managers in a construction company to include development and skills into BIM and it need a long time to train the workers that have abilities to manage BIM tools (Baltimore, 2021).

2.4.3 Financial Issues
Each project's success is determined by financial and investment difficulties. These challenges grow increasingly pressing as BIM technology advances. The lack of a true and thorough application of the model, as indicated in the "cultural" part, raises significant concerns among shareholders and customers (Sardroud *et al*. 2018).

2.4.4 Lack of Demand
The next challenge in introducing BIM was demand. BIM adoption was still not widespread in the construction industry. The market needs for implementing BIM are currently insufficient due to the ambiguity around the apparent advantages of BIM, particularly during the planning phase. The scarcity of interest in BIM usage was also caused by BIM's approach, which was unable to cut the time spent on drafting in comparison to the present drawing technique (Al-Ashmori *et al*., 2020).

2.4.5 Challenges in Policy
The effective completion of BIM-related construction projects and the enhancement of the long-term development of the BIM implementation are unquestionably influenced by legal and intellectual property legislation. Any legal risk relating to the ownership of BIM data should be resolved by the rules that encourage or require the deployment of BIM in building projects. If there is no clear policy, the licencing problem might result in contractual concerns. Therefore, it is crucial to have a clear and comprehensive strategy to give stakeholders a sense of security in sensitive information inside the BIM model, especially when managing construction projects within the context of an electronic platform (Lee, 2022).

2.5 Relation between BIM and Architectural Design Quality
BIM facilitates information interchange and cooperation among project participants in an interactive environment, lowering communication costs and construction waste.

2.5.1 Impact of BIM on Information Sharing Capability (ISC)

The advancement of technology has resulted in a revolution in information exchange, which has had a significant influence on the architectural project and outputs, as well as the responsibility of architects. BIM is a collaborative information resource that supports decision making by using multiple parameters linked to the designing, building, and implementation of the projects to generate complete data matching to the different phases of the project life cycle. (Raslan and Sayary, 2019).

2.5.2 Impact of BIM on Collaborative

Decision-Making Capability (CDC) BIM fosters collaboration skills by implementing an approach that allows multiple sectors with disparate aims and interconnected resources to collaborate and act collaboratively to address important challenges that require contribution to the identification that surpasses their capabilities. It aids in the improvement of decision-making capacities by coordinating between both the major person who is responsible and another interested stakeholder in order to make optimum decisions (Raslan and Sayary, 2019).

2.5.3 Impact of ISC on Building and Construction Quality

The combination of developed technologies such as internet, database system, data transmission etiquette, cloud applications, and extensible mark-up language with crucial data enables all sides to enhance information processing capabilities and architects to establish new design concepts even before to the construction stage. BIM creates a digital platform to create virtual buildings and the possibility for improved analysis of fundamental engineering data, particularly data linked to building quality and safety (Gerrish *et al*., 2017).

2.5.4 Impact of CDC on Building and Construction

Quality BIM offers the potential to create a graphic representation that can be utilised from the initial stages of building design to construction operation and management, giving control over all project construction. Furthermore, the stakeholders engaged in each step of the design must all be identified so that they may collaborate and adjust the parameters based on the design advantage. The needs provided by these stakeholders early on are translated to basic information or data that is kept, evaluated, and transmitted via BIM. Those inputs clarify the project is working and serve to increase effectiveness in construction project management by enhancing the amount of engagement among clients, Architects, Engineers, contractors, and another concerned professional.

3. Research Methodology

3.1 Research Design

This study uses a qualitative method which is interviewing architects who have experience of using BIM technology in construction projects. in the Johor Bahru area. The interview had been conducted with the respondents online meeting through Google Meet and Zoom. All information had been analysed and transferred to transcribe for the purpose of data analysis.

3.2 Research Process

3.2.1 Phase 1

The initial stage was described as the background of study which included topic of study, introduction, problem statement, objective of study and scope of study. During the literature review stage, researchers studied a lot of literary sources like journals, books, articles and reputable websites. All the source and information gathered from literary sources had been used in the literature review.

3.2.2 Phase 2

Qualitative data collection was used in this stage which is interview with respondents to gather data and information of objective study. The method is more focused on the quality of data. The data and information were generated to conclusion and provided more detail for the results.

3.2.3 Phase 3

In the stages, semi-constructed interviews were conducted with the respondents for objectives study. The collection of data was generated from interviews and concluded with the study according to the data analysis. The recommendations were provided based on related topics of study that could be a reference for future researchers.

3.3 Data Collection

The interviews had been conducted to collect information directly from respondents' first-hand experiences by meeting with them online meeting. The data and information that gathered from interviews will be converted to data analysis.

3.4 Population and Sampling

The target population in this study is the architect which has experience of using BIM technology in Johor. The data collection is limited to only architects that have experience of using BIM. The number of respondents was challenging due to lack of database that directly provides this information. The sampling method is simple random sampling that is used in this study.

3.5 Interview

In this research, the semi-conducted interview was conducted with respondents to achieve the objectives. The respondents had selected from the position of architect that had experience in using BIM in construction projects. Through the interview, communicated with respondent with questions to archive the information that might useful for the research. Each interview section was held for about 30-40 minutes to gather information from respondents, and interviews had been recorded.

3.6 Data Analysis

Thematic analysis was used in this research to assess the interview results for data analysis. Thematic analysis is a popular approach for analysing qualitative data. It is possible for a theme to emerge during the process of identifying, analysing, and reporting patterns and data. The pattern conveys information regarding research questions and reflects the participant's reactions.

4. Results and Discussion

This section has analysed the information collected from the respondents which is architects that had experience of building information modelling (BIM) technology through interview. The data had been collected through interviews with each respondent and transferred to transcript.

4.1 Respondent Background

Table 1 *Background Respondent*

Respondent	Designation	Working experience (year)	Experience in BIM project
R1	Architect	9	2
R2	Architect	12	6
R3	Architect	16	10

Table 1 showed the respondents background which the three respondents who are architects that had experienced work by using BIM. The three of the respondents had difference experience working years which is R1 had 9 year working experience, R2 had 12 year working experience and R3 had longest working experience that is 16 Year. R1 had experience in 2 BIM projects, R2 had involved in 6 BIM project and R3 had involved in 10 BIM project.

4.2 The Challenges Before Using BIM technology on Quality Design for Construction Industry

Table 2 showed the five (5) challenges faced by construction organisations as suggested by the respondents.

Table 2 *Challenges Before Using BIM Technology on Quality Design*

Challenges	R1	R2	R3
Drawing skills	✓	✓	✓
Time	✓	✓	
Run with deadlines	✓		
Draw in hardcopy			✓
Hard to meet clients' requirement	✓		

4.2.1. Drawing Skill (Hand Sketching)

Through interview, the results show all the respondents stated that the drawing skills by hand sketching is the main challenge before using BIM technology on quality design. Besides, 2 of the respondents stated that drawing by hand sketching need massive time consuming to complete the detailed drawing. According to Fakhry *et al.* (2021) had stated that hand drafting method can draw with own creativity, but it requires more time due to it difficult to remove item not the application had the undo command.

"Any drawing mistakes will cost delays and architect need to redraw the details and maybe even the whole drawing." (R1)

Besides, the clients have others request for information to change design on the drawing, it also causes them to redesign. Based on respondents' opinions, it shows that drawing skills is important which draw the building design with hand sketching . They need to focus on those drawings and all the details need to be clear without any mistakes. If had any mistakes on that drawing, it need to redraw or even whole drawing need to redraw. It could be a massive problem if this situation occurs because it takes a lot of time to draw whole drawing again. The client's needs and requirements are also important to the drawing because the building design needs to be according to client and make them satisfy. It would be a challenge to architect due to the need to draw well based on his creativity to fulfil the requirements of client's design. If had any changes of client to the design, it needs to redesign of redraw a new design plan for the clients.

4.2.2 Time

The second challenge, which is the time as show as Table 2, the R1 had stated that the time consuming for the drawing is one of the challenges for him.

"Need a lot a lot of time to complete the drawing and sketching by hand, this had made me stressed due to need to run with the deadlines of the project." (R1)

"Hand sketching for drawing can developing my own idea quickly in early stage but it may consume more time after the design stage that needed draw in more detail." (R2)

From the respondents' opinion above, it shows that they can produce a complete design of the building, but it needs more time for done the design and run with the time of the project deadlines.

4.2.3 Run with Deadlines

R1 had stated that he was stressed due to need run with the deadline of the project. This is because the clients had other ideas of design and do not have any idea about the timescale and work need to included. This situation, he only can follow the changes and rush for the time to complete it without delay. This shows that the architect needs a highly disciplined person to handle the pressure to complete the client's needs. Besides, architects run with deadlines also caused by the complexity of projects, mega projects that need a comparatively long time to design compared to smaller construction projects like shops. To ensure the design of the project is done before the deadline but also need to provide the best quality design of building that matches the client's requirements. So, the incorporation of a design method that would be accurately planned, allowing enough time for improvements, adjustments, in-depth investigation, evaluations, and final approval process, are requirements for achieving accurate design. These requirements also include properly documented interaction with the developers and designers of all stockholders.

4.2.4 Draw in Hardcopy

R3 had claimed that the drawing needs to draw in hardcopy is the challenge for him. This is because the all the design had been drawing in hardcopy need to be detail and neatly to avoid any error. Besides, all of the drawings are on 2D visualization and this has made problems that like all the construction work need to be coordinated from site to ensure the details had installed according to the details on drawing.

4.2.5 Hard to Meet Requirement of Client's Need

R1 had stated that some of the clients need innovative designs for their project. It had made his job more difficult because he needed to give the creative design that clients like. The innovative design of clients' needs not the only difficult thing that needs to concern but also the client's budget for the project. Designing an innovative design with a tight budget is like an impossible project for him.

4.3 Impact of After Using BIM Technology for Quality Design in Construction Industry in Malaysia

Table 3 showed the five (5) impact of after using BIM technology for quality design as aggreed by the respondents.

Table 3 *The Impact of After Using BIM Technology for Quality Design*

Challenges	R1	R2	R3
Improve quality and lifespan of building	✓	✓	✓
Provide better model quality	✓	✓	✓
Cost and resource saving	✓		✓
Identify problem and potential risk		✓	✓
Avoid delays and reduce rework			✓

4.3.1 Improve Quality and Lifespan

All of the respondents had stated that BIM help architect can design building faster than hand sketching and provide more detail and quality on BIM software. With this situation, it could speed up the project and workflow of whole project and let the construction start earlier. According to literature review from Reyes (2020) who stated that the BIM can help contractors to save time consumption and cost by choosing the materials that are cheaper and more quality for the building. It will be simpler to take environmental factors and modernization of designed structures into account throughout the building process.

"The BIM models provided details for facility management company for better view of building for maintenance. It can be transformed and connected with BIM to generate data from the building. It's able help to plan ahead of maintenance of building more easily and accurately." (R1)

"Project which using BIM can help to maximise lifespan and effectiveness of the project lifecycle." (R3)

According to Lahiani (2020), the building model generated from BIM which can help professionals had better understand the characteristics of materials of the building used which can be recycled or disposed of. This kind of knowledge is crucial for restoration since it will stimulate the recycling of previously used building materials, which could reduce wastage after each demolition. Based on the research above, BIM can help professionals know about which part of the building need to maintenance and which part of materials can be recycled for others uses or disposed. This helps them to save them for identifying the maintenance that need to do for the building and the time of maintenance also can be identify due to the 3D view of BIM. Besides, the enormous quantity of trash produced by the building sector is reduced with the use of BIM services. The requirement for infrastructure, changing consumer patterns, greater standards of life, and the obvious expansion of the global population are all contributing to the rapid rise in waste (ENG Firm, 2021)

4.4.2 Provide Better Model Quality

The table 3 shows three of the respondents had indicated that the BIM technology can provide better model quality for quality design Through the interview, there had mentioned about that BIM provide better model quality that could shows more detail of the building.

"By using BIM tools like BIM 5D that can help to estimate the cost of the whole project by automation, this help to save time consuming for calculating and improve productivity." (R1)

"By virtual simulation, architect can see the final view of whole building in 3D and also shows details of the building. Through BIM also can used to establish links of all project stages and phases like mechanical plan, engineering plan, structural plan and others." (R2)

The contractor able to present the project through 3D visualization that allows clients for a new experience to look for the building before preconstruction. According to Choi (2020), by applying a step-by-step method with respect to the comprehensive examination of outcomes can help architects and designers who desire to ensure design quality during the design stage or review. Software that supports rulebased quality control can facilitate quality checking in accordance with quality control criteria and minimise inefficient time and resource usage. By optimising the checking system's efficiency in regard to the requirements, errors mentioned in quality checking results might be reduced. Software is anticipated to increase the accuracy of outcomes and the effectiveness of quality control.

4.3.3 Cost and Resource Saving

R1 and R3 had stated that BIM technology had provided the services of construction cost estimation in planning stage. R1 stated

"BIM 5D and BIM 360 Docs can estimate and arrange the costs of materials, shipping fee, labour which can including payment of overtime and others."

This can help to find out the total cost of the project but also help to explore ways to lower down the costs. For example, choose the cheaper materials and buy it in lowest price to reduce cost. The architects can perform all the computations while using BIM. This programme may analyse many suppliers to discover which are the most costeffective in addition to showing how much a particular material costs. Further than, it may let us know if selling prices are unusually low and when it's the ideal moment to make a buy. Before BIM, project managers

and architects had to wait until construction was already underway to determine if the design actually functioned. If there were any errors or problems, they would become apparent at that time and would need to be corrected. This frequently involved redesigning, delays, or even reversing the work and beginning anew. Naturally, all of that resulted in increased expenses. But it's much simpler to see the finished structure now that BIM is available. This makes it possible for architects to identify and fix any problems before they occur. In other words, once building has started, adjustments and disruptions are significantly less likely to occur (Robert, 2022).

4.3.4 Identify Problem and Potential Risk

R2 had stated that BIM allows us to predict and avoid the potential risks or clashes during the construction stage and also reduce the potential of rework. R3 stated that the software BIM 360 Glue can help to detect the clashes by automated clash detection. It helps to reduce the possibility of redesigning the building. With BIM, it can help to determine that the installation is able to continue and have the opportunity to place component right before construction phase. The BIM 360 that is always updated could help to remove the outdated data and information, that can help to complete a perfect quality construction project. Clients will significantly be capable of understanding the building since BIM combines computer animation and virtual 3d flythroughs to increase the visualisation of a building, both from a technical perspective and the participant's personal experience. As a consequence, significant engagement between the client, designers, and other stakeholders is feasible even during this early stage, allowing for effective decision-making.

The quantity surveyors may utilise the model's area information to more quickly and accurately determine expenses. Conflicts detection is a feature of BIM visualizing approaches that enables the early discovery and correction of design flaws. BIM can decrease wastage and maintain low costs throughout the preconstruction stage, which lowers the chance of expense issues and project delays. This is the result of parametric modelling, which makes use of a relational database to store details on the components of a building and its connections. This enables it to conduct a thorough examination of the design, including the development of space estimations, power efficiency, design and analysis details, and conventional design documents. Therefore, there will be a significant decrease in the possibility of faulty measurements or expenses (White, 2019). Risk management also benefits from the use of BIM. A complete BIM model is a risk mitigation application since BIM may provide many opportunities, lowering unpredictability in the planning and coordination among project stakeholders, according to one assertion. Several BIM elements can enhance visualisation, reducing the risk of individuals involved in the project misinterpreting the design and facilitating a better understanding of the building timeline (Sami Ur Rehman *et al*., 2020).

4.3.5 Avoid Delay and Reduce Rework

R3 had claimed that, by using BIM tools can help to identify massive information including errors, calculation of the models. That information can be eliminated by BIM and help to save time and reduce the errors for avoiding rework activities. Though this, this can help to produce a quality construction project. In their investigation into the effects of 4D BIM on building projects, Crowther and Ajayi (2021) found that effective preparation, which improves planning and scheduling performance, evaluation and direction with a true improvement of expected and actual progress, and proper risk reflection, which addresses a variety of issues, are crucial ways that 4 D BIM can assist work performance. Therefore, it can be said that the construction sector is beginning to appreciate BIM's advantages.

4.4 The Implementation Strategies for BIM in Quality Design

There were five (5) implementation strategies for BIM in quality design as illustrated in Table 4.

Table 4 *Implementation Strategies for BIM in Quality Design*

Strategies	R1	R2	R3
Employ competent staff to operate software	✓	✓	✓
Discuss with BIM Expert to Improve BIM Toward Construction Company		✓	✓
Exposure BIM to Student Earlier		✓	
Provide Training Programs	✓		
Encourage Project Team to Employ BIM Technology for Future Project			✓

4.4.1 Employ Competent Staff to Operate Software

R2 stated that the company employs one BIM expert or professional to be a project coordinator or manager that can help to handle the BIM project.

"It is the easiest way to overcome the workforce shortage of BIM talent in working. The expert also can help to teach and guide the employees like On Job Training that can help them learning quickly and more efficiently." (R2)
"By hiring a professional to guide employees or juniors to conduct the BIM tools to do task that can help them learn faster. Addition, it saves cost that does not need to hire a professional company to operate BIM tools" (R3)

R1 claimed that giving software training on BIM for the new workers but it requires time to train them to become proficient. Therefore, He had added that *"By employ expert or staff can help to operate the software and also train the workers to enable them equip latest BIM knowledge and skills." (R1)*

According to Manzoor *et al.* (2021), by hiring BIM experts from developed countries will help to Construction firms can g*et a*l crucial data from the manufacturer before committing to incorporating and using BIM technology by engaging BIM professionals from developed countries, which will help to ensure that essential professional assistance and knowledge are accessible from the technology partner.

4.4.2 Discussion with BIM Expert to Improve BIM

R1 do not have discussed with BIM experts but in his opinion the undergraduate should be taught with BIM software as extra skills that might be useful for future work. This opinion is similar with the strategy which is given by R2 that is exposure to students earlier.

"The university should give proper education or training of BIM technology for students that could be useful for students having skills for their own future or work." (R2)

R2 had an experience discussion with BIM expert that about implementing of BIM technology toward construction company should be strengthened like provide free training to employees. Besides, the government should cooperate with private parties by giving incentives and support to construction companies that might afford the costs of implementing BIM. R3 stated that there is impossible and hard to g*et a*l of the construction companies to implement BIM technology but can aim for the target for bigger construction companies that have more budget and are willing to work together to improve BIM technology.

From above, know that the government should give cooperation for giving incentives to the construction company which might afford the cost of implementing BIM like reducing the prices of BIM technology. According to Rahim *et. al* (2022), the effort to enhance more companies in the construction field to better integrate BIM technology, the government needs to assist in reducing the initial investment of BIM. This is because high investment cost of BIM tools is a challenge to smaller construction industry that had stated on the literature review (Sardroud *et al.* 2018) which the company had facing financial difficulties.

4.4.3 Exposure BIM to Student Earlier

R2 had given that opinion that the university should give proper education or training in BIM technology to students that could be useful for students having skills for their own future or work. Professional parties should cooperate with education institutions that related architectural studies like Civil Engineering, Construction Technology Management, Engineering and others to adopt BIM software as their major principal subject. According to Farouk *et al.* (2023), had stated that the BIM should be introduced at the educational status or beginning in colleges. This can help the future generation to get early awareness of BIM and know how to use BIM. The Ministry of Education should promote BIM to university as a subject that is able to increase awareness of BIM. Besides, BIM also can as the curriculum of the students to enhance the knowledge of BIM as extra skills for the future. To achieve this situation, Malaysia government able to learn from other developed countries to enhance the BIM technology towards schools, colleges and universities.

4.4.4 Provide Training Programs

R1 stated that the company should give the employees training programs or webinars to improve knowledge and skills on BIM software. This could be useful for them in future projects and become a professional expert in BIM. This can help to one of the barriers of BIM adoption that is lacking skilled workers. Besides he stated that the government or professional parties should give training for the employees. According to the Rafindadi *et al.* (2020), provide the better technical assistance and training materials are important as a method to shorten the learning curve of the labours. Government should offer the training to the labours or crews on the BIM technologies which can refer to developed countries that had implement BIM like United Kingdom, United States, Germany and other countries. The conference, seminars, workshops should be held regularly with reasonable costs and promote active involvement and awareness among construction professionals.

Many organisations, including professional associations, governmental departments, and business associations, provide BIM training to Malaysian construction industry experts to facilitate BIM applications. But the emphasis is on the focus of this study is on BIM training provided by government organisations including the Public Works Department (PWD), the Multimedia Super Corridor (MSC), the Construction Research Institute of Malaysia (CREAM), and the MyBIM Center. These organisations play significant roles in the creation and administration of BIM training as well as its delivery in Malaysia. Numerous BIM training programmes, including

basic training and advanced training in the usage of BIM technology, are organised by PWD and CIDB (which is known as technical training) (Ang *et al*., 2022). BIM training is available both within and externally to the business. Organizations with more BIM expertise seem to be more likely to undertake in-house BIM training since they can supply BIM instructors or BIM executives to lead the training sessions. Through Ang *et al*., s studies (2022) show that businesses who employ their individual trainer for internal training benefit the organisation by aiding with training customization and reducing training expenditures. According to Ahmad Latiffi (2014) the government had given incentives to construction parties to implement the BIM technology in their project to improve the quality design of building and prevent delays of project.

4.4.5 Encourage Project Team to Employ BIM Technology for Future Project

R3 stated that the company had encouraged project team to prepare to change that implementing BIM will improve productivity and quality of the work. The support of top management is important to BIM implementation. Good communication between teams is important to know each other's work specifications and good team involvement can make the changes more quickly and assimilate into the organization. By employing BIM technology, they able to share information more quickly with the company and may significantly increase productivity. The amount of time needed to incorporate and modify new material can be reduced by collaborative work. Lower costs and, thus, better project planning efficiency result from improved production. The quality of building structures will eventually significantly improve as a result of the increased data volume and with increased precision in managing it.

5. Conclusions and Recommendations

5.1 The achievement of Research Objectives

The research summarizes the findings that transform from the results and data that had meet the three objectives of the study.

5.1.1 Research Objective 1: To determine the challenges before using BIM technology on quality design for construction industry

The first objective was to determine the challenges before using BIM technology on quality design which data collected through interview with architect. Through interview and observation, the results show all the respondents stated that the drawing skills by hand sketching is the main challenge before using BIM technology on quality design. Besides, 2 of the respondents stated that drawing by hand sketching need massive time consuming to complete the detailed drawing.

5.1.2 Research Objective 2: To investigate the impact of after using BIM technology for quality design in construction industry in Malaysia.

The second objective was to determine the impact after using BIM technology on quality design. The literature review research had helped to identify the second objective. Through the interview, they mentioned that BIM provides better model quality that could shows more detail of the building. Besides, BIM had improved the building quality and lifespan of the building through the models can generate data for facility management to arrange plan of maintenance.

5.1.3 Research Objective 3: To determine the implementation strategies for BIM in quality design.

The third objective was to identify the implementing strategies on BIM in quality design that collected data through interview. The results show all respondents had employed competent staff or experts to operate BIM software that can save costs for employ one professional to guide the employee or juniors to conduct the BIM task by On Job Training that can help them learn quickly. The respondents hope that the government and private sector can give more training for students that can able to attract interest of students willing to learn new knowledge of BIM. This can help them to learn extra skills that might be useful before entering for work.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Tan Zhi Cong, Mohd Yamani Yahya;* ***data collection:*** *Tan Zhi Cong;* ***analysis and interpretation of results:*** *Tan Zhi Cong;* ***draft manuscript preparation:*** *Tan Zhi Cong, Mohd Yamani Yahya. All authors reviewed the results and approved the final version of the manuscript.*

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