POLITEKNIK UNGKU OMAR

IMPLEMENTATION OF BIM TECHNOLOGY FOR SITE SAFETY LAYOUT AND MACHINERY ROUTES

MUHAMMAD AFIQ AIMAN BIN MARLIZAN (01BCT20F3025)

A report submitted in partial fulfillment of the requirements for the award of the degree of Bachelor in Civil Engineering Technology with Honors

CIVIL ENGINEERING DEPARTMENT

SESSION 2 2022/2023

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Thank you.

ABSTRACT

The construction sector will face new problems due to the expansion of the digital age, globalization, and environmental sustainability particularly when redefining accidents and fatalities in the Malaysian building sector. Potential dangers and collisions may be recognized and handled proactively by constructing a thorough BIM technology, in reducing risk and accidents. This research describes how Revit 3D modeling technology was used to improve site safety layout and machinery paths. Revit was a sophisticated BIM software application used to build precise 3D models in the design process. These findings emphasize the benefits of adopting Revit 3D models, such as greater visualization, increased communication among project stakeholders, and optimized safety management and machinery movement. A survey of 30 respondents was used to empirically examine usability factors. The descriptive analysis (mean, standard deviation), internal consistency (Cronbach's alpha value), and Independent Sample Ttest were all used to statistically analyze quantitative data. The findings of the statistical analysis indicate that the respondents' opinions on the viability of BIM technology on the project's effectiveness in visualizing, confirming specifications, and measuring at the safety site are good, with a mean value of 0.664. The findings provided may help with changes in various study environments to meet diverse pedagogical goals. The result presents BIM technology's considerable influence on building a safer and more efficient construction environment.

Building Information Modeling (BIM), safety construction, machinery.

ABSTRAK

Sektor pembinaan akan menghadapi masalah baharu berikutan perkembangan era digital, globalisasi, dan kelestarian alam sekitar terutamanya apabila mentakrifkan semula kemalangan dan kematian dalam sektor bangunan Malaysia. Potensi bahaya dan perlanggaran mungkin diiktiraf dan diuruskan secara proaktif dengan membina teknologi BIM yang komprehensif, dalam mengurangkan risiko dan kemalangan. Penyelidikan ini menerangkan cara teknologi pemodelan 3D Revit digunakan untuk memperbaik susun atur keselamatan tapak dan laluan jentera. Revit ialah aplikasi perisian BIM lanjutan yang digunakan untuk membina model 3D yang tepat dalam proses reka bentuk. Penemuan ini menyerlahkan faedah menggunakan model 3D Revit, seperti visualisasi yang lebih baik, komunikasi yang lebih baik di kalangan pihak berkepentingan projek, dan pengurusan keselamatan dan pergerakan jentera yang dioptimumkan. Tinjauan terhadap 30 orang responden digunakan untuk mengkaji faktor kebolehgunaan secara empirikal. Analisis deskriptif (min, sisihan piawai), ketekalan dalaman (nilai alfa Cronbach), dan Ujian-T Sampel Bebas semuanya digunakan untuk menganalisis data kuantitatif secara statistik. Hasil analisis statistik menunjukkan bahawa pendapat responden terhadap daya maju teknologi BIM terhadap keberkesanan projek dalam visualisasi, pengesahan spesifikasi, dan pengukuran keselamatan di tapak adalah baik, dengan nilai min 0.664. Penemuan yang disediakan boleh membantu dengan perubahan dalam pelbagai persekitaran pembelajaran untuk memenuhi matlamat pedagogi yang pelbagai. Hasilnya menunjukkan pengaruh besar teknologi BIM dalam membina persekitaran pembinaan yang lebih selamat dan cekap.

Pemodelan Maklumat Bangunan (BIM), keselamatan pembinaan, jentera.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The building sector in Malaysia keeps boosting the national economy by showing significant development, especially in redefining safety in the Malaysian building sector. Site workers was exposed to danger such as, falls, trips, struck-by, chemical exposed, and electric shocks are the most common mishaps in the construction industry, but stakeholders are solely concerned with cost, quality and completion of project were on schedule as a result of the frequent occurrence of accidents in the construction sites. Although the construction sector plays an essential role in economic success, the frequency of accidents and deaths in this industry continues to rank among the most dangerous in the world (Wasilkiewicz et al., 2016). Construction sites are often labelled as dangerous places to work on a worldwide scale (Sherratt, Farrell, & Noble, 2013). According to the Occupational Safety and Health Act of 1994 (Act 514), the employer is primarily responsible for ensuring workplace safety and health. The goal of this approach is to increase employers' ability to manage occupational health and safety effectively and efficiently in order to reduce accidents and illnesses. The issue of safety in the workplace is of great importance to be considered and complied with by every employee involved in construction work.

The percentage of accident cases and fatality ratios in the Malaysian construction industry are getting larger and gradually increasing each year. The Organization for Economic Co-operation and Development (OECD) in 2007, an accident was defined as an “unexpected and unplanned incident” that caused one or more illnesses, injuries, or fatalities while working in the construction industry. According to The International Labor Organization (ILO) estimates from 2012, occupational accidents have a devastating economic impact, resulting in a loss of 4% of global GNP (Gross national product). This is supported by research from the European Agency for Safety and Health at Work (EU-OSHA), which found that the cost of occupational illnesses and injuries accounts for 3.3%

of European GDP and 3.9% of global GDP (Gross domestic product) (EU-OSHA, 2017). Plus, location of construction site was crucial. The management is responsible for making sure the workplace is secure and free from health risks. Accidents involving machinery or vehicles are particularly dangerous, especially when cranes which are frequently used for lifting and moving objects are involved. According to Guo et al. (2012), inadequate or nonexistent safety training is a significant factor in the high accident rates in the construction sector. Risks to health and safety can arise from a variety of sources, including people, machinery, materials, the environment, and processes. Additionally, incidents and accidents frequently don't result from a single occurrence. For instance, there have been a few crane mishaps in Malaysia that have resulted in major injuries, fatalities, lost productivity, and property damage both on and off the construction site (Hamid et al., 2019).

The Construction accidents are on the rise, which is a highly concerning trend because of the lack of understanding about occupational safety and health in regulation, training, and occupational knowledge about the environment, experience, and demography of employees (Nurul et al., 2022). Through BIM implementation, the designers and builders may use BIM models and simulations to effectively mitigate (or eliminate) building site risks during the project planning stage. Such as, permanent anchoring points may be incorporated into the design by using BIM models to locate the positions of worker fall safety tie-off points. Building Information Modeling (BIM) is a rapidly developing idea that has the potential to revolutionize the entire construction sector. It might bring about significant changes in the way projects have been planned, constructed, and run (Ghaffarian Hoseini, 2017). Numerous advantages of BIM have been studied to demonstrate its potential effects and BIM were encouraged the construction sector to use it in projects. The use of BIM in the construction sector is primarily intended to boost productivity and efficiency in the construction sector.

This research looks into the viability of using BIM and 3D visualization to reduce accidents on building sites. the use of BIM-assisted site planning to address blind problems and ensure construction safety and feasibility as a foundation for making construction management choices in safety activities. Current safety work relies on the subjective assessment of engineering staff expertise or has been reinforced by 2D drawings as a planning and evaluation tool. In fact, through the use of BIM technology to plan and evaluate the preliminary work of the layout and heavy machinery route can help to see the 3D visualization of the environment on-site in order to help construction management in discussing the possibility of HIRARC in the construction phase and heavy machinery route such as the problem of lifting and distributing materials, and the deep excavation area. At the end of this study, able to identify the HIRARC and present alternative solutions to the stakeholders involved to prevent or eliminate hazards at the construction site using models from BIM technology at the construction site conforms with the necessary safety and health regulations in Malaysia.

1.2 Problem Statement

In the previous of DOSH investigation of the construction fatality statistics from 2013 to 2018 were described and addressed together with other problems. From the six different types of accidents that have been documented, accidents involving equipment, such as being struck by moving objects or vehicles, accounted for 18 incidents (12.4%) and four cases (3%), respectively from 145 cases reported. The relationship between the six primary contributing elements and accidents involving machinery operation on construction project. Each component was significantly increased the likelihood of equipment accidents such as Human factor, a dangerous workplace, poor management, and unsafe procedures are some of the reasons that are highly connected with equipment accidents. Construction is the industry with the highest rate of occupational deaths even though it ranks third in terms of injuries compared to services and manufacturing sectors. Instead of displaying a long-term steady trend, this industry continues to be the most perilous.

The causes of accidents in construction include negligence, human error, and mechanical failure. Although factors like inclement weather and other unforeseen issues can also cause construction accidents. Many accidents are caused by human negligence or someone’s failure to do their job. Whether that failure was something as drastic as forgetting to secure a machine, or something as seemingly minor as not cleaning up a coffee spill, these acts of negligence can be avoided before serious repercussions in such a dangerous environment and site project with the implementation of Building Information Model technology.

BIM-assisted technology and practical expertise may produce a spatial reality simulation, coordinately show, and review the problem in the working area. The model's level of similarity to the current scenario is high, and it can successfully finish the simulation. If there are issues or disputes, excellent planning and evaluation methods allow for quick modification and alternative surveys. This paper offers a quick glance at the implementation of BIM feasibility in the construction project. There is no doubting that BIM has offered several advantages throughout the building supply chain, notwithstanding the obstacles industry participants experienced in adopting BIM in order to integrate safety and health into the design phase of the building designed (Collado Marisca, 2022).

The purpose of this research is to increase students' knowledge of BIM in the value of safety at construction sites. Using BIM building process visualization, this study specifically aimed to improve students' capacity to recognize possible hazards in a construction project. The success of Prevention through Design (PtD) permits and facilitates a risk-mitigation and worker-safety strategy in the identification and treatment of hazards by engineers and designers. An action researcher approach with the industrial sector to the development and prototyping of BIM tools that enable engineers and designers to identify potential risks and prepare for appropriate risks a treatment based on a questionnaire developed for the feasibility of safety site layout and heavy machinery routes of a model on a construction project site.

Additionally, it will make it difficult to move machinery in site projects, such as the pile planting and crane operation in site areas where hazards can occur to workers if poor site planning. The accident at the construction sector project was also an enemy to the construction project which will lead to fatalities on employer, employee, and construction progress. Because of that, the level of safety at the workplace needs to be improved to reduce the rate of accidents or near misses occurring in construction site areas. From the issue's confirmation to the model's development to its application, the supervisor directing the pertinent stakeholders participating in the entire process can come to an agreement and accommodate divergent viewpoints. By simulating the BIM model, it may improve communication effectiveness and win over participants.

1.3 Objective Of Study

The aim of this objective is to develop the site planning visualization assembly using Building Information Modelling (BIM) to access project data for feasibility site planning to avoid project accident and over cost. Hence, to achieve this aim, the objectives listed are:

1. To identify the features and classification of safety planning approaches for site layout and routes at the construction site.
2. To develop the BIM visualization and simulation of machinery equipment and ancillary facilities at the construction site.
3. To access the feasibility of the BIM model at construction site.

1.4 Scope of Study

Machinery that isn't safe can seriously harm an accident. According to Health and Safety Executive (2013), moving tools and machines together might occasionally result in injuries. Besides, high potential dangers of equipment accidents exist in unsafe work environments. While many dangers may be promptly detected and eliminated, some create extremely unsafe situations that could jeopardize the workers' safety. Therefore, prior establish for identifying features and classification of safety planning in the construction sector, have to understand the practical issues the of current industry.

The study has been carried out through literature review on Malaysia’s Act and regulation on safety and health on construction sector for getting the data on issues that been study. The review has also been and study on BIM applications in the construction site and safety site management related to machinery site management. Act & regulation related:

1. JKR in ‘Specification for Occupational Safety and Health in Engineering Construction Works 2019’
2. DOSH - Factories and Machinery ACT 1967 (ACT139) (Building Operations and Works of Engineering Construction) (Safety) Regulations 1986

The Figure 1 show location of the student’s research was applied in the selected project of Kinta district, Perak Darul Ridzuan. The research of project-based location was the proposal to build a Mosque of Imam As-Syafie with building height 17.98m, 3 units of two type quarters (2-unit quarter type 1 and 1-unit quarter type 2), 3 units of shop lot with cooperation between architectural, mechanical and electrical, civil and structure advisors, quality surveyors and the contractor where the owner of the project was the Majlis Agama Islam dan Adat Melayu Perak. The area of the project site measuring 258' x 325' is a big project with a traditional concrete building with one floor above the ground for the mosque measured 66.76m x 69.07m, one floor above the ground of quarters measured 6.08m x 13.72m for both types, and one floor of shop lot measured 13.52m x 9.75m. The building design for quarter type 1 and type 2 was not much different except the two units of the quarter was combined. The project location was nearby residents of housing estates Meru Mentari and Meru Tropika.

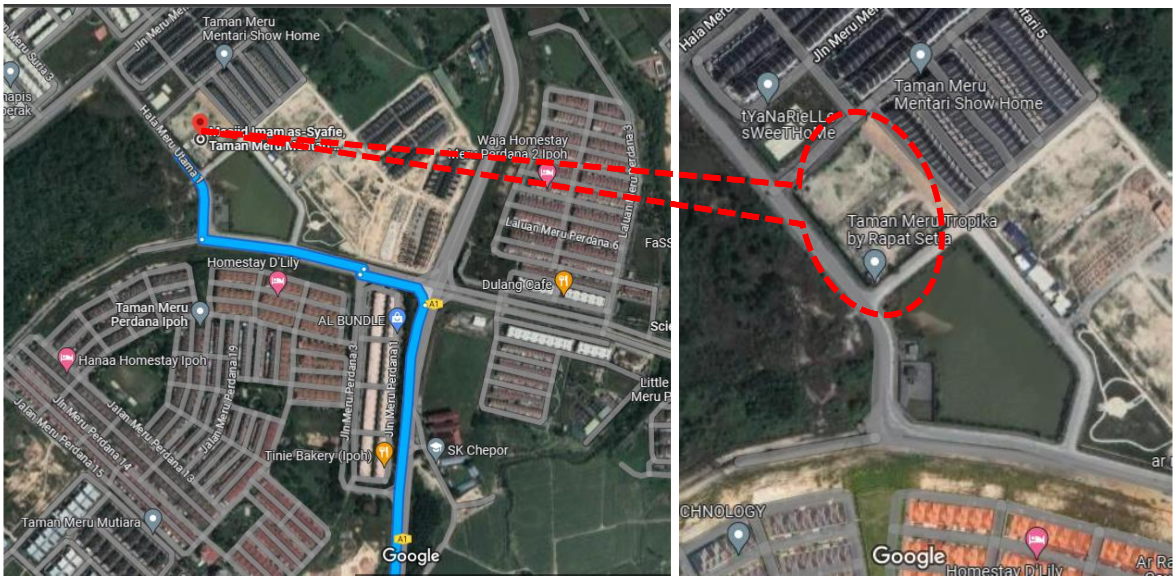


Figure 1*: The location of Masjid Imam As-Syafie site project (Source: Google Maps)*

The involvement of construction project is a contract between the client and other consultants. Which are architectural, civil and structure, mechanical and electrical consult, and quantity surveyor. In this study, a real construction project owned by the Majlis Agama Islam dan Adat Melayu Perak, was used to be examined in this research. The construction project that has been studied was a simple building structure that was built by the government sector and was located close to residents of the housing estates Meru Mentari and Meru Tropika. The site project has been cleared of some trees and other objects. The site project management was managed by:

1. Project director:

Monitoring the development of the project, managing the finances, and assuring its quality Making strategic conclusions and guiding project managers to put those decisions into practice while reporting on project status during meetings with clients, stakeholders, and project managers

2. Project manager:

plays the role of a planner, advisor, and a project management team leader to conceptualize and implement solutions that relate to quality or process improvements.

3. Design engineer:

offers expert advice on incorporating aesthetics and functionality into a space or building based on the needs and audience of their clients. They work closely with other professionals to help cater to their clients' requirements.

4. QA/QC:

QA (quality assurance) primarily focuses on the processes and procedures that improve quality, including training, documentation, monitoring and audits. QC (quality control) focuses on the product to find defects that remain after development.

5. Site engineer:

provide technical advice about, plan, organize and supervise construction projects. Site engineers tend to have more specific, technical knowledge than site managers

These accidents can be mitigated by publicizing the safety issues and unsafe behavior among employees and including employee participation in the creation of safety programs, conducting safety audits, and identifying alternatives to improve safety at construction sites. OSH Master Plan (2021) described the programs held for the strengthening of Security and Occupational Safety and Health (OSH) with one of the ways that were digital technology. To further improve the safety performance of the construction industry, some approaches are required in preventing accidents by using BIM which was correlated with the operator and heavy machinery.

This study will use the "Revit Architecture Autodesk 2022" drawing software tools to draw, plan, simulate, and use the "Navisworks management 2022" as a platform of communication management. The construction project drawing will be imported from AutoCAD 2021. According to the issues demand of preliminary work to analyze the relevant problems, to use the static and dynamic simulation by the 3D models for planning and assessment the interference conflict, security of machinery layout and route, construction material hoisting, and distribution.

1.5 Significant of The Study

This study has a variety of interests. Understanding and researching characteristics and categorization of safety planning methodologies for site layout and route at the construction site is important in this study. The researcher may gain a deeper understanding of workplace safety and apply solutions using the BIM technology approach by being aware of the essential requirements that are implemented in the management of off-site safety construction projects.

Building Information Modeling (BIM), according to CIDB (2013), is software that is placed on the computer and used to create the model virtually before it is produced in reality. such Revit, Tekla, Bentley, Autodesk, Vico, and Cost X are a few of the tools. Each instrument has a specific purpose and is used to manage a variety of tasks in building projects (L. Francois, 2012). According to RICS (2017), BIM is a strategy for fostering cooperation among the stakeholders, beginning concerned beginning with the design phase and continuing through the management facility. In contrast to traditional paper-based designs, BIM enables designer engineers to feel depth and other actual site characteristics. The stakeholders would have a better and more thorough grasp of the items under investigation the higher the quality, safety and accuracy of the information. Stakeholders might use more aspects in visual representation to exercise their vision and advancement.

This study is significant because it informs employers about the need to consider specific motivational traits seriously when managing and administering their employees. This can lead to employers adopting a responsible attitude and educating them about how BIM technology can improve workplace safety in the construction industry. This was believed that the outcomes of this study will help companies develop an environment at work that promotes employee loyalty. In addition, it is anticipated that this study will deepen and support the theories of BIM practices in safety site. The digital characteristics of BIM technology, such as accurate geometric mapping function, information connection and transmission, definition and description of 3D CAD (Computer-Added Design) component properties, aided in solving the problem of space simulation and technology selection, eliminating blind spots in the project management process, and broadening the scope of its application in construction management. To secure the integrity of the safety construction process, as well as to achieve the project's design goal, efficiency, and cost performance objectives. As a result, engineering planning and assessment will play a vital role on the building site for risk prevention, as desired by the stakeholders polled.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The impact of contemporary technology on a nation at the forefront of the industrialized world is amazing. Make advantage of Malaysian development construction technologies to make all the task easier. In this technological field, it is still possible to reduce the use of traditional building methods. As a result, the employment of technology in the construction business will be beneficial since it may boost production. Furthermore, it may be utilized anywhere and simplifies daily tasks owing to improvements such as software technology. In this chapter, the researcher will offer a summary of the literature on an ongoing investigation to identify current research knowledge.

2.2 Safety on Construction Sector

Based on Figure 2.1 explained a framework that divided causes into two categories: immediate (human and workplace factors) and underlying (management and external factors). The causes of occupational illnesses and accidents may all be connected to one another. Construction management is currently dealing with a number of issues, both uncontrolled and manageable. Uncontrollable elements are frequently present in the construction sector, including unpredictable weather, a lack of local resources, and a variety of restrictive requirements. By encouraging designers and builders to visually examine worksite conditions and identify dangers, the use of BIM technology can lead to an improvement in occupational safety. The project team can discuss and carry out a safety plan more efficiently by employing digital simulations and 3D models.

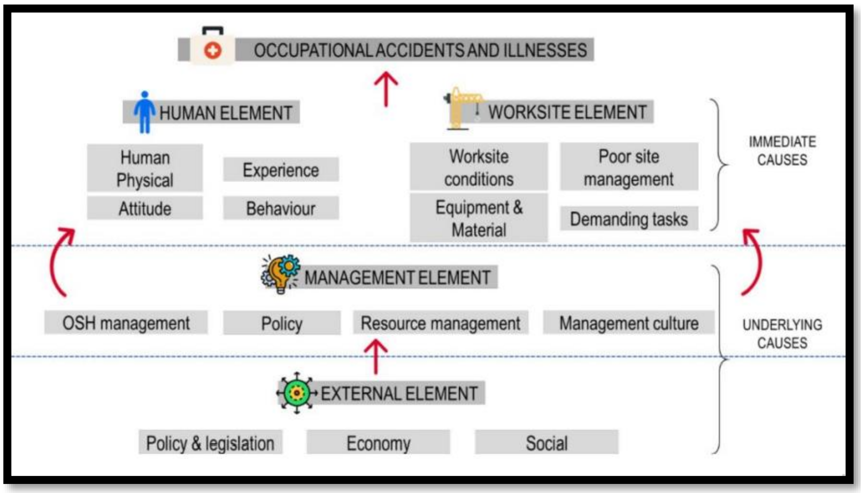


Figure 2.1: Framework for occupational diseases and accidents. (Source: Nur Nadia et al., 2022)

Additionally, Figure 2.2 shows the analysis referring to a period when the UK was an EU member. One of the lowest rates of fatal injuries within the EU is routinely seen in the UK that been recorded in Eurostat 2018. The 2018 UK fatal injury rate was lower than the EU average, in France, Spain, Italy, Poland, and Germany. The UK's 2018 fatal injury rate was comparable to Germany's (HSE, 2021). For the Asia area based on DOSM (2022), Japan had a fatal accident rate of 5.24 per 100,000 employees in the construction industry (all industries: 1.49 per 100,000 workers), while Singapore had a rate of 2.2 per 100,000 employees in the construction industry (all industries: 0.9 per 100,000 workers).

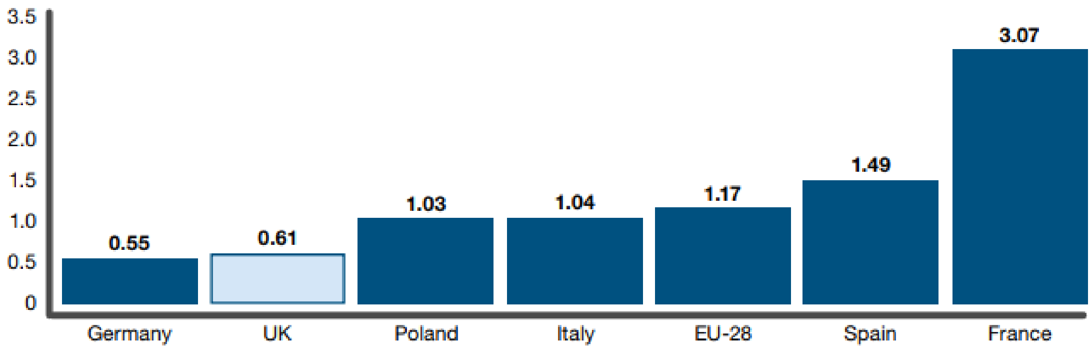


Figure 2.2: Fatal injuries in large EU economies. (Source: Eurostat 2018)

However, in the Asian region, Malaysia had the highest rate of worker fatalities (DOSH, 2019). Based on DOSM (2022), Other nations have similarly reported higher occupational mortality rates in the construction sector when compared to other industries. Table 2.1 explained a framework that divided causes into two categories: Occupational accident rate refers to per 1,000 workers and Occupational death rate refers to per 100,000 workers. The rate ratio per 100,000 workers in Malaysia also increases gradually from 2014

(4.21) to 2017. While for the fatality accident rate of US Bureau of Labor Statistics recorded 1,008 occupational fatalities in the US Construction industry, with a rate of 10.2 deaths per 100,000 employees, compared to a prevalence of 3.4 fatalities across all industries (BLS, 2021).

Table 2.1: The fatality rate per ratio of accident and death (Source: DOSH)

Year	2014	2015	2016	2017	2018	2019	2020	2021
Rate of Accident	3.10	2.81	2.88	2.93	2.40	2.71	2.18	1.43
Rate of fatalities	4.21	4.84	4.84	4.90	4.14	3.83	2.09	2.00

Prior to the coronavirus pandemic, there was a general decrease trend in the rate of worker self-reported injury. The rate in 2020/21 was lower than the pre-coronavirus levels in 2018/19. In 2018, the fatality rate resulting goes down because of the COVID-19 pandemic, also known as the coronavirus pandemic global pandemic of coronavirus disease in 2019. The construction industry itself during 2019 (3.83) to 2021 (2.00) and the same thing also happened to the accident rate ratio per 1,000 workers is goes down because all sectors have been shut down in other to focus on the national coronavirus pandemic.

Table 2.2 and Table 2.3 shows occupational accident statistics by sector that has been reported to dosh in the construction sector increased to 217 accidents in December 2021 from 206 accident in December 2020. Accidents in the construction sector in 2021 was recorded 65 deaths, 5 permanent disability and 147 non-permanent disability. Accident in 2020 was recorded 66 deaths, 3 permanent disability and 137 non-permanent disability that was reported to DOSH only. In Malaysia, 65 fatal construction accidents occurred as of 2021. Comparatively speaking, this was far less than in past years. This was partially brought on by the COVID-19 outbreak causing the suspension of various building projects. Accidents are unintended occurrences that happen without any preparation, desire, anticipation, or control and can result in property damage and financial loss in addition to harming people (Ali et al., 2010).

Table 2.2: Occupational accident statistics by sector until December 2020. (Source: DOSM, 2022)

SECTOR	NPD	PD	DEATH	TOTAL
Hotel and Restaurant	137	1	2	140
Utilities (Electricity, Gas, Water and Sanitary Service)	214	3	3	220
Finance, Insurance, Real Estate and Business Services	312	7	8	327
Construction	137	3	66	206
Transport, Storage and Communication	294	6	11	311
Manufacturing	4202	231	73	4506
Wholesale and Retail Trade	126	1	1	128
Public Services and Statutory Authorities	73	1	3	77
Mining and Quarrying	35	1	3	39
Agriculture, Forestry and Fishery	916	20	43	979
TOTAL	6446	274	213	6933

Table 2.3: Occupational accident statistics by sector until December 2021. (Source: DOSM, 2022)

SECTOR	NPD	PD	DEATH	TOTAL
Hotel and Restaurant	125	1	0	126
Utilities (Electricity, Gas, Water and Sanitary Service)	198	1	8	207
Finance, Insurance, Real Estate and Business Services	264	4	17	285
Construction	147	5	65	217
Transport, Storage and Communication	281	5	6	292
Manufacturing	4015	206	48	4269
Wholesale and Retail Trade	182	3	2	187
Public Services and Statutory Authorities	68	2	4	74
Mining and Quarrying	44	4	8	56
Agriculture, Forestry and Fishery	939	18	16	973
TOTAL	6263	249	174	6686

2.3 Type of Accident

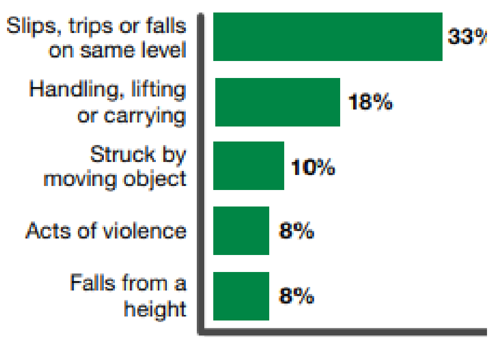


Figure 2.3: Non-fatal injuries to employees by most common accident. (Source: EU-HSE, 2021)

As reported by the employer in 2020/2021, non-fatal accidents involving employees are the most prevalent accident category that has been shown in figure 2.3. The injuries that related to slips, trips, or falls were 33% that was reported in HSE (2021). While, handling, lifting or carrying, and struck by moving object that related to human, machinery, and environment element show about 18% and 10% that been recorded. Only 8% recorded in HSE of non-fatal injuries such as acts of violence and falls from height.

The machinery accidents on construction sites happen recently and every year in Malaysia (DOSH). In 2019, 27 construction workers were killed in vehicle-related incidents. Twelve of them were general employees, while the remaining five were employers. Workers being crushed, struck by cars, or falling from them are the primary causes of fatality. The most common type of vehicle involved in deadly accidents was a truck. Based on cases that have been reported to DOSH 2022 in Table 2.4, 12 construction workers, 6 foreign workers and 1 general worker were killed in vehicle-related incidents. The latest report to DOSH was on Sunday, 21/08/2022.

Table 2.4: Reported case to DOSH Malaysia in 2022. (Source: DOSH,2022)

No.	**Date**	**Type of accident**	**Place**	**Case summary**
1.	2022-08-21	Dump truck driver killed.	Construction, Terengganu	1. A dump lorry driver was killed after plunging a 3-meter high hill after the lorry he was driving lost control. 2. The incident area is hilly and there are no warning signs and barricades. 3. There is no risk assessment record (HIRARC) for work processes and activities involving land trucks. 4. There is no safe work procedure for work processes and activities involving land trucks.
2.	2022-06-26	Worker killed after falling from a high	Construction, Johor.	1. A foreign construction worker fatally fell from level 3 after a formwork roof beam structure containing wet concrete collapsed along with the victim to level 1. 2. Construction works are not registered with DOSH.

No.	Date	Type of accident	Place	Case summary
				3. There are no safe work procedures for working at high. 4. No risk assessment record (HIRARC) for working at high.
3.	2022-06-24	Worker killed hit by the collapsed wall	Manufacturing, Sabah	1. A contract worker was killed after being hit by a wall collapsing as a result of a breach of shovel machinery. 2. No formal training record of drivers carrying shovel machinery. 3. Employers are instructed to update records of HIRARC and SOP-related work.
4.	2022-06-14	The dead worker was hit by a pipe.	Construction, Terengganu	1. A foreign worker died of internal bleeding as a result of the strong impact of an iron pipe that struck the victim. 2. During the incident, it is believed that there was a push (over force) by one of the Side Boom cranes that was assigned to lift the pipe and caused the pipe to come out of the pipe clamp and hit the victim who was on the edge of the pipe.
5.	2022-06-03 .	Workers killed after crush by machinery	Manufacturing, Johor.	1. A foreign general worker was killed after being stuck between an iron plate and a gantry crane pole. 2. The employer fails to ensure that the machinery has a valid certificate of fitness (CF). 3. The employer failed to supervise the storage of the remote control for the 'single girder cantilever gantry crane'

No.	Date	Type of accident	Place	Case summary
6.	2022-06-01	Worker killed after falling from a high	Construction, Pulau Pinang.	1. A sub-contractor worker for roof installation work died after falling from a 5.8-meter-high roof. 2. Still under investigation
7.	2022-05-28 . .	Foreign workers were killed in vehicle skidding	Quarry, Terengganu	1. A foreign worker was killed after the vehicle he was driving to work skidded while going down a steep and sandy shortcut. 2. The employer has instructed the shortcut road to be closed immediately. 3. The employer is instructed to prepare an internal investigation report of the accident and corrective action to be taken
8.	2022-05-24 .	Workers drowned	Ma	1. A worker drowned after falling into a 12 -foot -deep claybath pit. 2. Employer fails to maintain water reservoir ponds in effluents pond, claybath pit and other open ponds in the vicinity. 3. The employer failed to provide a risk analysis (HIRARC) for inspection activities in the effluent pond area and in the surrounding area. 4. There were no witnesses at the time of the accident
9.	2022-04-23	Killed after trapped by rotavator machine	Agriculture, Johor	1. A worker was killed after being trapped in a rotavator machine. 2. The employer failed to provide a complete HIRARC for the process of installing the rotorvator on the tractor. 3. The employer fails to provide an accident investigation report.

No.	Date	Type of accident	Place	Case summary
10.	2022-04-21	Truck driver killed	Construction, Sabah	1. A truck driver died after the truck he was driving lost control and hit a slope. 2. The victim does not have a full E license, only has a probationary license for a D license. 3. The fact that the terrain slopes more than 35 degrees. 4. Suspected failure of truck brake function.
11.	2022-04-20	Excavator operator drowned	Business Services, Terengganu	1. An excavator operator who was unloading goods into a barge was killed after the excavator he was driving slipped and fell into the sea with the victim. 2. Still under investigation
12.	2022-04-19	Worker killed after falling from a high	Construction, Pahang	1. A worker killed after falling from a skylift
13.	2022-04-06	Worker killed after falling from a high	Business Services, Terengganu	1. A worker killed after falling from a skylift machine after a cut tree swung towards the victim's body. 2. The tree cutting work is not known by the camp because it is managed by the local District Council
14.	2022-04-20	Excavator operator drowned	Business Services, Terengganu	1. An excavator operator who was unloading goods into a barge was killed after the excavator he was driving slipped and fell into the sea with the victim. The cases still under investigation.
15.	2022-04-02	Deadly worker thrown out of wheel loader	Construction, Pahang	1. A foreign worker died after being thrown out of a wheel loader that slipped into a ravine. 2. There is no permission to use a 'wheel loader' for the purpose of lifting goods. 3. Ride a wheel loader in the same cabin.

No.	Date	Type of accident	Place	Case summary
				4. The employer fails to conduct monitoring and inspection of the operation of machinery by incompetent persons.
16.	2022-03-24	Worker died after ran over by a lorry.	Manufacturing	1. A contract worker died after being run over by a truck while the victim was crossing the sidewalk to go out to rest. 2. The employer failed to establish a working system for traffic management control for pedestrian walkways and heavy vehicle routes
17.	2022-01-24	Fatal road accident	Agriculture, Terengganu	1. A farm worker was killed after falling from a motorbike he was riding while going through a road that was under repair. 2. There are no working procedures, HIRARC, PTW, signboard and supervision for road repair works in the farm.
18.	2022-01-24	The worker died after was thrown out of the overturned truck	Quarry, Perlis	1. A lorry driver died after the water tanker he was driving stopped and reversed and fell on the slope of a quarry hill. The victim was found to have been thrown out of the truck cabin under a rocky hillside. 2. The victim is newly appointed on a contract basis to be the driver of a heavy vehicle on a term contract. 3. The victim does not have a truck driver's license. 4. No training is formally given to the victim.
19.	2022-01-10	Worker were killed in a furnace explosion	Manufacturing, Pulau Pinang	1. A worker who was operating excavators for dredging work died after a nearby furnace that was in the process of shutting down for maintenance work exploded. 2. The cause of the incident is still under investigation

The unexpected failure of these equipment, vehicles and systems is disastrous, resulting in collateral damage, higher expenditure, disturbed project execution, loss of output, and, in some cases, fatalities. Heavy building equipment accidents caused by a failure are not only physically harmful, but also financially disastrous to sufferers. These devices are large, powerful, and at times difficult to operate, and they can cause serious injuries or even death if the right safety equipment is not used. Table 2.5 shows, research into the underlying causes of machine injuries should be conducted in the construction sector in order to prevent machine accidents.

Table 2.5: Article of Machinery and safety site issues.

No.	Date	Title	Place	Case summary
1.	Hüseyin Ertaş, Ali Sayıl Erdoğan	An Analysis of Occupational Accidents in Demolition Work. (2017)	Turkye	1. The risks associated with demolition and construction work are universal, 2. These risks include compounds in the composition of demolished or removed objects, as well as places with sharp edges or projecting spikes. An accidents caused by structural collapse and shattered glass as a result of building damage during demolition
2.	Williams, Opeyemi Samuel	Analysis of Fatal Building Construction Accidents: Cases and Causes. (2017)	Malaysia	1. Identify the types of fatal accidents on construction sites, as well as the causes of the incidents. 2. Cases were descriptively examined, yielding the discovery of falls from great heights lack of compliance with safe work procedures and their casual attitude.
3.	Jongko Choi, Bonsung Gu, Sangyoon Chin, Jong-Seok Lee,	Machine learning predictive model based on national data for fatal accidents of construction workers. (2020)	Korea	1. Based on industrial accident data gathered by the Republic of Korea's Ministry of Employment and Labour (MOEL) from 2011 to 2016, 2. A prediction model that detects the potential risk of fatality accidents at construction sites using machine learning. National data on 140,169 industrial accident victims in the construction industry from 2011 to 2016 (including 137,323 injuries and 2846 deaths)

No.	Date	Title	Place	Case summary
4.	Umar, Tariq and Egbu, Charles	Causes of construction accidents in Oman. (2018)	Oman	1. Identifying root causes of accidents is recommended for Oman's construction organizations. 2. The model categorizes construction incidents into four categories: "Equipment / Materials", "Workers", "Environment", and "Management". The model is being used in an Oman road development project
5.	Georgeta Buicaa, Anca Elena Antonova ,Constantin Beiua, Dragos Pasculescub, Dobra Remusb.	Occupational health and safety management in construction sector - the cost of work accidents. (2017)	Romania	1. The collective accident was triggered by the collapse of an improperly supported earth bank. 2. The purpose of this article is to analyse the collective work accident that happened in the civil construction industry and to create the essential organisational safety measures to prevent such accidents.
6.	A Ayob, A A Shaari, M F M Zaki and M A C Munaaim	Fatal occupational injuries in the Malaysian construction sector– causes and accidental agents. (2018)	Malaysia	1. Sarawak, Johor, and Selangor had the highest rates of occupational fatalities. 2. The lack of safety and health standards, as well as inadequate risk management execution, exacerbated the danger of occupational accidents. The principal unintentional agents are poor working conditions and inadequate transportation and lifting equipment, such as scaffolds.

No.	Date	Title	Place	Case summary
7.	Yifan Gao, Vicente A. Gonzalez, Tak Wing Yiu,	The effectiveness of traditional tools and computer-aided technologies for health and safety training in the construction sector: A systematic review, Computers & Education. (2019)	New Zealand	1. Workplace accidents are rise in this industry, resulting in higher rates of injury and economic loss 2. It was estimated that around 15% of all occupational injuries in New Zealand in 2015 resulting in a significant economic loss of approximately $108 million
8.	Amrutraj Dilip Patil, and Deepa A. Joshi	A Review Paper on Construction Site Layout Planning. (2013)	India	1. In India, site layout planning is mostly ignored. 2. Various methodologies, such as genetic algorithms, simulation techniques, and ant colonies, are utilised for site layout planning. The Genetic Algorithm is explored in depth in this study. focuses on the many software programmes that are utilised to solve the site layout challenge.
9.	M. Abune'meh, R. El Meouche, I. Hijaze, A. Mebarki, I. Shahrour,	Optimal construction site layout based on risk spatial variability. (2016)	South Africa.	1. dealing with possible threats such as fire and blast waves. 2. reducing risk from natural or manmade dangers remains a scientific issue 3. Modeling hazard interaction has shown the hazard interaction among site components and the attenuation of danger with distance.

No.	Date	Title	Place	Case summary
10.	Xin Ning, Jingyan Qi, Chunlin Wu,	A quantitative safety risk assessment model for construction site layout planning. (2018)	China	1. the optimisation issue does not include a comprehensive risk factor analysis. Risk hazards such as falling items, noise pollution, and toxic substances are frequently overlooked. 2. to provide a quantitative safety risk assessment model that includes factor identification and categorization, factor analysis, and the building of assessment functions for evaluating site layout proposals in a more quantitative and valid manner.
11.	Collado-Mariscal, D. Cortés-Pérez, J.P. Cortés-Pérez, A. Cuevas-Murillo	Proposal for the Integration of Health and Safety into the Design of Road Projects with BIM. (2022)	Indonesia	Between 2017 and 2019, a study carried out in Indonesia confirmed the increase in the number of occupational accidents, with 54% stemming from road construction. . These accidents result in increased costs, as well as the loss of time.

As a result, substantial study interest has been generated to explore the planning elements that contribute to injuries and fatalities. The purpose of this study is to overcome with the use of Building Information Modeling (BIM) has been introduced in Malaysia in line with the country's Construction Industry Transformation Program (CITP) can effectively aid us in promoting top-notch site safety planning. BIM such as Revit 3D model and Navisworks manage was described as an important technology in the construction industry. It is seen to be able to improve the efficiency of project implementation and the quality of the construction process. BIM is also said to improve teamwork, create effective communication between project teams involved, overcome delays, and reduce project costs. The construction stakeholders were currently practicing the OSH concept but with traditional procedures and approaches. The implementation of OSH in Malaysia’s construction industry is foreseen to be well-accepted as most of the stakeholders were familiar with the concept of design construction.

2.4 BIM Implementation in the Construction Sector

According to statistics from 2011, just 13% of developers utilized BIM a decade ago, and 43% were not even aware of it. Only 1% of UK businesses were unaware of BIM in 2020. The CIDB analysis of various BIM adoption rate in different countries. Table 2.6 show, a report evaluating the adoption of BIM in six nations, Malaysia, UK, the Czech Republic, Canada, Japan, and Denmark was released by National Building Specification (NBS) in 2016 (CIDB, 2019). The study revealed that each country's adoption rate was different, with Denmark having the greatest percentage of BIM adoption (NBS, 2016). Due to the high demand for BIM from significant projects that use BIM, the BIM industry in Denmark has expanded and become more organized. Followed by UK BIM adoption with 54% and 42% awareness rate of BIM in 2016. While the BIM awareness of rate (45%) and BIM adoption rate (17%) for Malaysia was higher with a 28% difference.

Table 2.6: The percentage rate for BIM for six countries in 2016. (Source: CIDB, 2019).

COUNTRY	BIM ADOPTION RATE	BIM AWARENESS RATE
Malaysia	17%	45%
UK	54%	42%
Canada	67%	98%
Denmark	78%	96%
Czech Republic	25%	51%
Japan	46%	92%

In 2019, Table 2.7 displays the adoption rate for BIM in Malaysia and the United Kingdom as a percentage in 2019. As a result, the UK was predicted to adopt BIM at a greater rate than Malaysia with 69% and 49%. The primary causes of the high BIM adoption rate have been found as early BIM adoption and a requirement for BIM deployment in 2013. In addition, the UK has given implementors possibilities through its worldwide leading position in the use of BIM, the supply of BIM services, and the creation of BIM standards (Paul, 2018). Therefore, there is intense competition in those nations' construction industries to adopt technology and change traditional construction processes to BIM-based technology. Nevertheless, Malaysia has shown great improvement with 32% of BIM adoption from 2016 and 2019.

Table 2.7: The percentage rate for BIM in Malaysia and the United Kingdom. (Source: CIDB, 2019)

COUNTRY	BIM ADOPTION RATE	BIM AWARENESS RATE
Malaysia	49%	74%
UK	69%	29%

In addition to OSHCIM 2017, CIDB's Occupational Safety and Health-Specification and Bill of Quantities (BQ) for Construction Work said that developers needed to have safety and health plans in place in order to guarantee that they complied with regulations and laws. To promote a safety culture, developers are also encouraged to deploy cutting-edge technologies for safety surveillance (DOSHM, 2022). The same 3D model may also be used by a stakeholder especially safety officer and supervisor to visualize the site's state and assess construction-related risks in order to prevent accidents on construction sites.

Besides, It can assist the management in creating an efficient safety plan to lessen the likelihood of an accident on a construction project, a thorough safety strategy is essential (Carter et al., 2006) (Zhang, P., 2013). It was to ensure that workers are prepared for any emergency circumstance or event, the developer should provide enough training to people in Hazard Identification, Risk Assessment, and Risk Control (HIRARC) while frequently perform evacuation training as part of the management plan. Based on Idris Othman et al. (2021), the researcher unequivocally states that BIM has not been implemented by those organizations.

According to the 2019 results, just 8.2% of the public sector and only 4.9% of the commercial sector are employing BIM technology. The Multipurpose Hall at the University of Tun Hussein Onn Malaysia (UTHM) in Malaysia's Southern area is the country's first project to use BIM (CREAM, 2012). The following in Table 2.8 shows the building in 2013 in Malaysia that use BIM in construction project:

Table 2.8: BIM Implementation Phases in PWD'S BIM Projects (Othman et al, 2021) (JKR, 2013) (MSC,2013) (CIDB, 2018).

Project	Concept design	Prelim design	Detailed design	Procurement	Construction	As build
National Cancer Institute Putrajaya					✓	✓
SMK Meru Raya Ipoh Perak		✓				
Health Clinic Maran Pahang		✓	✓	✓	✓	✓
MACC Selangor Shah Alam	✓	✓	✓	✓	✓	✓
MARA College Banting Selangor		✓				
MBKT Kuala Terengganu					✓	✓
Endocrine Complex Putrajaya			✓		✓	✓
Hospital p UTHM Batu Pahat Johor					✓	✓
Parit Buntar Hospital			✓		✓	✓
Bagan Datuk Polythecnic	✓	✓	✓		✓	✓
Kemaman Hospital			✓		✓	✓
Istana Raja Muda Perlis Arau	✓	✓	✓	✓		

Project	Concept design	Prelim design	Detailed design	Procurement	Construction	As build
Besut Polythecnic			✓		✓	
Pre-Approved Plan (PAP)		✓	✓			
Pendang Hospital			✓			
Pasir Gudang Hospital			✓			
Kajang Hospital		✓				
Seri Iskandar Hospital		✓				

The Malaysian construction sector is still governed by conventional methods, despite the fact that CIDB runs an annual program to encourage BIM among construction practitioners to enhance construction practices. BIM has a great deal of potential to make it easier to solve difficulties with building projects, the government encourages everyone involved in the industry to employ it in projects. BIM, for instance, may eliminate project delays, control the proper amount for each project, control the safety in construction, save construction costs, and reduce disagreements between construction actors (S. Rahim, 2015).

2.5 BIM Technology Towards Safety Planning

In Malaysia, the usage of BIM technology is prevalent during the design stage but is less prevalent during the building stage (Memon et al., 2021). Due to the fact, BIM technology is still not widely utilized throughout the building phase, the utilization of BIM technology in Malaysia is still at a low level (Othman et al., 2021). Building Information Modeling (BIM), according to CIDB (2013), was software that is placed on the computer and used to create the model virtually before it is produced. According to RICS (2017), BIM is a strategy for fostering cooperation between the parties concerned, beginning with the design phase, and continuing through the management facility.

However, the construction industry in Malaysia has been around for a long time the use of conventional methods (2-dimensional drawings) to methods based on concepts modern in line with current technological developments (Khairudin et al, 2022). BIM is a collection of technological advancements and operational procedures that have revolutionized the way infrastructure is planned, assessed, built, and maintained (Cho, H., 2011). The BIM idea was first developed by Professor Charles M. Eastman in 1970 (Eastman, C., et al., 2008) (L.H. Forbes, 2011)

This phase in Table 2.9 includes a lot of tasks including design, scheduling, and estimating, all of which often make use of BIM technology. BIM’s ability to examine the depth of information obtained from a design construction building has been made possible by a sophisticated visualization capability for construction professionals in architectural, structural, mechanical and electrical, and plumbing. Site safety management is challenged by this intricate setup. New tools, communication opportunities, and processes addressing site safety issues made possible by BIM technology can effectively aid us in promoting top-notch site safety planning. Designers may create designs that are more precise, less wasteful, and more in line with the owner's goals. The dependability of engineers' designs can be increased by increasing cooperation with architects and other engineering disciplines.

Table 2.9: BIM applications in a construction project. Source: (Furneaux, C. et al., 2008) (CREAM, 2012)(JKR, 2011).

Phase	Stage	Uses of BIM
Pre-construction	Existing conditions modeling	i. Enhances accuracy of existing conditions documentation.
	Planning	i. Identifies schedule sequencing or phasing issues.
	Design	i. Facilitates better communication and faster design decision. ii. Perform clash detection and clash analysis. iii. Increases design effectiveness.
	Scheduling	i. Enables project manager and contractor to see construction work sequence, equipment, materials and track progress against logistics and timelines established.
	Estimate	i. Enables generation of takeoffs, counts and measurements directly from a ii. 3-Dimensional (3D) project model.
	Site analysis	i. Decreases costs of utility demand and demolition.
Construction	Construction	i. Enables demonstration of the construction process, including access and exit roads, traffic flows, site materials, and machinery. ii. Provides better tracking of cost control and cash flow. iii. Enables tracking of work in real-time, faster flow of resources, and better site management.
Post-construction	Operation / Facilities management	i. Keeps track of built assets. ii. Manages facilities proactively. iii. Enables scheduled maintenance and provides a review of maintenance history.

Besides, Building Information Modeling (BIM) which is based on a multitude of software solutions, is a collaborative tool used by the AEC sectors (architectural, engineering, and construction services) (Robinson, C., 2007). BIM is a collection of technological advancements and operational procedures that have revolutionized the way infrastructure is planned, assessed, built, and maintained (H. Cho et al., 2011). Building information modeling (BIM) was now viewed as a potential technology that might assist to enhance worker safety and health in the construction sector (Seyed. M. K., 2012). BIM may be utilized in the facility and maintenance phase, job hazard analysis, design for safety, safety planning (pre-task planning), accident investigation, and worker safety training and education. Additionally, the constructability problems can be identified early on by contractors so that improvements can be made at a lower cost. In the end, owners will be able to utilize the models as the cornerstone of a thorough facility and asset management program for a very long time.

2.6 Advantages of BIM in Construction Sector.

The modern construction projects and working areas present difficult challenges in the construction sector. That refers to the complex interactions between various partners and companies. Site safety management is challenged by this intricate setup. In order to raise awareness of the value and capabilities of BIM from a safety and health point of view, the student would like to conduct a study on the level of BIM usage capabilities planning of heavy machinery movement on site where it is consistent with Malaysia's revisions to raise awareness of the rate and adoption of BIM from a safety and health point of view can effectively aid in promoting top-notch site safety planning.

In fact, Figure 2.4 shows the benefits of using BIM application in the construction sector can help experts in observed the same infrastructure and development from several angles based on the site using a real production model in the phase of the site project. This indicates that, in terms of the positioning of such things, the view is unchanged. It is an effective tool that makes transitions simple and efficient by enabling architects, engineers, and contractors to see how their work fits best in the overall scheme. It can be characterized as a shared design resource for accurate data and information needed to make decisions about various project components during the construction phase. Everyone involved in a project can communicate consistently and stay on the same page.

Figure 2.4: Benefits of BIM implementation (Furneaux, C. 2008) (Aryani Ahmad Latiffi et al., 2013) (JKR, 2013)

2.7 BIM Application Issues.

Based on Table 2.10, the table reveals that CIDB Malaysia (2019) has determined the difficulties that all Malaysian construction industries encounter while implementing the usage of BIM. The four fundamental pillars of human, process, technology, and policy are constantly linked to challenges in BIM (Vukovic, 2015). This is due to the fact in financial factors which the cost of a BIM program is anticipated to range from 55 USD (230.09 MYR) to 4,665 USD (19,516.03 MYR), based on an annual subscription fee (Autodesk Inc, 2021). Additionally, the price of updating a computer or business, as well as the price of buying and installing a graphics card, RAM, and a bigger monitoring system for the efficient use of BIM.

Table 2.10: Identified challenges in BIM implementation. (Source: CIDB, 2019)

No	2019	2016
1	High cost of technology	High cost of technology
2	High cost of software	High training cost
3	High training cost	Lack of BIM knowledge
4	Lack of BIM knowledge	High cost of software
5	Lack of experience to coordinate the construction documents by using BIM	Insufficient BIM training available
6	Lack of clear policies that support BIM implementation	Lack of time for experimentation and implementation in fast paced project
7	No established contractual framework for working with BIM	Lack of references to assist in implementing BIM
8	Reluctance to initiate new workflows for implementation of BIM	Lack of awareness of BIM benefits
9	Lack of organisation familiarisation to implement BIM	Lack of time to implement
10	Lack of time for experimentation and implementation in fast paced project	Lack of competency among team members in using BIM
11	Lack of time to implement	Existing hardware not capable to run basic BIM software
12	Lack of awareness of BIM benefits	Reluctance to initiate new workflows for implementation of BIM
13	Lack of references / sources to assist in implementing BIM	Lack of direction of BIM in industry
14	There is no BIM requirement / mandate in the industry	Our organisation is not familiar enough with BIM usage
15	Insufficient BIM training available	There is no BIM requirement/mandate in the industry
16	Resistance to change for new technology	BIM software is complicated to use
17	Lack of direction of BIM in industry	Resistance to change for new technology
18	Existing hardware not capable to run basic BIM software	The assumption that conventional methods are better than new processes
19	The assumption that conventional methods are better than new processes	
20	Hard to implement BIM coordination	

The another barrier limiting the adoption of BIM is the small pool of experts who are qualified and capable of applying it, which is seen as opposition based on the human element and policy element. According to other studies, a variety of survey types identified a lack of BIM expertise and knowledge as a major barrier to BIM adoption. When the industry lacks a set of BIM skills, this scenario happens.

Besides, some writers have outlined the conceptual framework for the integration of safety and health into construction projects, outlining the trends, advantages, and obstacles without explicitly specifying how they fit into the methodology and focusing largely on safety construction. BIM is frequently utilized for road design despite the aforementioned factors. In fact, China has developed an interest in the design of municipal roadways, integrating the BIM model with conventional CAD 2D drawings (Biancardo S.A., et al., 2020). Other writers, like Lou, Omoregie, and Turnbull, have investigated the use of BIM in complicated urban contexts (Liu B., et al. 2019). In addition, Hongling, et al. (2016)

developed a BIM-safety-rule-integrated system that automatically recognizes potential dangers by connecting Autodesk Revit and Unity 3D with design safety rules. However, this approach only took into account a small number of safety regulations for specific scenarios and did not examine the dynamic building process (Rafindadi, A.D., 2022).

2.8 Summary

Machinery and vehicles were vital aspects of the construction sector. They take different forms and encourage people to work with even less effort and increase production quality. Accidents related to machinery were vastly higher than any other form of work injury globally. Three out of the five deaths in the workplace are related to the construction industry. The occurrence of accidents related to heavy machinery is often associated with its severe impact on the project flow in terms of cost and time.

Building Information Modeling (BIM), according to CIDB (2013), was software that is loaded on a computer to build the 3D model and has been extensively utilized throughout the project lifecycle, encompassing the phases of planning, designing, acquiring, building, and operating and maintaining the project (table 5). According to RICS (2017), BIM is a strategy for fostering cooperation between the parties concerned, beginning with the design phase and continuing through the management facility. It goes without saying that Malaysia's building sector is dangerous. According to the Department of Occupational Safety and Health, DOSH (2021), the majority of fatalities included machine operators and employees who were struck by construction debris that had fallen on them. It was also a result of inappropriate work procedures being carried out in the region and a lack of sufficient management team oversight on the job site.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The goal of this chapter is to discuss the techniques and procedures utilized to efficiently handle contract-related paperwork. This chapter discussed the study location, sample size, demographics, research design, data collecting, data analysis, and hypothesis. In addition, data from primary sources (such as a survey questionnaire) and secondary sources (a literature review) will be acquired to meet the aims of this study. Many techniques or findings from this subject are primarily published in journals for others to learn from and build upon in future study.

3.2 Design Research

Research design is the conceptual structure within which research is conducted and includes the collection and analysis of data which are relevant to the research (Kothari, 2019). The research design based on figure 6, was conducted by four stages namely Phase 1 which was research problem statement. Phase 2 was data collection of classification and identification of safety site and machinery cases and solution through literature review and model develop, Phase 3 were the phase that researcher will develop 3D model using BIM technology (Revit 2024) to be implement during real-site project. Phase 4 were a survey of 30 respondents was used to empirically examine feasibility factors of BIM 3D model for safety site and machinery planning.

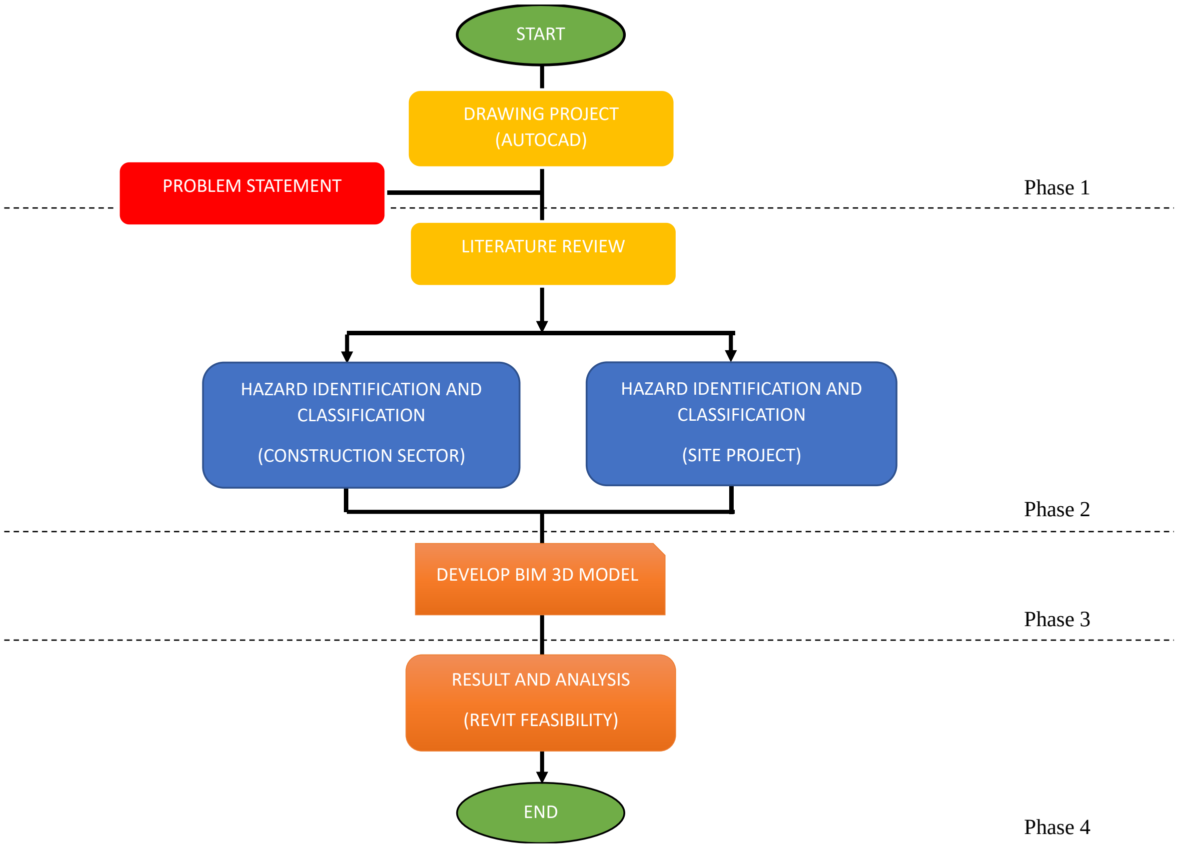


Figure 3.1: Research Framework

This framework provides as a guideline to conduct this project. This figure 3.1 represents the process in this study is separated by phase. This development research is a process approach from the beginning to the end of Implementation of BIM technology for safety site layout and machinery routes at site project Mosque of Imam As-Syafie, Meru, Perak. Throughout the process of finishing this project, four phases of approach will be used in Figure 6 Research flow of Methodology:

Phase 1 – Problem Discovery

Phase 2 – Literature Reviews (Primary Source and Secondary Source)

Phase 3 – Model Development

Phase 4 – Survey and Final Outcome

To achieve objective number one, to identify the features and classification of safety planning approaches for site layout and routes at the construction site. Research was identified during Phase 1 and Phase 2. Firstly, Phase 1 was identified from the problem that been issues was obtained during supervision on safety site and heavy machinery layout in construction building project in Kinta, Perak. After that,in Phase 2, the data collection of Hazards, and Safety & Health Regulations of construction project was gained from the primary resources which is from literature review. The legal requirements specified by the Jabatan Kerja Raya rules referred on the Factories and Machinery (BOWEC) Act 1967 with certain elements were taken into consideration for the creation of the suggested approach to better identify potential by means of BIM visualization of the construction process were the literature review such as articles, journal, E-books. Then, in Order to achive objective number two which to develop the BIM visualization and simulation of machinery equipment and ancillary facilities at the construction site was during Phase 3. In Phase 3, the legal requirements specified by the Jabatan Kerja Raya rules referred on the Factories and Machinery (BOWEC) Act 1967 with certain elements were taken into consideration for the creation of the suggested approach to better identify potential by means of BIM visualization.

The construction building will develop to 3D model using BIM-assist technology (Revit 2024) from imported 2D drawing project (AutoCAD) and site survey layout (AutoCAD or CADmapper) in solving the problem of work area simulation and technology selection, eliminating constraint in the site project. Lastly for achive objective 3 which to access the feasibility of the BIM 3D model at construction site during Phase 4. In Phase 4, researcher will develop the survey of pre and post and distributed amongst the unit of Malaysian construction industry players who in site project and whom were experienced or not in BIM technology in any construction project. After that, the data was analyzed using SPSS software to analyze the Survey form data. The IBM SPSS Statistics, Version 27 was used for statistical analyses. Such as Project Manager, Engineer, BIM expertise, and project Safety and Health Officer. The data was analyzed using content analysis based on the findings and discussed further of model to establish conclusion and recommendations for reduce the hazard on construction project. The content analysis was conducted conventionally with coding categories were derived from BIM access safety feasibility in visualization, simulation project..

3.3 Development of Research Model

3.3.1 Project overview:

The location of the study was applied in the selected project of Kinta district, Perak Darul Ridzuan. The research of project-based location was the proposal to build a Mosque of Imam As-Syafie with building height 17.98m, 3 units of two type quarters (2-

unit quarter type 1 and 1-unit quarter type 2), 3 units of shop lot with cooperation between architectural, mechanical and electrical, civil and structure consultant, contractor and the client of the project was the Majlis Agama Islam dan Adat Melayu Perak. The area of the project site measuring 258' x 325' was a big building project with one floor above the ground for the one floor above the ground of quarters measured 6.08m x 13.72m for both types, and one floor of shop lot measured 13.52m x 9.75m. The building design for quarter type 1 and type 2 was not much different except the two units of the quarter were combined. The project location was nearby residents of housing estates Meru Mentari and Meru Tropika. Employ 3D models utilizing BIM technology, which it was particular to the tools used for this construction project, based on drawings produced from AutoCAD 2D drawings

The amount of safety and Job Hazard Identification (JHI) required in a construction project can be influenced by the project's complexity, originality, and kind. Every project is distinct and individual. Although repeating elements may be included in project delivery and activities, they are always unique in their composition or arrangement. Traditional safety practices (drawing paper) and JHI procedures may not be enough for complicated projects since some dangers may not be easily spotted, as they may be in basic jobs, due to workers' literacy and experience levels. Advanced technologies, such as BIM-based tools, safety levels, and JHI, can minimize the shortcomings of traditional approaches by delivering information close to the reality of the building site before it begins

3.3.2 BIM design process:

This technique continues to employ 3D models utilizing BIM technology, specifically Revit, which it was particular to the tools used for this construction project, based on drawings produced from AutoCAD 2D drawings. To produce the form of the structure building design idea such in Figure 3.3, the 2D model will be imported into the use of the 3D model for this design process. The procedure to construct the model will be planned at this phase based on the original specifics of the Revit designs.

The risk analysis for this study was conducted using based on regulations of the Malaysian Standard is identical to ISO 14122-2:2001, Safety of machinery – Permanent means of access to machinery – Part 2: Working platforms and walkways and EN ISO 16090-1:2023(MAIN) Machine tools safety - Machining centres, milling machines, transfer machines - Part 1: Safety requirements (ISO 16090-1:2022) be applied from exported AutoCAD 2021 to Revit 2024 for the purpose of analyzing the health and safety details in building projects. This process is necessary to do a 3D analysis of the dangers.

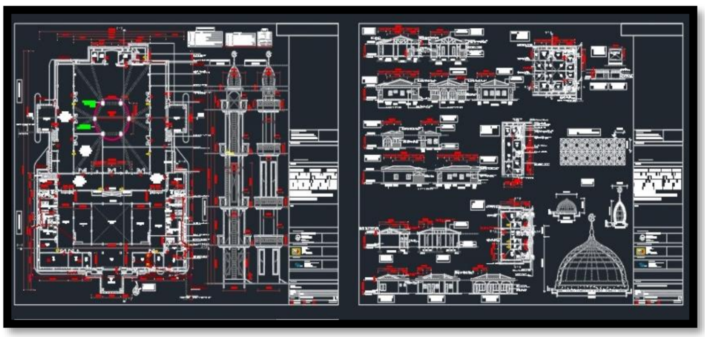
Referenced International Standards	Corresponding Malaysian Standards
ISO 14122-1, *Safety of machinery - Permanents means of access to machinery - Part 1: Choice of fixed means of access between two levels*	MS ISO 14122-1, *Safety of machinery - Permanents means of access to machinery - Part 1: Choice of fixed means of access between two levels*
ISO 14122-3, *Safety of machinery - Permanents means of access to machinery - Part 3: Stairs, stepladders and guard-rails*	MS ISO 14122-3, *Safety of machinery - Permanents means of access to machinery - Part 3: Stairs, stepladders and guard-rails*

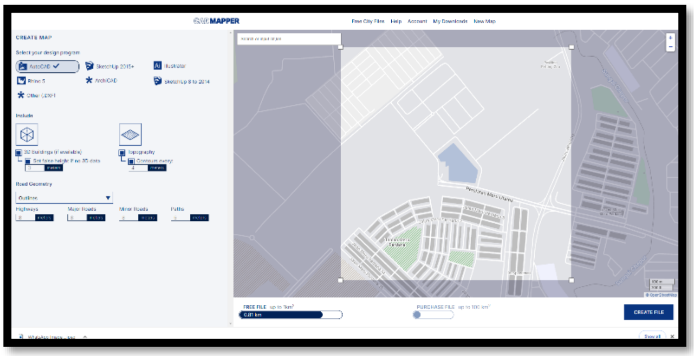
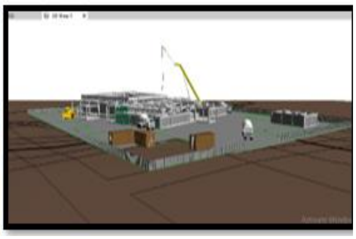
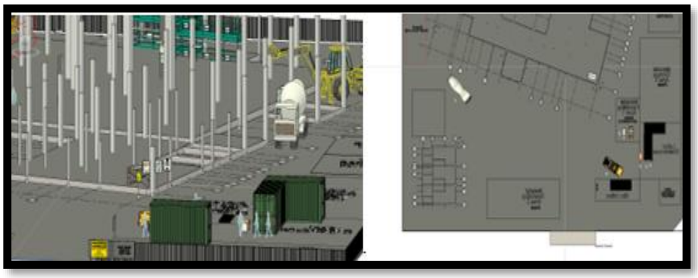
Figure 3.2: Equivalent Malaysian Standards

Figure 3.3: Safety site project management based on Revit software.

The location where the construction will take place is discretized geometrically in the Revit 3D model. The parameters for the specific risk analysis are generated in this stage and assigned to each zone and phase in accordance with the tasks that must be completed throughout execution. Utilizing the recognized hazards, this stage enables the creation of the fewest possible parameters, optimizing the procedure. By using the 3D model to generate the plans and specifications for preventative measures such show in Table 3.2 using the 3D model to generate the plans and specifications for preventative measures, it also guarantees the ability to comply to legal obligations.

Table 3.1: BIM Model Development

Process	Work Description
	Step 1: Insert the imported 2D drawing project AutoCAD into the BIM Revit model.

<table>
<tr><th>Process</th><th>Work Description</th></tr>
<tr><td></td><td>Step 2: Download site location from CADmapper and open in AutoCAD for layout layer adjustment.</td></tr>
<tr><td></td><td>Step 3: Model develop based on real-time progress on site project.</td></tr>
<tr><td></td><td>Step 3: Build and distribute model component in the site project model (site facilities for stakeholders and labor)</td></tr>
<tr><td>
</td><td>Step 4: Deliver the site progress, information and report (convert to PDF) to stakeholders using WhatsApp.</td></tr>
</table>

3.4 Analysis and Risk Management in the BIM Model

The risk assessment process starts with the identification of the specific risks involved in the site activities (transport to site project, excavation works, machinery works). The first step in the risk assessment is to identify the risks. This work of the technician is based on guidelines or internal engineering documents and, in this research, was used to generalize the results, applying the guide described. This is based on the study carried out by the Occupational Safety and Health and the Malaysian Public Works Department and establishes a methodology for carrying out a general risk assessment of all the work units related to building construction. It determines the probability, consequences and magnitude of the associated risks for each activity of the work units, as well as the preventive measures to be adopted in order to reduce them, based on the criteria of the technicians who comprise this organization. From this preliminary identification, a grouping of the specific risks in the main work units is carried out.

The construction phase of the 3D model assess risk such show in Table 3.1, with the parameters in the model being evaluated in accordance with the 3D analysis of the zone. This makes it possible to analyze hazards in relation to construction zones and phases, helping to improve risk management through the use of colour filters and data tables and facilitating, for instance, the study of risks brought on by machinery interference between operations. In order to build the traceability of the entire process in a single model, this permits re-evaluation.

Table 3.2: Revit 3D model parameter.

Safety management	**Commands in Revit**
Safety signs	Placing decals, texts
Machinery	Component Placement
Project parameters	Project parameters
Equipment information (Type and quantity)	Project browser, schedule

BIM visual parameter & description & application

1. writing and symbols > number, words, sentences, sign = label, type, property, symbol
2. dimension and geometry > line, distance, volume, elevation, height, depth = to observe working/equipment zones, distance between object, collision of two or more objects, clear zone, workspaces, opening/holes
3. animation > imitation of movement of objects = to represent walkthrough (emergency
4. route), work progress
5. colour > visual impressions that are reflection of light from objects = to provide indicators/location of hazards
6. shading > colour intensity on the surface of objects exposed to light = to locate area of hazards due to lack of insufficient visibility
7. texture > surface condition of objects (rough, smooth, reflective, etc.) = to identify surface of objects with potential hazards

Figure 3.4: BIM visual parameter description.

Risk assessment methodologies are based on the identification of risks associated with tasks. These tasks can be related to BIM objects, and their geometric definition and the information associated with them depends on the LOD defined in the project such in Figure 3.4. Therefore, the risk assessment depends on this LOD, so that the health and safety technician must indicate the LOD with which the project is evaluated to meet the standardization requirements. This study aimed to integrate risk assessment into the design phase. This involved adopting an LOD of 300, so that the risk assessment in the model could be carried out per unit of work. The risks are grouped according to the main work units: land clearing, embankment, piles planting, lifting, cut and fill, and concreting.

3.5 Data Collection

The methods of collection provide detailed instructions on how to collect data from a questionnaire using a Google form. In this study, the quantitative method was chosen. This method allows for the collection of reliable and accurate data, as well as quick data collection and a broader scope of data analysis. The site, respondents, and research method will all be discussed. These data ensure that all project objectives can be met.

3.5.1 Location

This research will be conducted at a Work Based Learning (WBL) site project under the procurement department and site because the analyst believes the procurement department is familiar with the circumstances and conditions linked to machinery. Respondents are looking for people who are involved in the site project (site employees) and have BIM competence.

3.5.2 Respondents

Respondents can be any age, but their age is set by the scope of the study, and they must give informed consent to participate. A survey was distributed to 30 respondents, who included procurement department officials, site personnel, and foreign workers (Indonesian) to answer survey questions. The validity of a sample size is determined by several factors, including the study design, methodology, and statistical analysis techniques.

A greater sample size, in general, provides for more accurate and precise data analysis and minimizes the chance of sampling error. In other circumstances, however, a sample size of 30 respondents might give enough data for effective analysis, especially if the research intends to find basic patterns or links in the data. Uma Sakaran (2003) defines sampling as the process of selecting an acceptable number of populations to be examined in order for the study and comprehension of the nature or qualities of the sample to reflect the population. Purposive sampling was employed in this study to obtain a response to the research aim from a specified group while also reducing expenses and time.

3.5.3 Questionnaire Survey

The questionnaire was used by the researchers to collect data for this study. Data could be gathered using a Google form. When researchers understand what the study requires, the questionnaire is an effective data collection tool. The questionnaire will be distributed to respondents via Google Form links.

In this study, the questionnaire is divided into two questionnaires which are Pre-test and Post-test and each questionnaire has two main sections, Section A and Section B. For pre-test, Section A will focus on the demographic information of the respondent meanwhile Section B will focus on constraint drawing elements of current method in safety and resource management. For the Post-test, Section A will focus on the demographic information of the respondent meanwhile Section B will focus on the feasibility of BIM technology application for Safety Site layout and Machinery routes.

Table 3.3: Distribution of the questioner items for pre-test.

Section	Aspects of evaluation
A	Demography information
B	Identification of constraint safety elements in construction site

Table 3.4: Distribution of the questioner items for post-test

Section	Aspects of evaluation
A	Demography information
B	Feasibility of BIM technology application for Safety Site layout and Machinery routes

Table 3.5: Likert scale items

Scale	Description
1	Strongly Disagree
2	Disagree
3	Satisfactory
4	Agree
5	Strongly Agree

3.6 Data Collection

Data analysis is the methodical application of statistical and/or logical approaches to describe and demonstrate, compress, and recapitulate, and assess data. Depending on the business and the goal of the analysis, there are various methodologies and strategies for performing analysis. All of these different approaches to data analysis are based on two major areas of research: quantitative methods and qualitative methods.

When the data is collected, the Statistical Package for the Social Sciences (SPSS) software will be used to calculate it. The data will be represented by tables. Furthermore, SPSS version 27, Excel Solution and Social Science Statistic includes a number of statistical methods that can be used, such as:.

1. Descriptive statistics, including methodologies such as frequencies, cross-tabulation, and descriptive ratio statistics.
2. Numeral outcome prediction such as linear regression.
3. Prediction for identifying groups, including methodologies such as cluster analysis and factor analysis.

3.6.1 Reliability Test

According to Sekaran and Bougie (2009), the dependability of a measure reflects the degree to which it is devoid of bias (error) and hence provides consistent measurement throughout time and across the numerous components in the instrument. In other words, a measure's dependability is an indication of the stability and consistency with which the instrument assesses the idea and aids in determining the "goodness" of a measure.

3.6.2 Frequency Test

Respondents can be of any age, but their age is determined by the scope of the study, and they must provide informed permission in order to participate. To answer survey questions, a survey was issued to 30 respondents, who comprised procurement department officials, site staff, and foreign labour (Indonesian). Several factors influence sample size validity, including study design, methodology, and statistical analysis approaches.

3.6.2 Mean and Average Mean

The mean (or arithmetic mean) is a type of average. It is computed by adding all of the values and dividing the total number of values by the total number of values. The word "average" refers to the value obtained by dividing the sum of a set of quantities by the total number of quantities in the set. The standard deviation is calculated by taking the square root of the variance. The average deviation, often known as the mean absolute deviation, is another measure of variability.

3.6.2 Paired T-test

A paired t-test is used to determine the difference between two variables. These two components are typically separated by time. The test can be used when there are two data values in paired measurements. Pre-test and post-test results, for example, were gathered and will be used to compute the result. In addition, the distribution of differences between matched measurements should be typical.

3.7 Summary

This chapter summarizes the procedures for model creation, data gathering, and information in the study. The collected data will be analyzed to determine the outcomes. Furthermore, this chapter focuses on the location of the assessment procedure, respondents, model development, and data analysis.

According to research, the usage of 3D visualization is superior to the present way. In comparison, the present system relies on 'AutoCAD drawing' to update the site and resource status, which might lead to oversight. In terms of flexibility, this BIM technology is more detailed, simple, and easy to use. In the long term, all procurement department personnel and workers will benefit when they wish to update the status of the project site, resources, and machines, and may assist in the beginning of paperwork for the project such as scheduling of construction materials.

In addition, the method will be thoroughly provided based on current issues, as well as proper planning when implemented and customised to the location. This is based on all possible work and available sources such as papers, interviews, and experience. The process route that will be executed for this project and applied to the on-site working environment will be appended after this chapter.

CHAPTER 4

DATA AND ANALYSIS

4.1 Introduction

The researcher should have a notion of what the project's projected outcome will be in this chapter. It is also one of the pre-project planning activities, and researchers considered carefully evaluating what data will be generated throughout the project's execution. The quantitative method by distributing the questionnaire to more than 30 respondents had given the feedback and process by IBM SPSS. Result had been analysis by Paired T test. The survey findings and data will be addressed in this part, which will offer an overview of current BIM technology in building projects from the perspective of a consultant and is expected to aid in the achievement of third objectives to access the feasibility of the BIM model at construction site. The findings are thought to be useful in understanding the present state of BIM implementation in the Malaysian building sector and encouraging consultants to move to BIM design process. The survey was divided into Pre-survey and Post-survey, as follows:

1. Pre-survey: Construction safety identification
2. Post-survey: Implementation of BIM model

4.2 Identifying the Safety Practice at Site Project

The survey was divided into two groups: male and female that involve in any project. The survey given to respondents were chosen based on their engagement in broad disciplines engaged in building projects throughout the design stage, in accordance with the study's objectives. According to the data, all respondents had expertise and engagement in construction projects from numerous disciplines, with industry experience ranging from 1 year to over 50 years. It is crucial to examine the responses of respondents from various construction industries with varying backgrounds since they will provide varying degrees of knowledge, comprehension, and acceptance of BIM.

4.2.1 Respondent's Information

Section A is a demographic data section that includes five questions on the respondent's backgrounds. The respondents of pre and post questionnaire was same. The items are as Gender, Age, Position, Work Experience, and BIM Involvement.

a) Gender

This research included 22 (73.30 percent) male respondents and 8 (26.7 percent) female respondents. Male respondents exceed female respondents by a wide margin, as seen by the proportion. This is because a male, rather than a woman, dominated the responses at the construction site, whereas most of the females are related to documentation. The number of respondents by gender is shown in Table 4.1 below.

Table 4.1: The Number of Respondents by Gender

No	**Gender**	**No. of respondent**	**Percentage (%)**
1	Male	22	73.3
2	Female	8	26.7
Total		2	100

b) Age

Table 4.2 shows the age groupings of the respondents in this research. The age groups were divided into four categories by the researchers. This section was formed to assist with data processing and identifying respondents on the job site and office. In this survey, the age group 26-35 years old has the most responses, with 20 more than 50 percent (66.7 percent), followed by 18-27 years old, which has 6 respondents (20 percent) different 3 respondents than 36-45 years old. Only one respondent (3.3 percent) are 55-64 years old. There is not a single person above the age of 65 years who has responded.

Table 4.2: The Number of Respondents by Age.

No	Age	No. of respondent	Percentage (%)
1	20-29 years old	8	26.7
2	30-39 years old	16	53.3
3	40-49 years old	6	20
4	50 years old and above	0	0
Total		30	100

c) Position

The job title at the construction site, which comprises Project Director, Project Manager, Project Engineer, Safety and Health supervisor, Site Engineer, Site supervisor, Site worker, BIM Engineer and others is the final piece of demographic information. Table 4.4 shows that Site supervisor had the most respondents, with 8 respondents (26.7%). The other respondents consist of Project Engineer, Safety and Health supervisor, Site Engineer, and Site worker, came in second with 4 replies (13.3%). The BIM Engineer and Others post is placed third, with 2 respondents (6.7%), followed by the Project Director, and Project Manager with 1 response (3.3%).

Table 4.3: The Number of Respondents by Position.

No	Position	No. of respondent	Percentage (%)
1	Project Director	1	3.3
2	Project Manager	1	3.3
3	Project Engineer	4	13.3
4	Safety and Health supervisor	4	13.3
5	Site Engineer	4	13.3

No	Position	No. of respondent	Percentage (%)
6	Site supervisor	8	26.7
7	Site worker	4	13.3
8	BIM Engineer	2	6.7
9	Others:	2	6.7
Total		30	100

d) Work Experience

Majority respondents in this survey (53.3%) had none of BIM construction experience, with 13.3% respondents having 1 - 3years of BIM construction experience. There are 10 respondents with les than one years of BIM experience, accounting for 33.3% of the total. The number of responses by experience is shown in Table 4.4 below.

Table 4.4: The number of respondents by work experience

No	Experience	No. of respondent	Percentage (%)
1	< 1 years	10	33.3
2	1 - 3 years	4	13.3
3	3 - 5 years	0	0
4	>5 years	0	0
5	None	16	53.3
Total		30	100

4.3 Construction Safety Practice Identification

4.3.1 Respondent Perspective (Pre-survey)

Section B (Pre-survey) presents the respondents' perspectives on issues related to identification hazard and safety at site project. Respondents were asked to choose their level of agreement on a scale of 1 to 5. This survey displays the results of a questionnaire distributed to respondents, which included Project Director, Project Manager, Project Engineer, Safety and Health supervisor, Site Engineer, Site supervisor, Site worker, BIM Engineer and others to determine what needs to improve safety construction productivity and what system criteria that team will want to monitor construction. Below table shown the data collection of issues related to existing method.

Table 4.5: Issues Related to pre-survey of Construction safety identification.

No	Constraint elements	Issues Related	Level of Agreement				
			Strongly Disagree	**Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
			1	**2**	**3**	**4**	**5**
1	Site Identification	a) Improper construction Resource management (Management of material and machinery)	0	0	0	16 (53.3 %)	14 (46.7%)
		b) Scattered building materials or construction waste on working area at the construction site.	0	0	0	26 (86.7 %)	4 (13.3%)
		c) Poor housekeeping	0	0	0	24 (80%)	6 (20%)
		d) Unsafe site condition	0	0	0	26 (86.7 %)	4 (13.3%)
		e) Unsafe site condition (Machinery	0	0	0	23 (76.7 %)	7 (23.3%)

		route)					
2	Feasibility in Current Method	a) 2D drawing has sufficient data or information (visualize in two-dimensions)	0	0	0	18 (60%)	12 (40%)
		b) Current 2D drawing will be easy to individuals to understand the design.	0	0	0	29 (96.7 %)	1 (3.3%)
		c) Lack of 3D visualization which cause misunderstanding and poor communication in project success	0	0	0	0	30 (100%)
		d) The site planning need to design and develop a efficient site planning to reduce accident in site project.	0	0	0	3 (10%)	27 (90%)
		e) 2D drawing could help to create the prototype for spotting the problem	0	0	0	28 (93.3 %)	2 (6.7%)

4.3.2 Reliability Statistics

Reliability analysis may be used to investigate the properties of measuring scales and the items that form the scales. The reliability analysis procedure computes several commonly used scale reliability metrics as well as information on the correlations between scale items. Intraclass correlation coefficients can be used to calculate inter-rater reliability estimates.

Table 4.6: Reliability Statistics

Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N. of Items**
.491	.477	10

4.4 Feasibility in BIM Model Implementation

4.4.1 Respondent Perspective (Post-survey)

Based on Table 4.7 below, respondents are the same as the pre-questionnaire for this application post-survey of Implementation of BIM model. Therefore, the data collection for demographic will be the same as pre-questionnaire. Section B (Post-survey) presents the respondents' perspectives on issues related to application in planning using BIM 3D visualization at site project. Respondents were asked to choose their level of agreement on a scale of 1 to 5. This survey displays the results of a questionnaire distributed to respondents same as pre-questionnaire.

Table 4.7: Issues Related to post-survey of Implementation of BIM model.

	Constraint elements	Issues Related	Level of Agreement				
			Strongly Disagree	**Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
			1	**2**	**3**	**4**	**5**
1	Site Identification	a) Provide a 3D model and development of the project.	0	0	0	1 (3.3%)	29 (96.7%)
		b) Reduce any mistakes during the construction work.	0	0	0	4 (13.3 %)	26 (86.7%)
		c) Detect intersections between design elements,	0	0	0	6 (20%)	24 (80%)

		geometry and schedules.					
		d) BIM is used as monitoring of work movements, the quantity of materials and equipment at the construction site.	0	0	0	13 (43.3 %)	17 (56.7%)
		e) Guarantee the level of safety at the construction site with BIM technology.	0	0	0	5 (16.7 %)	25 (83.3%)
2	Feasibility in BIM Method	a) BIM is able to help in the revision of model, preparation, and drawings.	0	0	0	5 (16.7 %)	25 (83.3%)
		b) Provide visualization and table of numbers for equipment, and materials.	0	0	0	9 (30%)	21 (70%)
		c) BIM is able to visualize the destination to reduce time waste of the activity.	0	0	0	16 (53.3 %)	14 (46.7%)
		d) BIM helps in verifying measurements and specifications at the construction site using schedule.	0	0	0	1 (3.3%)	29 (96.7%)
		e) BIM also can ensure that the	0	0	0	2 (6.7%)	28 (93.3%)

		unsafe working conditions can be reduce (cause due to transportation activity)					

4.4.2 Reliability Test after BIM implementation Method

Reliability analysis may be used to investigate the properties of measuring scales and the items that form the scales. The reliability analysis procedure computes several commonly used scale reliability metrics as well as information on the correlations between scale items. Intraclass correlation coefficients can be used to calculate inter-rater reliability estimates Data Analysis (Post-survey).

Table 4.8: Reliability Statistics.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N. of Items
.664	.645	10

4.5 IBM SPSS V27 Data Analysis (Pre & Post-survey)

SPSS is an acronym that stands for Statistical Package for the Social Sciences, and it is used by a wide range of academics to analyze complex statistical data. In this study, SPSS will be used to analyze the data. The methodical application of statistical and logical approaches to explain, demonstrate, and condense. Data should be summarized and evaluated. Researchers use data analysis to reduce data to a story and evaluate it to get different perspectives. Data analysis assists in reducing massive volumes of data into smaller, more consumable portions (parts).

4.5.1 Data Analysis Pre-test

In order to accive the objective number three which is to access the feasibility of the implementation using IBM SPSS, Table 4.9 presents the sample of each item of the variables. Table 4.10 presents sample of each item of the variables. The sample results indicate that the highest mean rating of 4.57 show the safety identification of construction waste on site are not well managed because of lack of resources, management, and attitude which impact on working environment that could lead into incident (standard deviation =0.504). Similarly, the mean rating of 4.50 indicated that Unsafe site condition (Machinery route).was the important needed to well prepare and managed to avoid any type of hazard and constraint in the site project (standard deviation = 0.630). The Levene test for equality of variances shows that are no significant differences between the male and female groups variance (F=5.657, p=0.024) since the p value is less than 0.05. Furthermore, the result in Table 2 shows that there are no significant difference between the male and female groups in their managed scattered building materials or construction waste at working area in the construction site (t=-26.085, p=0.000).

Table 4.9: Pre-test of Site Project Condition Statistics

No	Variables	Mean	Std. Deviation
1	Improper construction Resource management (Management of material and machinery).	4.37	.669
2	Scattered building materials or construction waste on working area at the construction site	4.57	.504
3	Poor housekeeping	4.20	.551
4	Unsafe site condition	4.40	1.22
5	Unsafe site condition (Machinery route).	4.50	.630

Table 4.10: Independent Samples Pre-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
1.Improper construction Resource management (Management of material and machinery)	.762	.390	.466 .380	28 4.918	.645 .720	.080 .080	.172 .211
2.Scattered building materials or construction waste on working area at the construction site	5.657	.024	-.828 -.894	28 6.186	.414 .405	-.200 -.200	.241 .224
3.Poor housekeeping	.000	1.000	2.958 2.777	2 5.4198	.006 .036	.600 .040	.203 .216
4.Unsafe site condition	.847	.365	.441 1.000	28 24.000	.663 .327	.040 .040	.091 .040
5.Unsafe site condition (Machinery route)	.154	.698	-.187 -.183	28 5.631	.853 .861	-.040 -.040	.214 .218

4.5.1 Data Analysis Post-test

After the implementation of the 3D model on site project, all of the 30 respondents' data shall be collected via questionnaire survey form. The result in Table 4.11 shows that there is no significant difference between the male and female groups in the post-survey conducted where Cronbach's Alpha Value obtained is 0.664. Table 4.12 presents sample of each item of the variables. The sample results indicate that the highest mean rating of 0.497 is Provide a 3D model and development of the project which was alternative to stakeholders in detecting BIM is able to visualize the site project. (standard deviation = .183). Similarly, mean rating of 4.83 indicated is guarantee the level of safety and health of workers at the construction site with implementation of BIM technology (standard deviation = .407). The Levene test for equality of variances shows that are no significant differences between the male and female groups variance (F=5.657, p=0.024). Table 4 shows that there are no significant difference between the male and female groups in their BIM because it able to visualize the starting point and destination to reduce time waste of the activity (t=-5.757, p=0.000)

Table 4.11: Post-test of BIM model implementation

No	Variables	Mean	Std. Deviation
1	Provide a 3D model and development of the project.	4.97	.183
2	Reduce any mistakes during the construction work.	4.87	.346
3	Detect intersections between design elements, geometry and schedules.	4.80	.407
4	BIM is used as monitoring of work movements involving workers, the quantity of materials and equipment at the construction site.	4.57	.504
5	Guarantee the level of safety and health of workers at the construction site with implementation of BIM technology	4.83	.379

Table 4.12: Independent Samples Post-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
1. Provide a 3D model and development of the project	15.970	.000	1.713 1.000	28 7.000	.098 .351	.684 .684	.399 .684
2. Reduce any mistakes during the construction work.	1.756	.196	-.602 -.660	28 12.394	.938 .939	-.032 -.032	420 .421
3. Detect intersections between design elements, geometry and schedules	.744	.396	-.377 -.374	28 15.060	.552 .519	-.251 -.251	.417 .380
4. BIM is used as monitoring of work movements involving workers, the quantity of materials and equipment at the construction site	17.630	.000	-1.482 -2.485	28 12.297	.709 .715	-.157 -.157	.419 .422

	5. Guarantee the level of safety and health of workers at the construction site with implementation of BIM technology.	17.630	.000	-1.482 -2.485	28 21.000	.150 .021	-.600 -.600	.404 .241

4.5 Paired Samples

A paired sample show in Table 4.13, the result t-test found this difference to be significant for all variables being measured, the value of t of the potential usefulness is 26.83 and the value of p is < .00001. The result is significant at p < .05. The value of t of perceived ease of use is 26.08 and the value of p is < .00001. The result is significant at p < .05. This implies that the application's implementation in monitoring is more effective and efficient than the present way.

Table 4.13: Paired Samples Pre & Post-Test.

Pair	Paired Diffrerent / Mean	t	Significant (two-tailed)
Site Identification	3.18	26.08	.000
Feasibility in BIM Method	3.35	26.83	.000

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter summarises the results, conclusions, and suggestions based on the data analysed in the preceding chapter. In managing site material resources at suppliers in Meru, Perak, the Implementation of BIM Technology for Site Safety and resource management is more efficient. It is assessed by assessing the extent to which certain study objectives have been met.

5.2 Conclusion

The research framework in this study is design thinking. Design thinking is a design methodology technique that offers a solution-based approach to issue resolution. It is extremely beneficial in solving complicated challenges that are ill-defined or unknown by identifying the human needs involved in the situation and re-framing it in human-centric ways through brainstorming sessions.

BIM technology can potentially improve the current building design process by allowing for better visualization through 3D modeling, the coordinated and collaborative workflow between various disciplines, and the ability to perform design optimization and clash analysis before the construction phase. Prior to model implementation, the project encountered several challenges, including manual and labor-intensive machine coordination, inefficient resource utilization, and insufficient quality control. However, with real-time visibility and monitoring capabilities, stakeholders can now track the flow of construction resources and manage construction resources. Industry participants are increasingly beginning to recognize its potential, which has gradually led the sector towards greater technology and digital growth. The equipment planning of BIM technology in construction projects also able to increase stakeholder communication and project visibility by providing a critical platform for visualizing and successfully collaborating for the site project. As a result, this study is regarded as the foundation for future research on the strategic application of BIM in the construction sector.

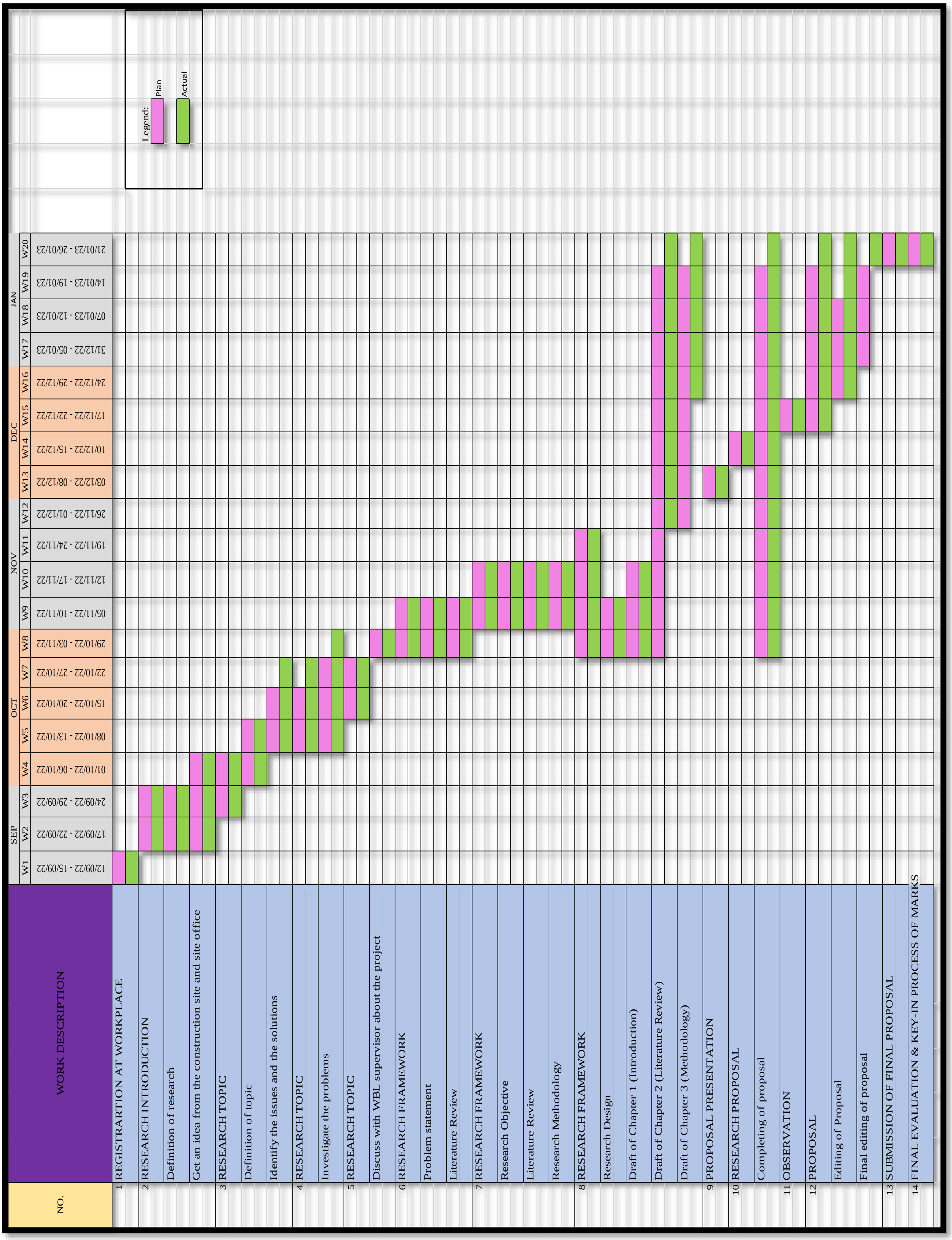
5.3 Recommendations for the Improvement

Finally, the survey findings indicate that the application has the potential to considerably improve project planning efficiency in site construction. Improved planning skills, increased efficiency, and better tracking of job progress are among the predicted benefits. These elements are critical in achieving prompt issue discovery, effective team member collaboration, and overall project execution optimization.

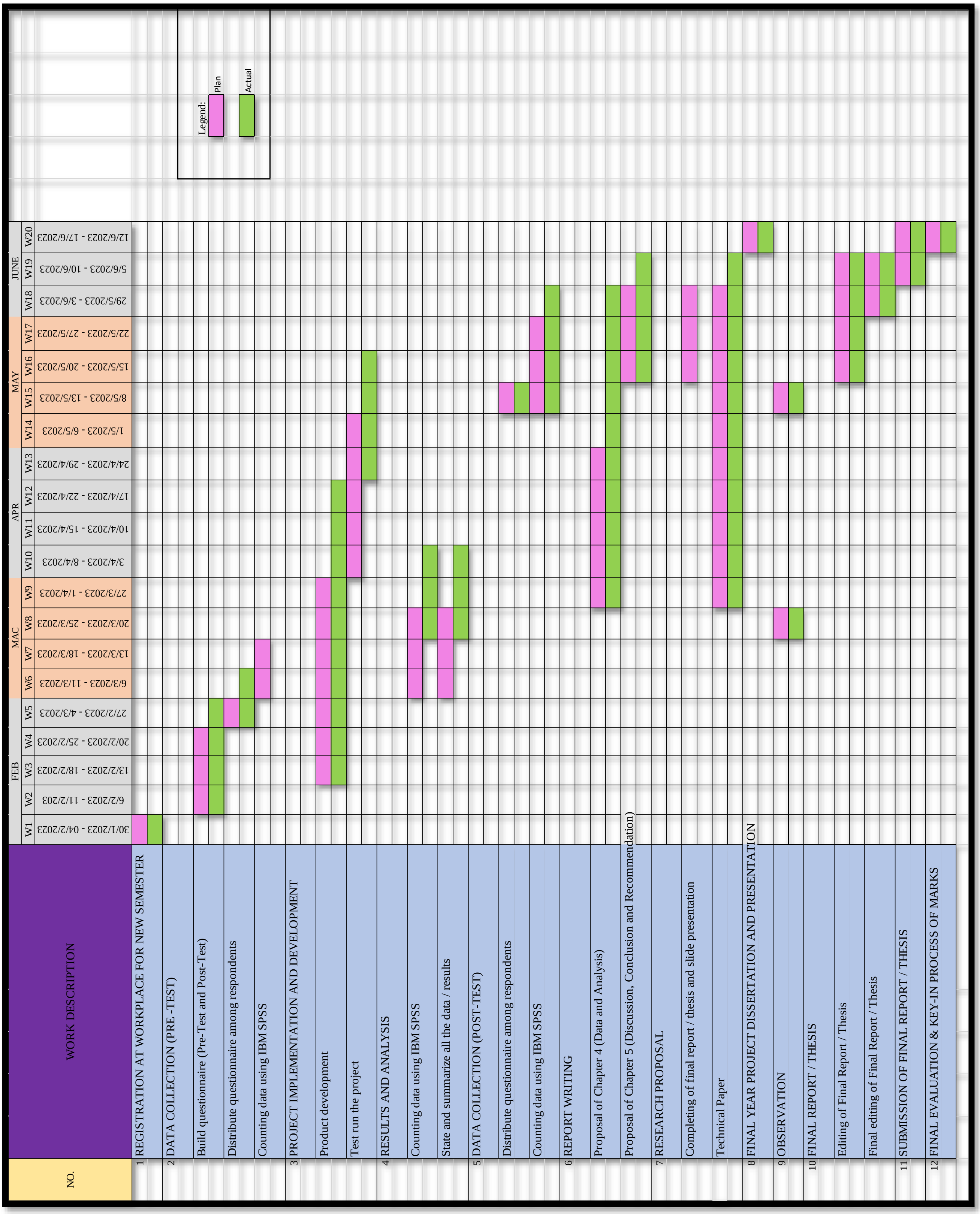
It is crucial to emphasize, however, that these results are based on survey responses from a specific sample of respondents. Further testing and feedback from a larger variety of stakeholders in the construction sector would be valuable to confirm and generalize these findings. Overall, most respondents responded positively, indicating that the prototype has the potential to improve project planning efficiency in site construction. Based on this input, further development and modification of the application are anticipated to provide favorable results and lead to improved project management practices in the construction area.

APPENDIX

Gantt Chart Semester 7



Gantt Chat Semester 8



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