RESEARCH IN MANAGEMENT OF TECHNOLOGY AND BUSINESS
e-ISSN: 2773-5044

RMTB

Vol. 5 No. 1 (2024) 1165-1178
https://publisher.uthm.edu.my/periodicals/index.php/rmtb

Usage of BIM for Improvement on Design Coordination in Construction Industry

Tan Yee Ling [1], Sulzakimin Mohamed[1,2]*, Adejoh Ahmodu Adaji[3]

[1] *Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, 86400, MALAYSIA*
[2] *Centre of Sustainable Infrastructure and Environmental Management (CSIEM) Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, 86400, MALAYSIA*
[3] *Department of Building, Nigerian Army University Biu NIGERIA*

*Corresponding Author: zakimin@uthm.edu.my
DOI: https://doi.org/10.30880/rmtb.2024.05.01.081

Article Info

Received: 31 March 2024
Accepted: 30 April 2024
Available online: 30 June 2024

Keywords

BIM, Design Coordination, Construction Industry

Abstract

Nowadays, Building Information System (BIM) is one of the most exciting developments in the Architectural, Engineering, and Construction (AEC) sector. However, there is a lack in using BIM in construction industry in Malaysia. The objectives of this research are to study on the improvement that BIM can do for design coordination in construction industry, study the benefits of BIM coordination for future development and investigate the strategy of BIM's improving coordination in construction project among project managers in Kuala Lumpur. This study has been conducted in Selangor and Kuala Lumpur area of Malaysia. The methodology of this study included interview and gathered information and data from articles, news, and related journals. A total of 3 respondents are interviewed in order to gain deeper insight needed for the purpose of this research objectives. The analysis of data shows that the benefits and strategy of BIM in the construction industry are well and truly existed. Most of the respondents stated that clash detection, communication and 3D models can improve the communication. Moreover, the reduce reworks and visualize can brought the benefits of communication. In addition, adoption and integration and collaboration and communication have brought the strategy of communication. These bring benefit and strategy of BIM by providing construction industry to improve design coordination.

1. Introduction

Building information modelling (BIM) is a cutting-edge method of tackling building design, construction, operation, and maintenance (Latiffi, Brahim & Fathi, 2016). As mentioned by Tahir *et al.* (2017), BIM adoption has been mandated by a few client organizations, including Henderson Land, for use in all design and construction projects. Some clients directly oversee the BIM technology's adoption, training, and management.
The significance of knowledgeable professionals in utilizing the "full potential" of BIM as an integrated practice (Jacobsson & Merschbrock, 2018). As mentioned by Jacobsson & Merschbrock (2018), BIM technicians, BIM operators, BIM coordinators (BCs), and BIM managers are just a few of the new specialized BIM-related roles that have lately emerged because of the rising adoption of BIM. Building information modelling (BIM) teams,

also known as BIM-based construction networks, are teams that work on BIM-enabled projects and may have individuals from different organizations and disciplines who are geographically scattered (Oraee *et al.*, 2019). However, our observations of design coordination meetings indicate that even when BIM tools are readily available, practitioners frequently revert back to 2D digital and paper-based drawings and rarely interact with BIM tools on their own without the help of a BIM Coordinator (Oraee *et al*., 2019). As stated by Al Hattab & Hamzeh (2013), information is gathered and transparently shared between the many users (owners, architects, structural and MEP engineers, consultants, contractors, and subcontractors) in BIM-based projects, where interaction is more fluid and overlapping.

As mentioned by Teo *et al.* (2022), the use of 2D software may be rendered obsolete in the future as the building industries gradually adopt BIM and MEP services become technically more difficult to coordinate due to the need to adhere to individual services' codes of practise and ceiling height limitations. By providing a shared environment for all information identifying a structure, facility, or asset, together with its common elements and operations, BIM offers a new way of working (Merschbrock & Munkvold, 2015).

1.1 Research Background

Files One of the most popular and highly regarded uses of BIM in the construction industry is for design coordination and conflict identification (Mehrbod *et al.*, 2019). As mentioned by Teo *et al.* (2022), the workflow for design coordination is improved when appropriate management techniques are combined with cutting-edge technology and this also reduces conflict on the building site and lowers labour costs. As stated by Mehrbod *et al.* (2019), practitioners usually return to 2D digital and paper-based designs even though BIM tools are easily accessible, and they hardly ever use BIM tools independently without assistance from a BIM Coordinator. As mentioned by Mehrbod *et al.* (2019), the crucial and difficult process of design coordination makes ensuring that building designs satisfy the practical, aesthetic, and financial demands of project stakeholders. As mentioned by Yarmohammadi & Ashuri (2015), during the preconstruction stage of building projects, the design coordination of mechanical, electrical, and plumbing (MEP) systems is a manual procedure. As stated by Leite (2019), more generally design coordination enables the integration of designs by many specialty designers and builders to produce a single, coordinated set of designs that can be constructed without component collisions.

1.2 Problem Statements

All tables should The synchronisation of current design practise and construction delivery, as well as inconsistencies in the way that multidisciplinary teams handle and exchange project lifecycle data, have historically been problems (Anderson, Akponeware & Adamu, 2017). Admittedly, as affirmed by Anderson, Akponeware & Adamu (2017), older designers who are more accustomed to conventional 2D-based coordination may have a poor understanding of collision detection software tools, which could result in incorrect interpretations of false positives and false negatives, delivering misleading findings during MEP collaboration. Design challenges including disparities between designs, illogical designs, clashes, and missing pieces are the most frequent problems in BIM-based design coordination (Nasuha, Rahman & Haron, 2023). As mentioned by Anderson, Akponeware & Adamu (2017), unfamiliarity with the programme also results in substantial collisions when a clash detection test is done, and non-BIM qualification increases design errors and clashes.

As mentioned by Wang & Leite, (2013), the majority of the knowledge at stake was tacit knowledge based on specialized skills and experiences, which is difficult, if not impossible, to centralize or formalize, even if the majority of the confrontations described in the coordination conference followed recurring patterns. The causes of design disparities include poor coordination of the design process and a lack of communication (Nasuha, Rahman & Haron, 2023). These factors also prevent knowledge reuse and transfer across different disciplines (such as between design and construction) and projects. (Wang & Leite, 2013). The inability of many stakeholders to collaborate due to communication through 2D information affects communication during meetings (Bhat, Trivedi & Dave, 2018). As affirmed by Oraee *et al.* (2019), Ineffective collaboration may result from stakeholders' lack of motivation for early integration and different project participants' communication styles. Insufficient communication, a lack of understanding of BIM by the design manager, modelling instructions not being used for the project, a hurried design schedule, conflicts between models, frequent changes during design, and an unclear scope were some of the coordination issues that were highlighted (Bhat, Trivedi & Dave, 2018).

Building design coordination is typically carried out in a traditional environment by visual inspection, when 2D designs are examined and potential conflicts are noted. Due to the ineffectiveness and error-proneness of this procedure, several conflicts frequently go unnoticed and must be resolved in the field, which is time-consuming and ineffective (Mehrbod *et al.*, (2019). As stated by Yarmohammadi & Ashuri (2015), the old

method's manual nature not only prolongs the procedure but also negates the advantages of performing MEP coordination. Moreover, as mentioned by Mehrbod et. (2019), when exchanging technical information amongst project participants, practitioners frequently fall back on 2D paper-based technical drawings, while 3D design information is still underutilized. The designer and engineer spend a lot of time and effort on low-value production tasks like drafting and documentation in the conventional two-dimensional (2D) project delivery process (Singh, Sawhney & Borrmann, 2017). When trying to record the knowledge or outcome of design issue conversation, switching from one type of design representation to another takes time, is mistake prone, and causes information loss (Mehrbod *et al.*, (2019). Design coordination is typically done in a traditional environment by visual inspection, which compares 2D designs and identifies any conflicts (Mehrbod *et al.*, 2019). As affirmed by Yarmohammadi & Ashuri (2015), traditional coordination involves systematically overlaying 2D drawings of various MEP systems on a glass lighting table, comparing them to one another, and looking for any conflicts. Due to the ineffectiveness and error-proneness of this procedure, several conflicts frequently go unnoticed and must be resolved in the field, which is time-consuming and ineffective (Mehrbod *et al.*, 2019). As stated by Mehrbod, Staub & Tory (2013), the team's capacity for collaboration, problem-solving, and decision-making during design meetings is limited by the communication of project information through paper-based information representations.

2. Literature Reviews

2.1 Introduction

With the goal of reducing losses brought on by a lack of complete integrated life-cycle knowledge about facilities, information-rich BIM models have made it possible for design coordination to start earlier in the project and more effectively facilitate collaboration between many disciplines (Leite, 2019). As mentioned by Leite (2019), BIM offers a number of advantages, including earlier and more accurate visualizations of a design, automatic low-level corrections when a design is changed, generation of accurate and consistent 2D drawings at any stage of design, earlier collaboration of multiple design disciplines, and simple verification of consistency to the design intent, among others.

2.2 Building Information Modelling (BIM)

Building Information Modelling (BIM) is a technological advancement and a method that has revolutionized how buildings are planned, designed, assessed, built, and managed (Latiffi, Brahim & Fathi., 2016). It consists of intelligent building elements or environmental factors that each have data properties and parametric rules (Logothetis, Delinasiou & Stylianidis, 2015).

BIM is a collaborative platform used to process, develop, communicate, and analyse construction projects utilizing a digital information model over the course of the project's construction life cycle, it is sometimes referred to as n-D modelling, virtual modelling, or virtual prototyping technology (Al-Ashmori *et al.*, 2020). As mentioned by Li & Tang (2021), you cannot alter the database or application structure, change the data bureau structure, or make any other changes while developing the system.

Many people consider the development of the ArchiCAD software programme in Hungary in 1982 to be the true start of BIM, and the development of the Revit software programme in 2000 marked a significant change in the direction of efficient BIM application (Smith, 2014). As affirmed by Logothetis, Delinasiou & Stylianidis, (2015), BIM was initially used in 1987 by the company Graphisoft with the platform ArchiCAD as part of the Virtual Building idea.

2.3 Design Coordination In BIM

The procedure that drives and dictates how practitioners interact with design information and what steps are required to resolve design challenges makes it essential to comprehend building design coordination (Mehrbod *et al.*, 2019). BIM coordination is crucial because it enables information sharing among stakeholders, breaks down communication barriers, enhances decision-making, and promotes teamwork throughout the project lifecycle (Farouk *et al.*, 2023). Design coordination is typically done in a traditional environment by visual evaluation, which compares 2D designs and identifies any discrepancies (Mehrbod *et al.*, 2019). As mentioned by Farouk *et al.* (2023), A precise roadmap workflow, containing process information that refers to the debates and choices made during coordination sessions, is necessary for the BIM coordination process.

2.4 Improvement of BIM for Design Coordination

1. BIM Improve Clash Detection

Make the claim that collaboration in BIM can only be effective when stakeholders agree to jointly develop and improve a model. The BIM software available for clash detection is BIM modelling design software and BIM integration tools that perform clash detection. As mentioned by (Paik, Leviakangas & Choi (2022), collaborating amongst various segments, BIM coordination enables discussion and settlement of significant disagreements and design differences in terms of design flaws and design inconsistencies. As stated by Shyamkant, Patil & Pataskar,(2017), for the BIM modelling design software the software's proprietary models are the only ones that can be used for clash detection in this, which has limitations. The software alerts you of a collision, for instance, when you attempt to place a slab on a group of walls in Revit that do not touch each other.

2. BIM Improve Communication
The contractor and client's communication issues have been resolved thanks to the precision and thoroughness of the current building construction drawings produced using BIM technology (Goh *et al.*, 2014). As stated by Melzner *et al.* (2015), through the use of 3D models, communication with other project stakeholders that have diverse backgrounds was made simpler. Benefits can be realized when BIM is viewed as a process that spans the entire project lifecycle rather than just a technology. Effective cooperation, communication, and working towards a common objective all aim to add value for the project owner and minimize, if not eliminate, waste in the project delivery process (Al Hattab & Hamzeh,2013). As mentioned by Oraee *et al.* (2019), the standardized usage of BIM enables the streamlined sharing of models and simple data exchange amongst several stakeholders, contractors, and end users on BIM-enabled projects. The ongoing evolution of collaborative technological requirements as well as the effects of virtual working, interoperability, data interchange, and industry foundation classes (IFC) are the main issues of interest in the technology "push" that has grown to be a significant theme (Oraee *et al.*, 2019).

3. BIM Improve Method Manual
As stated by Bryde, Broquetas & Volm (2013), all information, data, and documentation related to projects and assets must be in electronic format under the terms of 3D BIM. Fewer parties have been involved in the project, MEP coordination chores have be prioritized and finished sequentially, and 3D BIM models have be developed to generate 2D coordinated drawings for submission, all of which have speed up the building process. This has improved the organization of the BIM design coordination management and improve the knowledge of the project's requirements by the relevant services. Construction and installation of the corresponding components would proceed more quickly and smoothly as a result, with fewer disputes and conflicts occurring on the construction site (Teo *et al.*, 2022). Utilize BIM integration technology in the early planning stages to eliminate flaws in conventional two-dimensional CAD drawings, hence lowering the likelihood of design revisions during the building phase and raising the project's overall quality Lee *et al.*, 2015).

2.5 Benefits of BIM

1. Reduce Rework and Cost Savings
The study shows that BIM can identify mistakes, omissions, and clashes prior to construction, which reduced waste and improved the efficiency of the construction processes (Eldeep, Farag & el-Hafez, 2021). By having a better grasp of the BIM enablers, organizations may be able to plan for the adoption and implementation of BIM more effectively and reap its potential advantages without making costly mistakes (Abbasnejad, Nepal & Drogemuller, 2016).

This study provides recommendations for ensuring BIM quality for accurate quantity take-off, which is essential for the application of BIM technology to the building construction process and cost estimation (Kwon, Jo & Cho, 2011). As mentioned by Chen, Wang, & Bi (2021), project cost management may be made more effective and efficient by utilizing BIM technology, and this technology can be applied to each individual step of a project.

2. Enhanced Project Quality and Safety
Furthermore, a true "as-built/as-damaged" BIM model of an existing building necessitates a high semantic level with original documents as well as observations of the building states through visual inspections, diagnostics, and monitoring. As stated by Bruno, De Fino & Fatiguso (2018), a potential challenge in this regard would be the introduction of BIMcloud and BIM repository services with the goal of lowering the size of BIM deliverables and shifting from file-based BIM to data-based BIM. Another important contribution to construction automation for refurbishment has be the integration of BIM with automation systems, which have increase quality control during diagnosis, design, and work execution.

3. Streamlined Scheduling and Visualization
Concurrent construction is aided by using BIM throughout the project lifetime. It can undoubtedly aid in the development stages of a project's lifecycle, from the early conceptual phase to the design, construction, and

Research in Management of Technology and Business Vol. 5 No. 1 (2024) p. 1165-1178

operation phases, and finally to demolition (Al-Ashmori *et al.*, 2020). BIM has the potential to integrate time and cost, allowing for real-time updates and assessing the efficiency of the tracking and monitoring process throughout the project phases. BIM may also be used in the assessment and analysis of green construction. It can also be utilized for clash identification and design optimization. It is simple to comprehend and visualize complex designs (Tariq *et al.*, 2019).

4. Improved Facility Management
It can be used by the owner to understand the project's needs, by the design team to research, plan, and develop the project, by the contractor to oversee construction, and by the facility manager during the project's use and decommissioning phases (Bryde, Broquetas & Volm, 2013). As mentioned by Tariq *et al.* (2019), facility managers use the 6D BIM method to manage and maintain a facility over the course of a building's life. BIM have thereby enabled the quick examination of various possibilities relating to the performance of a building throughout its life cycle, which could result in potentially positive project results (Bryde, Broquetas & Volm, 2013).

2.6 Strategy to make BIM more acceptable by construction players

1. Adoption and integration of BIM
The goal to promote multidisciplinary collaboration from the very beginning of a project is a key aspect of working in a BIM environment (Ahmed, McGough & Austin, 2013). As stated by Poirier, Staub-French & Forgues, (2015), the organizational push (i.e., opportunities, intent, and incentives) and project pull of BIM (i.e., project BIM requirements and uses, procurement, and project incentives), as well as the organizational pull with regard to learning and assessment, define the interface between the organizational and project context.

As stated by Davies, McMeel & Wilkinson (2017), it is given as a legitimate model of BIM adoption that may be used as a development step on the way to a more thorough implementation as well as a stand-alone adoption model. By having a better grasp of the BIM enablers, organizations may be able to plan for the adoption and implementation of BIM more effectively and reap its potential advantages without making costly mistakes (Abbasnejad, Nepal & Drogemuller, 2016).

2. Collaboration and Communication
Some people define BIM as "data sharing, and not just data exchange," while others see it as an integrated model, "a software application," or a set of shared digital representations and a common language that enables interoperability (Alnaser & Harty, 2016). As mentioned by Du *et al.* (2020), according to recent research, BIM-based projects enable teams to communicate at a better level of maturity. In fact, increased communication has been named one of the top 10 benefits of BIM adoption in the construction industry (Du *et al.*, 2020).

3. Continuous Improvement and Evaluation
By making models of existing structures, putting out alternatives, examining and contrasting the building performance of these alternatives, and modelling improvements, BIM, which is a technique for estimating correct building information, can be used to anticipate the energy performance of retrofit solutions (Habibi, 2017). As stated by Al Ahbabi & Alshawi (2015), the advantages of building information modelling (BIM) can be maximized over time by clients using a continuous improvement approach to continually improve their performance and procedures.

3. Research Methodology

3.1 Introduction

One methodology, the qualitative approach, has been used in this study. While the primary goal of the qualitative technique is to identify the BIM design coordination is suitable to the finally disseminate for the maximum impact to improving the coordination in the construction industry. Since it can offer background information on the subject under investigation and permit more in-depth analysis to address "how" and "why" concerns, the qualitative case study method was used Jacobsson & Merschbrock, 2018).

3.2 Research Methodology Process

This study advances our knowledge of how research methodology classes are structured as well as the wider implications of the various strategies for the scholarly development of research methodology as a separate field (Daniel, 2017). There are ten stages in this research which include turn the idea into research question, review the literature, design the study and develop method, writing research proposal, issues about finding, obtain ethical and trust approval, collect and collate data, analyse the data and interpret findings, implication research

for clinical practice and identifying how findings could be put into practice and report on the study and disseminate the findings.

3.3 Formulation of Research Problem

The first stage is to develop a research problem that clarifies the purpose and goals of the investigation. Finding a research challenge leads to additional inquiries and opportunities. It is a chance to put novel concepts to the test or reframe existing issues in light of new information (Tan, 2007). The balance between the difficulty of data collecting and the validity and relevance of the results can be achieved by carefully taking into account these criteria while developing a research question and designing a research methodology (Prechelt, Zieris & Schmeisky, 2015). In this research, there are three objectives are mainly highlighted, which are study the improvement of BIM can do for design coordination in construction industry, the benefits of BIM coordination for the future development and the strategy of BIM that can improve the coordination in the construction project.

3.4 Conceptualizing a Research Design

A plan, structure, and strategy for an inquiry known as a "research design" is created in order to find solutions to the issues raised by the research topic. The suggested research technique enables a researcher to theories and learn from the intervention at the industry partner(s), while doing rigorous and pertinent design science research. It does this by building on well-established notions like patterns, design theories, and the design theory nexus (Buckl *et al.*, 2013). The plan is the full strategy or schedule for the study. After establishing the study objectives, the research design is planned. The procedures and methods for gathering and analyzing the desired data would be laid out in a study design.

3.5 Collection of Data

Primary data collection refers to the fieldwork approach's data collecting that comes directly from the source. In research using regression, comparative, and historical methodologies, primary data are frequently used (Tan, 2007). For instance, the sources for literature reviews are typically found in published journals, books, and other materials.

The secondary data, however, are gathered using a desk study method using information that has been published and is available in some form. When developing techniques, case study, experimental, and survey approaches are frequently used (Tan, 2007). To gather data or information from various construction professionals, for instance, utilize a questionnaire or a personal interview.

Routine data can offer an accurate and practical form of data gathering for study, yet it is possible to observe significant limits of agreement between data sources (Bryant *et al.*, 2014). As stated by scholars are highly recommended to employ the most up-to-date techniques for data collection because primary research has always been the foundation for the formation of new knowledge (Chidlow *et al.*, 2015).

1. Primary Data

Information that has been obtained by a person other than the researcher is referred to as secondary data. This data source offers details on the research topic covered by the most recent state-of-the-art methodology (Kassu, 2019). After reviewing a sizable number of documents and reports from businesses in online forms, this research comes to a conclusion.

2. Secondary Data

Research conducted in libraries and online has produced primary data. Various library resources, such as books, journals, magazines, and articles, have been used to gather pertinent data. The websites that are trustworthy, like those run by registered organizations, the government, and other organizations, are where most of the data generated by internet users is searched. Additionally, Google Scholar and books are the primary search engines utilized for research. These are used to obtain journals, articles, conference papers, and books about electronics.

Secondary data analysis is an important technique to take into consideration since these data sets can improve science and test hypotheses by boosting the rigor and applicability of research to the broader public (Davis, Jager & Maslowsky, 2015).

3.6 Methods of Data Collection

This investigation demonstrates that data gathering strategies (such as interviewing, observing), as well as data analysis techniques (such as qualitative, quantitative), are all a part of research methodology (Chu & Ke, 2017). The process of doing research then moves on to choose the data collection procedures, which may include interviews, observational techniques, document analysis and simulation (Tan, 2007). Primary data, also referred

to as fieldwork, and secondary data, are the two basic ways to data gathering (Naoum, 2001). To acquire primary data for this study, literature reviews on connected subjects have been used. While using interviewing techniques for secondary data collection. In order to determine whether the study goals are applicable and compatible with the research challenges, these two results have been combined in the end.

3.7 Research Instrument

A research instrument is a piece of equipment used by researchers to collect, gauge, and analyse data from people related to their area of study. Observations, experiments, questionnaires, interviews, surveys, and other data collecting techniques can all be used as research tools. A trustworthy method for assessing the caliber of simulation-based research publications is provided by this instrument (Fey, Gloe, & Mariani, 2015).

3.8 Interview

A conversation between two or more people during which the interviewer asks questions in order to get information from the interview is another way to obtain the data. The possibility for the respondent to provide a more in-depth response is provided by the data collection, which is typically richer and more contextual information.

According to our argument, it is important to take into account the potentials for the technique's application in order to understand the relationship between the interview as a method of data creation for research and the methods of knowing about the world, or the epistemology from which the interview-based research proceeds (Edwards & Holland, 2020).

In this research, qualitative method has been undergone by interview. This semi-structured aims at consulting the opinion of BIM professionals to verify the BIM improving the coordination, benefits of BIM coordination for the future development and the strategy of BIM can improve coordination in the construction project.

3.9 Data Analysis

This research used qualitative methods to conduct. Articles, journals, and news are found to do the part of literature review. The benefits and strategies are concluded after plenty of articles to support the result of findings. Because it can extract more information than a conventional survey or interview approach and because the programme is automated, this analytical method can be utilised as a market research tool (Kim, & Kang, 2018). It can also save money and time. Furthermore, qualitative methods can also be used at the stage of collecting data using interviews. This research has been interviewing the players that are involved in BIM professional. In order to know which benefits and strategy they found in recent years. Other than that, we have known what benefits and strategy the best option for them is to improve their current coordination in the construction industry through interviewing them.

3.10 Content Analysis

The properties of different kinds of communication, such as text, images, or audio, can be analysed and interpreted through the application of the study approach known as content analysis. The key benefits of content analysis are that it is content-sensitive, that it can be utilised in a wide range of research methods, and that it can be used to examine a variety of qualitative data sources (Kyngäs, 2019). It entails methodically examining the information in these materials, spotting trends, themes, and other important characteristics, then making deductions or coming to conclusions about the information.

4. Research Findings and Discussion

For this research, three participants are recruited for the interview. Respondent 1 is a chief operating officer and has worked as BIM consultant for 6 years. He is actively participating in the application of the BIM process for projects of diverse sizes and origins. He works hard to deliver values to clients, like spearheading design coordination, offering helpful criticism during conversations, keeping them informed, and making the most of the BIM process.

Respondent 2 is a project manager and has been working as a BIM consultant for 10 years. He is designed to provide accurate and cost-effective solutions. He In order to guarantee data integrity and remove any disparities in data capturing, our method is predicated on the best technology currently available and industry-accepted practices.

Respondent 3 is a project manager and has been working as a BIM architecture, planning and design for 10 years. He efficiently manages project data to be disseminated and utilized throughout the project life cycle without loss, contradiction, or misunderstanding.

4.1 Data Analysis for First Objective: The Communication Improvement That BIM Can Do for Design Coordination in Construction Industry

Table 1 *BIM improve communication*

Question	R1	R2	R3
Can you provide me some examples of BIM enhance the communication during the design coordination?	3D model	3D model	3D model

Table 1 shows the feedback given by R1, R2, and R3 to know the communication among project stakeholders. R1, R2, and R3 use the same method to communicate with project stakeholders. The improvement of communication as mentioned by R1, R2, and R3 are same as Bryde, Broquetas & Volm (2013), all information, data, and documentation related to projects and assets must be in electronic format under the terms of 3D BIM.

"Able to simulate the services in high level in 3D to ensure ceiling height of the designed space is achievable." (Respondent 1)
"*In design coordination, BIM allows stakeholders to visualize the entire project in a 3D model, enabling better coordination and identification of clashes or conflicts early in the design process. This visual clarity helps teams collaborate efficiently and resolve issues before construction begins*." (Respondent 2)
"*…if we build in 3D that will help to convey the design intend, can see the appearance of building that might help improve communication and see it from that angle*." (Respondent 3)

Table 2 *Resolve the impact*

Question	R1	R2	R3
How BIM find out and resolve the impact of communication in design issues early?	Clash detection	Clash detection and analysis	Detect issues

Table 2 shows the feedback given by R1, R2, and R3 to know the BIM find out and resolve the impact of communication in design issues early. R1, R2, and R3 highlighted the same way to find out and resolve the impact which is clash detection. The improvement of communication as mentioned by R1, R2, and R3 are the same as Shyamkant, Patil & Pataskar (2017), for the BIM integration tools that perform clash detection is used to find incompatibilities between various non-proprietary software (software from different vendors), but the software that creates the component of the model that clashes needs to be changed.

"*BIM software has the ability to conduct clash detection in the software to detect clashes*." (Respondent 1)

"*BIM helps find and resolve design issues early through clash detection and analysis. By identifying clashes in the virtual model, teams can address issues before they become costly problems during construction. This proactive approach improves overall communication and project outcomes*." (Respondent 2)

"*In the project, we organize biweekly design review and reach the contractor. They have showcased the federated models from there also, that can detect any issues and ask the contractor to resolve the issues within 2 weeks.*" (Respondent 3)

Table 3 *Key practices to effect.*

Question	R1	R2	R3
8. When using BIM, what is the key practices to effect communication?	Constant communication	Establishing clear communication protocols	Clear communication

Table 3 shows the feedback given by R1, R2, and R3 to know the key practices to effect communication when using BIM. R1, R2, and R3 highlighted the same key practices to effect communication is communication. The

Research in Management of Technology and Business Vol. 5 No. 1 (2024) p. 1165-1178

improvement of communication as mentioned by R1, R2, and R3 are the same as Lee *et al.* (2016), the system's goal is to transport data, provide smooth communication between participants, and enable the use of that data by those participants in a single, integrated system.

"*Constant Communication of issues and work programmed to ensure all parties are updated with the latest state of the project*." (Respondent 1)

"*Key practices for effective communication with BIM include establishing clear communication protocols, conducting regular project meetings, and providing training for team members to enhance their BIM skills. These practices ensure that everyone is aligned and working cohesively*." (Respondent 2)

"*For example, during the designing workshop we highlight the comment or findings. When they got the comment, they have gone back to the office, sometimes they have to relay this information to who are involves in the projects such as contractors, engineers and designers*." (Respondent 3)

4.2 Data Analysis for Second Objective: The Benefits of Communication in BIM Design Coordination for Future Development

Table 4 *Benefits on project timelines, budgets, and future projects*

Questions	R1	R2	R3
Can you share examples of BIM communication benefits on project timelines, budgets, and future projects?	Reduced redundant or abortive works	Reduce the chances of costly rework and avoiding unnecessary expenses	Reduce reworks

Table 4 shows the feedback given by R1, R2, and R3 to know the examples of BIM communication benefits on project timelines, budgets, and future projects. R1 highlighted benefits that fewer unnecessary or abandoned works. R2 stated that benefits can minimize the likelihood of expensive rework and steer clear of needless expenditures. R3 highlighted that can minimize the likelihood of expensive rework and steer clear of needless expenditures. The benefits of communication as mentioned by R3 are the same as Eldeep, Farag & el-Hafez (2021), research indicates that Building Information Modeling (BIM) has the capability to detect errors, omissions, and conflicts before construction begins, resulting in decreased waste and enhanced construction process efficiency.

"It has greatly reduced redundant/abortive works due to uncoordinated works, which have impacted the time and cost of the project. Learnings from the project have be brought forward to the future development projects to minimise similar issues." (Respondent 1)

"*Picture this: with clear BIM communication, project timelines become more predictable. Changes can be swiftly implemented, reducing the chances of costly rework. Budgets benefit as well—accurate information exchange helps in avoiding unnecessary expenses and ensures that resources are allocated efficiently*." (Respondent 2)

"When using BIM, they have addressed the problems virtually in the design stage. So, when in the construction that may reduce the reworks in the construction site." (Respondent 3)

Table 5 *External stakeholders and influence project approvals*

Questions	R1	R2	R3
7. How does BIM help communicate with external stakeholders and influence project approvals?	Visualize a project in 3D	Comprehensive and visually compelling model	Visualize

Table 5 shows the feedback given by R1, R2, and R3 to know the BIM help communicate with external stakeholders and influence project approvals. R1, R2, and R3 use the same method which is visualized to communicate with the external stakeholders and influence project approvals. The benefits of communication as

mentioned by R1, R2, and R3 are the same as Al-Ashmori *et al.* (2020), can help during the various stages of a project's lifecycle, from the initial conceptual stage to the phases of design, construction, and operation, and ultimately to the demolition stage.

"BIM allow authorities to gain access to information on the project, ability to visualise a project in 3D have speed up the process of approval and level of confident." (Respondent 1)

"BIM is the language that speaks to external stakeholders. By presenting a comprehensive and visually compelling model, project approvals become smoother. It's not just about conveying information but doing it in a way that resonates with diverse stakeholders, building trust and support for the project." (Respondent 2)
"Visualization is one of the tools available to us in BIM. Generally, BIM assists in explaining or demonstrating case design intend to other stakeholders." (Respondent 3)

4.3 Data Analysis for Third Objective: The Strategy of Communication in BIM to Improve Design Coordination in Construction Project

Table 6 *Strategies use to establish effective communication*

Questions	R1	R2	R3
What key strategies do you use to establish effective communication in BIM design coordination?	Implementation of CDE	Understanding the project's unique needs	Establish the project requirement

Table 6 shows the feedback given by R1, R2, and R3 to know the key strategies used to establish effective communication in BIM design coordination. R1 highlighted that CDE implementation is the key strategy used to establish effective communication in BIM design coordination. Therefore, R2 stated that the key strategies are understanding the project's unique needs to establish effective communication in BIM design coordination. However, R3 highlighted that determining the requirements for the project is the key strategies. The strategy of communication as mentioned by R3 are the same as Poirier, Staub-French & Forgues (2015), the organizational push and project pull of BIM (i.e., procurement, project incentives, and project BIM requirements and uses) as well as the organizational pull regarding learning and assessment define the interface between the organizational and project context.

"*Implementation of CDE*." (Respondent 1)

"*Effective communication in BIM design coordination starts with understanding the project's unique needs. I focus on clear and concise language, using terminology that resonates with all stakeholders*." (Respondent 2)

"*Put in the requirements, so that the contractors or the designers knows that the client want and need to know what the project want."* (Respondent 3)

Table 7 *Benefits from strong communication strategies*

Questions	R1	R2	R3
10. What benefits have you seen from strong communication strategies in BIM design coordination, such as improved project outcomes and client satisfaction?	Enhanced Preparation Client	Strong communication strategies	No overrun cost and delay

Table 7 shows the feedback given by R1, R2, and R3 to know the benefits from strong communication strategies in BIM design coordination, such as improved project outcomes and client satisfaction. R1 stated that strong communication strategies improve preparation customer. The strategy of communication as mentioned by R1 are the same as Al Ahbabi & Alshawi (2015), clients who use a continuous improvement approach to enhance their performance and procedures can optimize the benefits of building information modeling (BIM) over time. Otherwise, R2 highlighted that the powerful way of communicating is the strong communication strategies. Therefore, R3 stated that strong communication strategies are no delays or overrun expenses.

Research in Management of Technology and Business Vol. 5 No. 1 (2024) p. 1165-1178

"*Enhanced Participation of Client in the project implementation to ensure the requirements are met, sharing of design intentions among contractors and consultants help to provide a better understanding which result in a better/practical solution to the issues*." (Respondent 1)

"*Strong communication strategies in BIM design coordination translate into tangible benefits. Improved project outcomes stem from streamlined workflows and reduced errors. Client satisfaction rises because of transparency, timely updates, and a collaborative approach*." (Respondent 2)

"When they coordinate, using the BIM with the right way and correct coordination. The proper or well implemented BIM can contribute to the successful of the project in terms of no overrun cost and delay." (Respondent 3)

The research has shown that using the BIM improvement the communication for the design coordination such as clash detection, communication, and 3D models, the benefits of communication in the BIM for design coordination such as reduce reworks and visualize. The strategies of communication in BIM for the design coordination such as collaboration and communication, adoption and integration of BIM, and continuous improvement and evaluation

5. Conclusion and Recommendation

According to the results of the research, the researcher had suggested some recommendations how the communication improvement of BIM for the design coordination in the construction industry Malaysia.

1. Investment on BIM training
Provide the for all team's members who have to involve in the project on BIM tools, getting the latest BIM technology skills and proficient use to improve the efficiency in the construction projects.

2. Frequently coordination meeting
Frequently arranged the coordination meeting with all stakeholders and team members to discuss and communicate the updates, concerns, problems, and make sure everyone clearly understand and get the latest project information.

The study's result shows that BIM design coordination is very important to every construction company at each level. All the respondents agree that BIM design coordination is the most important aspect to construction company. It is important to manage and monitor the company profile and valuable items for the project. It can detect early clash detection to decrease the problems on site. It can clear communication with stakeholders and client to understand the projects and 3D models can communication with stakeholders. Besides that, BIM has brought the benefits in design coordination which is visualization can help to explain and demonstrate the design. Reduce reworks to minimize similar issues. Therefore, BIM has brought the strategies of communication in design coordination which is collaboration and communication the information to all project's participants. Adoption and integration of BIM to continuous improvement approach to enhance their performance and procedures.

From the data collected, it can be concluded that every worker in a construction company should have the knowledge of BIM for design coordination to start earlier in the project and more effectively. In a nutshell, construction industry is an industry that needs to be focused because it helps develop Malaysia to a better country by building railway, commercial building, residential building and so on. Better software and technologies to design coordinate could bring benefits to themselves and for the project.

Acknowledgement

Communication and completion of this research is made possible through support from FPTP and assistance by Universiti Tun Hussein Onn Malaysia.

Conflict of Interest

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

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Tan Yee Ling, Sulzakimin Mohamed;* ***data collection:*** *Tan Yee Ling;* ***analysis and interpretation of results:*** *Tan Yee Ling;* ***draft manuscript preparation:*** *Tan Yee Ling, Sulzakimin Mohamed, Adejoh Ahmodu Adaji. All authors reviewed the results and approved the final version of the manuscript.*

References

Abbasnejad, B., Nepal, M., & Drogemuller, R. (2016). Key enablers for effective management of BIM implementation in construction firms. Science & Engineering Faculty.

Ahmed, A., McGough, D., & Austin, S. (2013, July). Integration of BIM in higher education: Case study of the adoption of BIM into Coventry University's Department of Civil Engineering, Architecture and Building. In Sustainable Building and Construction Conference (SB13) Coventry University (pp. 394-403).

Akponeware, A. O., & Adamu, Z. A. (2017). Clash detection or clash avoidance? An investigation into coordination problems in 3D BIM. *Buildings, 7(3), 75.*

Al Ahbabi, M., & Alshawi, M. (2015). BIM for client organisations: a continuous improvement approach. *Construction Innovation.*

Al Hattab, M., & Hamzeh, F. (2013, July). Information flow comparison between traditional and BIM-based projects in the design phase. In Proceedings for the 21st annual conference of the international group for lean construction (Vol. 10). n. July.

Al-Ashmori, Y. Y., Othman, I., Rahmawati, Y., Amran, Y. M., Sabah, S. A., Rafindadi, A. D. U., & Mikić, M. (2020). BIM benefits and its influence on the BIM implementation in Malaysia. *Ain Shams Engineering Journal, 11(4), 1013-1019.*

Alnaser, A., & Harty, C. (2016). The Implications of BIM Use on Communication Channels in the Design Process. In CIB World Building Congress (pp. 930-941).

Bhat, V., Trivedi, J. S., & Dave, B. (2018, July). Improving design coordination with lean and BIM, an Indian case study. In Proc. 26 Annual Conference of the International. Group for Lean Construction (IGLC) (pp. 1206-1216).

Bruno, S., De Fino, M., & Fatiguso, F. (2018). Historic Building Information Modelling: performance assessment for diagnosis-aided information modelling and management. Automation in Construction, 86, 256-276.

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of building information modelling (BIM). International journal of project management, 31(7), 971-980.

Chen, B., Wang, P., & Bi, L. (2021). Application Research of BIM Technology in Project Cost Management in the Era of Big Data. BCP Business & Management.

Davies, K., McMeel, D., & Wilkinson, S. (2017). Making friends with Frankenstein: hybrid practice in BIM. Engineering, Construction and Architectural Management.

Doudilim, Y. V. L., Masrom, M. A. N., Latiffi, A. A., & Kasim, N. (2021). Building Information Modeling (BIM) Implementation Towards Improving Collaborative Communication in Construction Projects. Research in Management of Technology and Business, 2(2), 395-414.

Du, J., Zhao, D., Issa, R. R., & Singh, N. (2020). BIM for improved project communication networks: Empirical evidence from email logs. Journal of Computing in Civil Engineering, 34(5), 04020027.

Eldeep, A., Farag, M., & el-Hafez, L. (2021). Using BIM as a lean management tool in construction processes – A case study. Ain Shams Engineering Journal.

Farouk, A. M., Nasuha, A. N., Rahman, R., Zakaria, Z., & Haron, A. T. (2023, May). Design coordination in BIM: Decision criteria for determining tolerances. In AIP Conference Proceedings (Vol. 2688, No. 1). AIP Publishing.

Goh, K. C., Goh, H. H., Toh, S. H., & Peniel Ang, S. (2014, November). Enhancing communication in construction industry through BIM. In 11th International Conference on Innovation and Management (pp. 313-324).

Habibi, S. (2017). The promise of BIM for improving building performance. Energy and Buildings, 153, 525-548.

Jacobsson, M., & Merschbrock, C. (2018). BIM coordinators: a review. Engineering, Construction and Architectural Management, 25(8), 989-1008.

Kassu Jilcha, (2019). Research Design and Methodology. Text Mining - Analysis, Programming and Application [Working Title], 1–12. intechopen. Retrieved June 29, 2022.

Kwon, O., Jo, C., & Cho, J. (2011). Introduction of BIM Quality Standard for Quantity Take-off. Journal of the Korean Institute of Building Construction.

Latiffi, A. A., Brahim, J., & Fathi, M. S. (2014). The development of building information modeling (BIM) definition. In Applied mechanics and materials (Vol. 567, pp. 625-630). Trans Tech Publications Ltd.

Latiffi, A. A., Brahim, J., & Fathi, M. S. (2016). Transformation of Malaysian construction industry with building information modelling (BIM). In MATEC Web of Conferences (Vol. 66, p. 00022). EDP Sciences.

Lee, W., Kang, S., Moh, R., Wu, R., Hsieh, H., & Shu, Z. (2015). Application of BIM coordination technology to HSR Changhua station. Visualization in Engineering, 3(1), 5.

Leite, F. L. (2019). BIM for design coordination: a virtual design and construction guide for designers, general

contractors, and MEP subcontractors. John Wiley & Sons.
Li, J., & Tang, F. (2021, May). Construction Technology Safety Management under the Background of BIM and Information System Modeling. In 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS) (pp. 59-63). IEEE.
Logothetis, S., Delinasiou, A., & Stylianidis, E. (2015). Building Information Modelling for Cultural Heritage: A Review. ISPRS Annals of Photogrammetry, Remote Sensing & Spatial Information Sciences, 2.
Mehrbod, S., Staub-French, S., & Tory, M. (2013). Interactions with BIM tools in design coordination meetings. In Proceedings of the Canadian Socety of Civil Engineering 4th Construction Specialty Conference (pp. 1-10).
Mehrbod, S., Staub-French, S., Mahyar, N., & Tory, M. (2019). Beyond the clash: investigating BIM-based building design coordination issue representation and resolution. J. Inf. Technol. Constr., 24(2019), 33-57.
Mehrbod, S., Staub-French, S., Mahyar, N., & Tory, M. (2019). Characterizing interactions with BIM tools and artifacts in building design coordination meetings. Automation in Construction, 98, 195-213.
Melzner, J., Feine, I., Hollermann, S., Rütz, J., & Bargstädt, H. (2015, October). The influence of building information modelling on the communication management of construction projects. In The 15th International Conference on Construction Applications of Virtual Reality, At Banff, Banff, Canada.
Merschbrock, C., & Munkvold, B. E. (2015). Effective digital collaboration in the construction industry–A case study of BIM deployment in a hospital construction project. Computers in Industry, 73, 1-7.
Naoum, S.G. (2001). Dissertation Research and Writing for Construction Students, United Kingdom: Butterworth Heinemann
Nasuha, A. N., Rahman, R. A., & Haron, A. T. (2023, May). Design coordination in BIM: Clash resolution process and affecting factors. In AIP Conference Proceedings (Vol. 2688, No. 1). AIP Publishing.
Oraee, M., Hosseini, M. R., Edwards, D. J., Li, H., Papadonikolaki, E., & Cao, D. (2019). Collaboration barriers in BIM-based construction networks: A conceptual model. International Journal of Project Management, 37(6), 839-854.
Paik, S. M., Leviakangas, P., & Choi, J. (2022). Making most of BIM in design: analysis of the importance of design coordination. International Journal of Construction Management, 22(12), 2225-2233.
Poirier, E., Staub-French, S., & Forgues, D. (2015). Embedded contexts of innovation: BIM adoption and implementation for a specialty contracting SME. Construction innovation.
Portal Rasmi Lembaga Pembangunan Industry Pembinaan Malaysia (CIDB), reached at address. https://mybim.cidb.gov.my
Shyamkant, B. G., Patil, A., & Pataskar, S. (2017). Cost and time optimization for construction of residential building by clash detection in building information model (BIM). Int. Res. J. Eng. Technol, 4(01).
Singh, M. M., Sawhney, A., & Borrmann, A. (2019). Integrating rules of modular coordination to improve model authoring in BIM. International Journal of Construction Management, 19(1), 15-31.
Smith, P. (2014). BIM implementation–global strategies. Procedia engineering, 85, 482-492.
Strauss, A.L. & Corbin, J (1990) Basics of Qualitative Research: Grounded theory procedures and techniques, Sage, Newbury Park CA.
Tahir, M. M., Haron, N. A., Alias, A. H., Al-Jumaa, A. T., Muhammad, I. B., & Harun, A. N. (2017). Applications of building information model (BIM) in Malaysian construction industry. IOP Conference Series: Materials Science and Engineering, 291, 012009.
Tan, W. (2007). Practical Research Methods. Pearson Education South Asia
Tariq, M. A., Farooq, U., Aamir, E., & Shafaqat, R. (2019, July). Exploring adoption of integrated building information modelling and virtual reality. In 2019 International Conference on Electrical, Communication, and Computer Engineering (ICECCE) (pp. 1-6). IEEE.
Teo, Y. H., Yap, J. H., An, H., Yu, S. C. M., Zhang, L., Chang, J., & Cheong, K. H. (2022). Enhancing the MEP Coordination Process with BIM Technology and Management Strategies. Sensors, 22(13), 4936.
Wang, L., & Leite, F. (2013). Knowledge discovery of spatial conflict resolution philosophies in BIM-enabled MEP design coordination using data mining techniques: a proof-of-concept. In Computing in Civil Engineering (2013) (pp. 419-426).
Yarmohammadi, S., & Ashuri, B. (2015). Exploring the approaches in the implementation of BIM-based MEP coordination in the USA. Journal of Information Technology in Construction (ITcon), 20(22), 347-363.
Daniel, B. (2017). Contestable professional academic identity of those who teach research methodology. International Journal of Research & Method in Education.
Prechelt, L., Zieris, F., & Schmeisky, H. (2015). Difficulty Factors of Obtaining Access for Empirical Studies in Industry. 2015 IEEE/ACM 3rd International Workshop on Conducting Empirical Studies in Industry.
Buckl, S., Matthes, F., Schneider, A., & Schweda, C. (2013). Pattern-Based Design Research - An Iterative Research Method Balancing Rigor and Relevance.
Bryant, M., Santorelli, G., Fairley, L., Petherick, E., Bhopal, R., Lawlor, D., Tilling, K., Howe, L., Farrar, D., Cameron, N., Mohammed, M., & Wright, J. (2014). Agreement between routine and research measurement of infant height and weight. Archives of Disease in Childhood.
Chidlow, A., Ghauri, P., Yeniyurt, S., & Cavusgil, S. (2015). Establishing rigor in mail-survey procedures in

international business research. Journal of World Business.
Davis-Kean, P., Jager, J., & Maslowsky, J. (2015). Answering Developmental Questions Using Secondary Data.. Child development perspectives.
Chu, H., & Ke, Q. (2017). Research methods: What's in the name?. Library & Information Science Research.
Fey, M., Gloe, D., & Mariani, B. (2015). Assessing the Quality of Simulation-Based Research Articles: A Rating Rubric. Clinical Simulation in Nursing.
Edwards, R., & Holland, J. (2020). Reviewing challenges and the future for qualitative interviewing. International Journal of Social Research Methodology.
Andzayi, C., & Ikwen, E. (2014). Developing Beginning Reading Skills among Primary School Pupils in Cross River State, Nigeria: A Pilot Study Report.
Kim, S., & Kang, J. (2018). Analyzing the discriminative attributes of products using text mining focused on cosmetic reviews. Inf. Process. Management
Kyngäs, H. (2019). Qualitative Research and Content Analysis. The Application of Content Analysis in Nursing Science Research.