The Study of BIM on Controlling the Violation of Safety Rules in Building Project

by

Lissaailin Binti Sugito

24499

Dissertation submitted in partial fulfillment

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(Civil Engineering)

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CERTIFICATION OF APPROVAL

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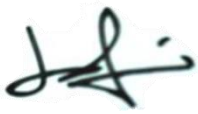

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in references and acknowledgements and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Lissaailin Binti Sugito

ABSTRACT

The Building Information Model (BIM) is largely used in the building industry, as it is one of the most dangerous industries in which to work. It is indeed very essential for each of the workers to follow the safety rules on the ground. In line with current technological developments, BIM models are used for project virtualization from concept to completion before the actual construction is completed. However, using BIM can make a significant contribution to the prevention of serious on-site accidents. The intention of this study is to investigate on how BIM can actually control the violation of safety rules as well as taking the perception of Engineers and Architects towards it. The main focus of this study is to analyze the factors and importance elements that contributing to BIM application on controlling the violation of safety rules as well as the perspective of professionals on BIM implementation on controlling the violation safety issues in building project in Malaysia. The methodology of this research will be started with gathering information through literature review about relation of the BIM software with the safety and health concerns in building construction industry. Then from the study of the literature review, a research questionnaire will be produced aligned with the purpose of this study. Once the questionnaire has been prepared, a pilot survey will be performed to improve and validate the main questionnaire. After obtaining the key questionnaire results, these data will be analyzed using three methods which are: The Relative Importance Index (RII), the Average Index (AI) and the Cronbach alpha using the SPSS software.

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All praise is due to Allah, the Lords of the worlds. Without His permission I can never get to complete this project successfully.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 1

INTRODUCTION

1.1 Background

Building Information Modeling (BIM) is a method for generating and interpreting information of construction project during the life cycle of a project. Creating a digital BIM facilitates consultant and constructions organization that engage with building project to maximize their capability, resulting in a significantly higher value for the resources. Generally, many people see the BIM software is just tool that converting 2D drawing into 3D modelling, anyhow it is actually beyond than that. As demand of technology evolves, BIM models are becoming extremely advanced and data-rich, that benefiting to designers, stakeholders and developers progressively. These research implemented opportunities for enhancing the management, maintenance and redevelopment of buildings (Ruikar 2016). Ever since 1970's, transformation from conventional building techniques to BIM-based concept has been one of the most highly argued and reported mainly in construction. Hence, the Architecture, Engineering and Construction (AEC) industry has been gradually accept and implementing this BIM software in daily work (Othman, Al-Ashmori et al. 2020). Today, a few countries such as United Kingdom (UK), Australia, Denmark and a few advanced countries that used this BIM in construction. In Malaysia, Director of Public Department (PWD) were introduced and implemented BIM in construction around 2007. The construction of Multipurpose Hall in Universiti Tun Hussien Onn Malaysia (UTHM) was one of the earliest projects that involved and implemented using this BIM software (Latiffi, Mohd et al. 2013).

The Health, Safety and Environment (HSE) study found that the building industry suffered more serious accidents which can lead to fatalities compare to any other sectors and workers' accidents and illnesses cost billions annually due to a lack of safety protection in the construction sector (Marefat, Toosi et al. 2019). Thus, it is crucial to have a job safety in building construction industry. A compelling number of studies have shown

that the lack of incorporation of occupational health and safety during the design process is one of the key causes of occupational injuries. There are also various factors for causes of the injuries, including lack of appropriate tools, coaching and designer leadership (Cortés-Pérez, Cortés-Pérez et al. 2020). The complexities and ambiguity arising in the design of the project also can contribute to the causes of fatalities. According to (Malekitabar, Ardeshir et al. 2016), construction industry needs safety planners to implement technology as fresh and creative as possible to ensure that they cover as much as possible predictable surprises. Integrated modeling techniques, accompanied by multi-dimensional visualization technology, and Building Information Modeling (BIM) have led to the automated recognition, analysis and evaluation of building information also the construction safety threats during the design process.

Increasing the utilization of BIM in AEC industry will shift where the method of safety can be addressed. BIM and its digital ecosystem within it now enable us to make a better use of design and construction data in a more rational manner. It enables the data generated by the design process to be reprocessed and contributes to improving productivity in other areas of the project. Therefore, this research investigates and describes the uses of BIM as a platform on controlling safety violation issues in construction building project.

1.2 Problem Statement

The construction sector has a high-risk sector because of the high risk of accidents numbers occurring within one area of project. The reasons are time, cost and quality, which are often considered to be the vital ahead of protection. Safety issues are considered mainly secondary and seize role in building construction. Many corporations instead of adopting full accident management strategies, they are more focusing on optimizing the profit. Many workers are not given prioritize to the needs on safety because employers are not realized how high the real cost of an accident is before it occurs. The statistic of accidents occurred in the construction industry show that the accidents rate is still high in Malaysia building construction industry and it give us a perception that building construction industry is among the emerging sectors that required a significant and rapid reform from the current site safety practices. In order to controlling the violation of safety rules in building project, preventive measures must be taken during pre-construction phase and must know the causes of accident. Therefore, there are two problem statement for this research, which are:

1. What are the factors that contributing to BIM on controlling the violation of safety rules in building project?
2. What are the points of view of the engineers respecting to the factor contributing the effectiveness of BIM in dealing with the violation of safety rules on construction site?

1.3 Objective

The objectives of this research are:

1) To study the factors contributing of BIM on controlling the violation of safety rules in building project.
2) To analyze the importance of controlling the violation of safety rules using BIM in building project.
3) To investigate the level of perception among the professional industries of BIM on controlling the violation of safety rules in Malaysia.

1.4 Scope of Study

The framework of study of this project will be performed based on the building construction project. In this study, the implementation of the gap system tends to boost its validity by defining relative variables not yet addressed by previous researchers. Research will be conducted on the basis of issues and problems take place during pre-construction process. The factors contributing of BIM on controlling the violation of safety rules BIM and performance practice of professionals' industries of BIM on controlling of safety rules on site construction project will be further discussed and investigate through questionnaire distribution to professional people from the industry.

The participation of people working in the organization plays an important part for this analysis. This research will enable the results of its participation to attain the objective of the questionnaire and interview session, in particular the safety officer, security staff, engineers and contractors.

Chapter 2

LITERATURE REVIEW

Two main streams of literature are closely related to this research are influence affecting of BIM on the violation of safety rules and importance of controlling it. In the following, due to its preliminary importance, the author will pay major attention on factors contributing of BIM on controlling the violation of safety. Then, the author will simply review the importance of controlling the violation of safety rules using BIM.

2.1 Accidents rate in construction sites

The building industry has historically known recognized as one of the most dangerous industries in many parts of the world (Chong and Low 2014). Incidents and casualties persist exist in the construction industry due to large-scale construction projects and inadequate safety management systems on the part of the contractor. According to the report of the Department of Occupational Health and safety (DOSH) Malaysia, the total number of cases of occupational injuries that occurred until July 2020 is 4,125 including non-permanent disabled persons, permanent disabled persons and death, as exhibited in Figure 1 below.

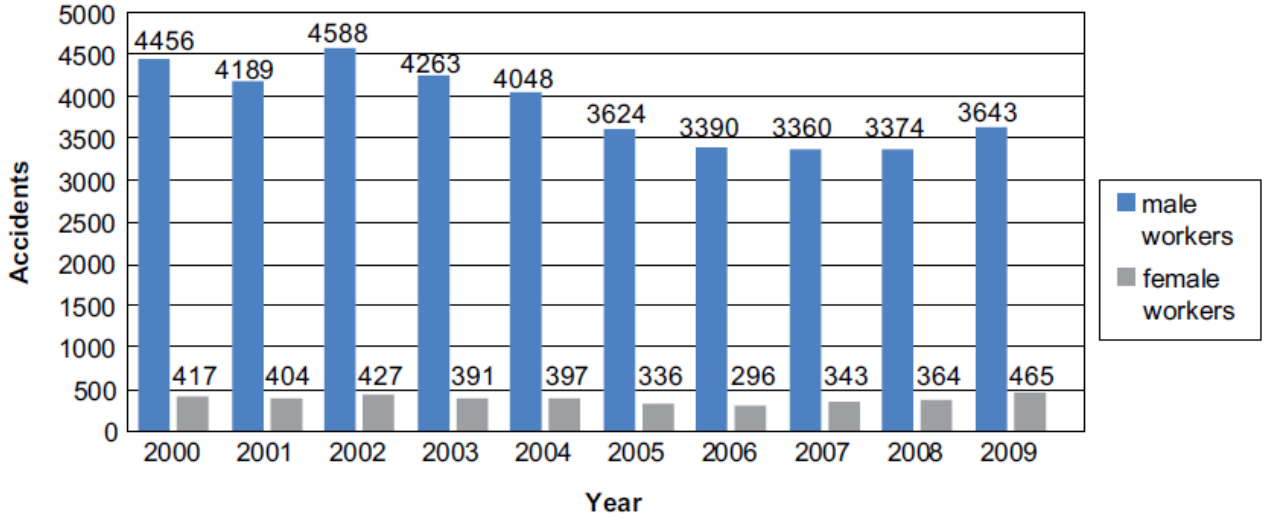

Figure 1 Occupational accidents statistic from January to July 2020

OCCUPATIONAL ACCIDENT STATISTICS BY STATE JANUARY TO JULY 2020 (REPORTED TO DOSH ONLY)

STATE	NPD	PD	DEATH	TOTAL
JOHOR	647	33	29	709
KEDAH	204	10	2	216
KELANTAN	55	2	2	59
MELAKA	195	4	3	202
N SEMBILAN	233	12	2	247
PAHANG	222	8	9	239
PERAK	438	13	1	452
PERLIS	18			18
PULAU PINANG	409	12	7	428
SABAH	130	9	15	154
SARAWAK	221	11	15	247
SELANGOR	886	29	20	935
TERENGGANU	65		5	70
WPKL	135	2	3	140
WP LABUAN	8	1		9
TOTAL	3866	146	113	4125

Source: International Policy and Research Development Division

Figure 2 Total numbers of accidents by gender

In 2000-2009 Social Security Organization (SOCSO) identified 656 555 industrial accidents and 42 775 in Malaysian construction industries in all industries (6.5% of all industrial accidents). Data have been retrieved on paper from SOSCO's headquarters' Annual Reports 2000–2009. The total number of gender accidents between 2000 and 2019 is shown in Figure 2. (Chong and Low 2014).

Accent on the average in the construction industry the number of deaths, permanent incapacity and permanent incapacity was 70, 50 and 7 cases between the years 2007 and 2012, according to DOSH in Malaysia as reported by (Williams, Hamid et al. 2017). These accounted for 53%, 40% and 5% of all injuries at work in all sectors. Apart from that, according to (Nnaji and Karakhan 2020) in 2017, more than 970 construction workers were killed in the US construction industry. This significant amount results in a death rate of approximately 10 workers killed per 100,000 full-time construction workers per year. Constructors in developing countries worldwide have a 3–4 times higher risk of a fatal accident than other industries, according to the International Labor Organization (ILO). In developed countries, this pattern continues to expand to 6 times more likely as stated by (Nnaji and Karakhan 2020). Thus, it is important to keep on searching ways or

any improvement to the existing solution to minimize these issues in construction building project.

2.2 Factors contributing of BIM controlling violation of safety issue

In paragraph below will discussed more on how BIM software that can contributes to helps the AEC industry in controlling the violation of safety rules.

2.2.1 Application of BIM in safety rules

Nowadays many BIM-based software packages have well-established features and are used by design and construction professionals. BIM is a fantastic visualization tool that offers a three-dimensional (3D) simulated image of the building project, that gives a better understanding and proper insight of what the finished product would look like (Alizadehsalehi, Yitmen et al. 2020). Such methods are also creating an ideal guiding principle for BIM-based site development and safety planning. (Khoshnava, Ahankoob et al. 2012) mention that from the recent stages of the study, the existing BIM-based software tools available for site safety planning. This software was identified into 6 functions and one of them were to determine the various acceptable tools for building safety planning based on the key strengths and limitations identified.

The adoption of BIM technology will also facilitate to improved safety in the workplace by implanting more illustrative designs and safety plans on the buildings. In addition, using BIM, it is offering methods to track and envision up-to-date maps and site status data that would allow better safety management to connect security problems closer to building planning, such as informing site workers and others (Azhar and Behringer 2013). (Latiffi, Mohd et al. 2013) in his study stated that, the implementation of BIM during the pre-construction process is more prominent than during the construction and post-construction phases. This is because various activities have been carried out at this level, such as design, scheduling/preparation and estimation; these activities usually require the use of BIM technology.

Apart from that, the BIM concept defines the simulated construction of a facility prior to its actual physical construction in order to minimize ambiguity, improve safety, work out problems and visualize and evaluate potential effects (Khoshnava, Ahankoob et al. 2012) . In addition, BIM avoids errors by allowing conflict or 'clash detection' where the computer model effectively illustrates the team where parts of the building can mis-contact and overlap, such as: structural frame and construction services pipes or ducts. 3D objects are also machine-readable, spatial conflicts in a building model that can be automatically verified.

Supplementary to the use of BIM for safety, in the design of the site may be the simulation of the formwork processes and tools during the construction process. Examples of these involve viewing BIM-based packages to gain a mutual understanding or view descriptions, or product and quantity information.

2.2.2 Advantages BIM in safety

From the finding of (Ganah and John 2015), BIM is increasingly regarded as emerging technologies with the potential to facilitated stakeholders cooperation, improve the quality of knowledge available for decision-making, improve the quality of services supplied and reduce time and expenses at any point of the building's life cycle. One of the main benefits of BIM in terms of 2D and 3D computer-assisted design (CAD) is that BIM not only reflects and controls graphics but also knowledge that enables automated developments of drawings and reports, interpret design, simulation schedules, facility management, etc., eventually enabling the construction team to make sophisticated knowledgeable decisions (Khoshnava, Ahankoob et al. 2012). Hence, the use of BIM in the AEC sector would also help to strengthen the approach to security. The detailed design process provides a critical opportunity to remove hazards before they surface on the job site (Zhang, Teizer et al. 2013). Prior research reveals that there is a shortage of relevant

tools and services to facilitate designers when it comes to building safety. The existing approaches often used for process and report safety data for decision-making in the field of construction health and safety (H&S) have demonstrated inefficiencies. Technology may possibly play a critical role in further minimizing incident rates until it has a positive impact on subsequent safety preparation procedures.

Rules-based control systems for building models have been built as part of the modern BIM technology which is 3D visualization and 4D simulation improve the ease and level of understanding of construction processes (Marefat, Toosi et al. 2019). They improve overall coordination between project representatives. These algorithms are essentially in laid in BIM and can therefore allow extra efficient planning of safety prior to and during building construction process. These technologies can improve safety by computerized hazard detection in initial process and provide cost-effective and simpler methods to resolve safety clashes. The purpose is to immediately recognizes these complex circumstance as the building is develop, to identify their position in a virtual 3D environment, and to provide interactive or automated solutions and simulation of protection systems to alleviate the established hazards (Zhang, Teizer et al. 2013).

2.3 Importance BIM in safety rules

The introduction of innovative technologies and techniques enables safety practitioners to take serious account of the safety of staff and to plan and enforce robust safety programs. Innovative technology can increase safety efficiency at the construction site, but most advances are restricted to the construction stage only (Alizadehsalehi, Yitmen et al. 2020). Conventionally, safety managers mostly observe the actions on construction site by adapting to their job experience and depending on their direct observation. Dynamic BIM can improve the practice of safety management in the architecture, engineering and construction (AEC) industry by optimizing the risk management plan and constructive response method.

Research on the use of technology and computerized solutions for H&S management has emerging gradually, as innovations can provide numerous safety advantages by identifying occupational threat that are not usually viable for employees and removing occupational threat in the beginning of the life cycle of the project. Correspondingly, the dominant purpose of Building Information Modeling (BIM) is to increase efficiency through efficient information exchange and communication, but BIM may also be used to enhance the H&S of staff. In required to practice building staff and machinery mechanics, mixed-reality simulation is used to recognize and reduce occupational hazards and risks associated with construction and machine operation tasks. Crucially, implementing safety management technology will contribute more efficient controls (e.g. engineering controls) than merely educating staff on how to diagnose the hazards (Nnaji and Karakhan 2020). Hence, it is important to recognize and resolve possible the construction hazard in the early phase of the design process.

As stated in the (Nnaji and Karakhan 2020) researches, a study about the development of safety-rule checking platform that can analyze the building scheme and immediately detects any possible risks to the workplace. If a danger has been defined and classified, preventive measures will be created by the platform to remove or minimize the threats from the design or during the fabrication process. The equipment and platform mentioned above will use BIM to plan the layout protection of construction workers before starting construction. Designing the safety of construction workers guarantees that a large sections of the physical threats is eliminated from the construction development, which is the most competent of risk reduction strategy according to the risk management process.

Factors that discourage individuals from implementing technologies used for H&S management but those who restraint their authorities must ensure that the post-utilization adoption should be established for the effective development of technologies in the H&S management construction project. (Ganah and John 2015) claimed that, the lack of dynamic and reliable way on forecasting peak risk levels, safety management on

construction sites is carried out at a consistent level of effort, concentrating on availability and use of personal safety gears, training, casualty and near miss investigations, and taking measures to comply with regulatory specifications. As the conditions of site changing over time, it is essential to perform uncertainty analysis prior to the any activity at any moment although is challenging especially if the activity needs to be carried out repeatedly. This needs more time than most contractors or employees are prone to spend, and thus safety management at building construction sites frequently experienced from a low level of performance, with successful risk analysis seldom carried out. Hence, as a design and construction information become progressively digitally transmitted, the AEC sectors need to spend more in effectiveness combined with technology and ability to use such technology to help boost H&S on construction sites and take measures to fulfil regulatory requirements.

In different circumstances, the adaptation of these technologies to be more specialized elements still in an active area of study that need to be more discovered. In this context, an impressive results have been attained both in terms of the integration of BIM with state-of-the-art technologies and their implementation in demanding the case studies. For instance, the study from (Getuli, Capone et al. 2020) demonstrates the successful of using the BIM, VR image processing and machine learning solutions to optimize the automation in construction building controlling measures of risk activities, which is considered to be particularly on productivity of employees and error-prone will be reported by BIM-based advanced technologies for the performances testing of a especially massive and complex facility such as a shopping complex.

Chapter 3

METHODOLOGY

Throughout this section, the methodological approach towards this study will be addressed and outlined in order to achieve the objectives of this project. The arguments of these aspects contribute a greater interpretation of the suitability of the research engaged and its potential to provide accurate response to the survey questions of the report.

3.1 Project Activities

There are several activities compromising (6) main activities.in performing this project as follows:

1. Research on the background of the causes and effects of the accidents in building project and effectiveness using BIM in construction industry in previous publications.
2. Develop a few questionnaires forms for survey purposes.
3. Converge quantitative and qualitative data.
4. Indicate the acquired information and details from the participants.
5. Compute, give suggestions and draft project report against the research finding
6. Produce thesis on the finding for Final Year Project full report.

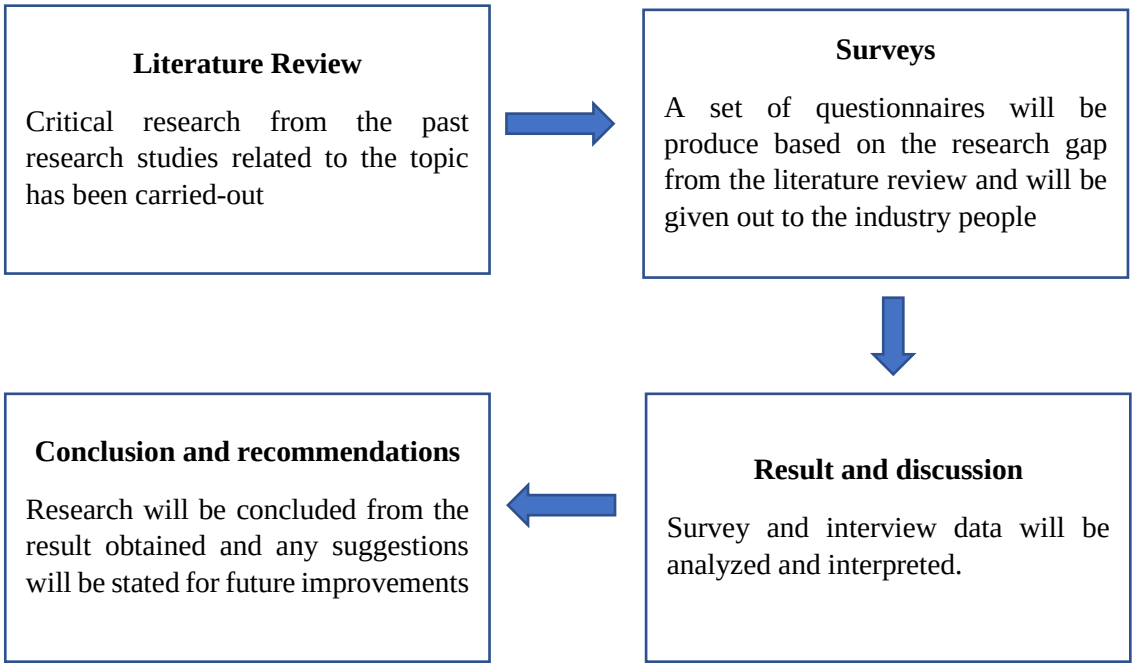

Figure 3 The flow of research methodology

3.2Research Methodology

The research approach, which included the collection of information for the investigation of the topic of the exploration, was chosen as the research purpose for this report. Four phases of this study which are literature review, questionnaire, data collection and data analysis will be conducted accordingly to complete this research.

3.2.1 Literature Review

A literature review is a comprehensive summary of information recorded through article reading and writing that is relevant to the chosen interest of research area A series of collection data through further readings from journals, articles, newspaper, conferences paper, information through internet and dissertations will be used for overview understanding of the issues related to the research. The objective of this process is to provide an overview of the importance for research to proceed the research in a new field and most importantly, to guarantee that research do not replicate the work that is being done from other publishers.

In the literature review, the research focused on the:

1) To study the factors contributing of BIM on controlling the violation of safety rules in building project.
2) To analyze the importance of controlling the violation of safety rules using BIM in building project.

3.2.2. Questionnaires

The next data is the distribution of questionnaire survey to relevant technical field participating in the construction building project This survey includes professionals from the construction industry who have encountered these safety concerns during the construction project cycle. The questionnaire's questions are structured to achieve the goals set out above as mentioned in introduction part. Interview sessions will be proposed in order to obtain direct information on this analysis of the case study.

3.2.2.1. Draft (Pilot survey)

Before the author proceed for the actual survey questionnaires, the author is required to create a pilot survey. The actual finalized questionnaires will be done in the FYP 2 including execution of questionnaires to companies to obtain results. This questionnaire considers all the factors contributing of BIM on controlling the violation of safety rules in building project and all these elements are much likely to be taken into considerations in conjunction with to their appropriate priority. All these aspects including major elements are taken as questions which can be answered in five different approach (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) according to which BIM implementation in controlling violation safety rules can be measured.

1. Factor Categories

This questionnaire considers all the contributing factors contributing of BIM on controlling the violation of safety rule which are still pivotal issues until today particularly on construction site. All these considerations will be treated as queries with five possible

answers (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) with the element mentioned contributing to the implementation of BIM in controlling the violation issues.

2. Classifiers

Correspond to the factors that will be listed in the survey questionnaire, the respondents can be categorize into those who work with the safety team or professional that related to any construction organizations.

3. Category factor variables

Below are the possible factors will be included in the questionnaire that will be distribute to the possible respondent in the organization.

a. Personal Factor

b. Management Factor

c. Resources Factor

3.2.2.2 Actual survey form

As for the actual survey form, the author completed the form based on the respondent's comments on the pilot survey form. The survey form had been done in both hardcopy and online questionnaire.

3.2.3. Data collection

The information gathered from the study will classified into main-input and sub-inputs. While the main-inputs are collected through answers from questionnaires and online survey, sub-inputs will be collected from tools or materials such as article from websites and books, prior paperwork and dissertation accomplished by those who interested on planning research in other types of the industry, in order to get the preview of how planning process effect those organization.

3.2.3.1. Primary Data

In addition to the current research input collection as a module for this discussion, a list of questionnaires will be adapted and will be given to the respondents. There are three (3) part in the questionnaire, as follow:

1. Part A: Shall consists of information of the respondent.
2. Part B: A set of multiple choices questions that will be focuses on factors and significant of controlling the violation of safety rules using BIM software. The respective respondent will be evaluated whether the BIM software is capable for controlling and minimizing the violation of safety rules in current building construction industry.
3. Part C: Open-essay (interview) questions to gain the respondent's opinion regarding the current implementation and possible barriers of the BIM towards the minimization of the safety rules.

3.2.3.2. Secondary Data

Any of articles or publication, paperwork and thesis related to this research are identified as references. These materials are primarily obtained from UTP's Information Resource Centre (IRC), library and e-Resources.

3.2.4 Data Analysis Method

Once the data collection has been done from the respondent, the final data from the questionnaire will be gathered and compiled. Compiling the data into organize form will be easier to interpreted and see the appropriate result. From the questionnaire that have been construct for the respondents, there will be two parts in Section B which about the factors and importance of controlling the violation of safety issues. Hence, data analysis will be done for Section B. For the Section A and C will be about the general background information of the respondent and open-ended question about the

implementation of the software respectively. Thus, for Section A there will be a simple analysis will be done and no analysis for Section C

The interpretation of the survey questionnaire will be evaluated through a few methods which are Relative Importance Index (RII), Average Index (AI) and Cronbach's Alpha using SPSS software.

3.2.4.1 Relative Importance Index (RII)

The data gather from Section B will be evaluated using Relative Importance Index to obtain the highest top rank of question that will give a result for this research. The scale ranged of 1 (Strongly Disagree) to 5 (Strongly Agree) has select and transfer to relative important index for each question in Section B as follows:

$$RII = \frac{\Sigma w}{AN}$$

Where: w → weighting given to each factor by the respondents (1 to 5)

A → is the highest weight (i.e. 5)

N → the total number of the respondents

The rating scale used as below:

- Strongly Disagree = 1 (1.00 < Average Index < 1.50)
- Disagree = 2 (1.50 < Average Index < 2.50)
- Neutral = 3 (2.50 < Average Index < 3.50)
- Agree = 4 (3.50 < Average Index < 4.50)
- Strongly Agree = 5 (4.50 < Average Index < 5.00)

3.2.4.2 Average Index

In order to infer the preferences and perceptions of respondents who have encountered or have the violation of safety issues during the execution of construction process or during the planning stages, some semi - structured interview to assess the

significance of the index. Based on the data collection that was transmitted, the average index was calculated using the formula below. Some modifications were implemented on how the weighting was concluded so that the author could expand on the average index model.

1- Strongly Disagree; 2- Disagree; 3- Neutral; 4- Agree; 5- Strongly Agree

The Average Index formula as below:

$$\textbf{Average Index (AI)} = \sum(\beta \times n) / N$$

Where: $\beta \rightarrow$ is weighing given to each factor by responden

$n \rightarrow$ is the frequency of the respondents

$N \rightarrow$ the total number of the respondents

The rating scale used as below:

- Strongly Disagree = 1 (1.00 < Average Index < 1.50)
- Disagree = 2 (1.50 < Average Index < 2.50)
- Neutral = 3 (2.50 < Average Index < 3.50)
- Agree = 4 (3.50 < Average Index < 4.50)
- Strongly Agree = 5 (4.50 < Average Index < 5.00)

Subsequently, the data from Section B of the questionnaire will be evaluated using Average Index method. The data that have highest Average Index will be marked as the most common elements that exist in the building construction industry. Otherwise, for the aspects that have least Average Index will be illustrate as less often to be relevant.

3.2.4.3 SPSS (Reliability Test)

Created by one of today's top research tools, the letter "SPSS" stands for the Statistical Packages Social Sciences It is used globally for the analysis of statistical data, particularly in the social sciences. This software mainly used by most of the researchers, marketing organization, survey companies, and other to extract and get a reliable result from a set of features that provide by this software.

3.2.4.4 Cronbach's Alpha

Cronbach's alpha is known as one way to measure the strength of that consistency of the elements. It is used to measure and assess the reliability or internal consistency of a set of the scale item. The reliability of any given measurement refers to the extent to which it is a consistent to measure a concept.

Cronbach's alpha is computed by correlating the score for each scale item with the total score for each observation (usually individual survey respondents or test takers), and then comparing that to the variance for all individual item scores

$$\alpha = (\frac{k}{k-1})(1 - \frac{\sum_{i=1}^{k} \sigma_{y_i}^2}{\sigma_x^2})$$

Where: $k \rightarrow$ is refers to the number of scale items

$\sigma_{y_i}^2 \rightarrow$ is refers to the variance associated with item i

$\sigma_x^2 \rightarrow$ is refers to the variance associated with the observed total scores

Cronbach's alpha is thus a function of the number of items in a test, the average covariance between pairs of items, and the variance of the total score

3.3 Gantt Chart

Table 1 Timeline FYP1 gantt chart

TIMELINE FYP 1 GANTT CHART

Tasks/Week	1	2	3	4	5	6	7	8	9	10	11	12
Selection of Project Topic												
Preliminary Research Work												
Submission of Progress Assessment 1 (SV)												
Proposal Defense												
Submission of Interim Draft Report												
Submission of Progress Assessment 2 (SV)												
Submission of Interim Report												

Table 2 Timeline FYP2 gantt chart

TIMELINE FYP 2 GANTT CHART

Tasks/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Project Work Continues																	
Pilot Survey																	
Questionnaire Distribution & Interview																	
Submission of Progress Assessment 1 (SV)																	
Data Analysis																	
Submission of Draft Dissertation																	
Submission of Progress Assessment 2 (SV)																	
Submission of Dissertation (Softbound)																	
Submission of Pre-recorded Video (Viva)																	
Q&A Session (Viva)																	
Submission of Project Dissertation (Hardbound)																	

Process Key Milestone

Chapter 4

RESULT & DISCUSSION

4.1 Data Analysis Result

This section presents the outcomes or interpretations of the questionnaire conducted to the organization as well as further analyzes to provide a systematic and informative discussion. In order to provide a good judgment and a recommendation each of the outcomes will be validate by the current literature review in Chapter 2 to be thoroughly reviewed and assessed.

4.2 Pilot Survey

The pilot survey was performed between the experts from both academic and business practitioners. The questionnaire is circulated to a total of thirty-five (25) respondents for each sector and stakeholders that participating in the building construction industry. From the thirty-five (20) questionnaires released, 30 data were received from each sector, resulting in 86 % returned to success. After getting some responses, the structure of the questionnaire was amended, with some improvements proposed to the questions to be answered and the format of the survey itself. Then the completed vast survey will be carried out.

4.3 Questionnaire Survey

The ultimate questionnaires were circulated to experts whether in academic institutions, engineering firms, consulting firms, construction companies and government sector. A sum of 60 questionnaires were circulated to all sector of the companies as mentioned before, through online platform by using google form to distribute the questionnaires. However, only 50 questionnaires were returned with valid response. There are four major part included in the questionnaire which are general information, factors and importance of controlling the violation of safety issues also the response about the implementation of BIM on the violation of safety rules.

4.4 General Information of Respondents

These questionnaires were circulated around to the professional that related to building construction industry who are working from different companies in Malaysia. From the feedback of the questionnaire, here is the summary of the Section A of the questionnaire.

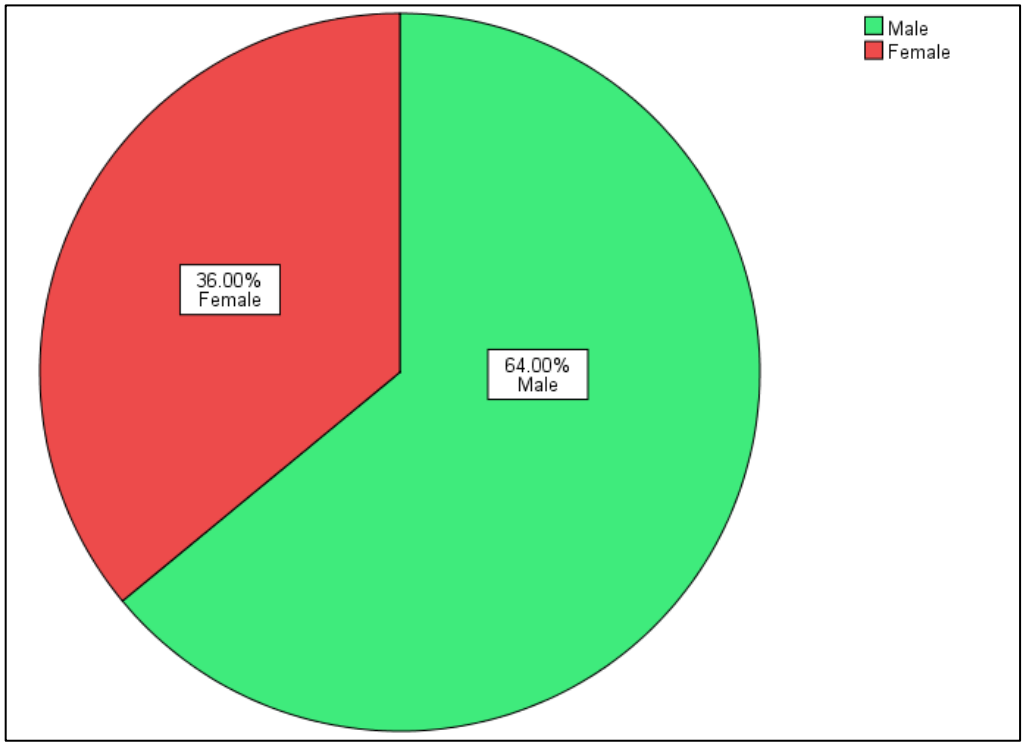

Figure 4 Gender of the respondents

Based on Figure 4 above, from a total of 50 respondents, 64% of the respondent were male and 36% were female. This is proven that in Malaysia there are almost no limitations to females entering any sector or profession.

Meanwhile, as shown in Figure 5 below is the summary of the age of respondent that varies from 20 years old to 40 years old and above. From the graph, the author can conclude that highest percentage of age group of respondents is 26-30 years old (42%) followed by 20-25 years old (30%) and others group.

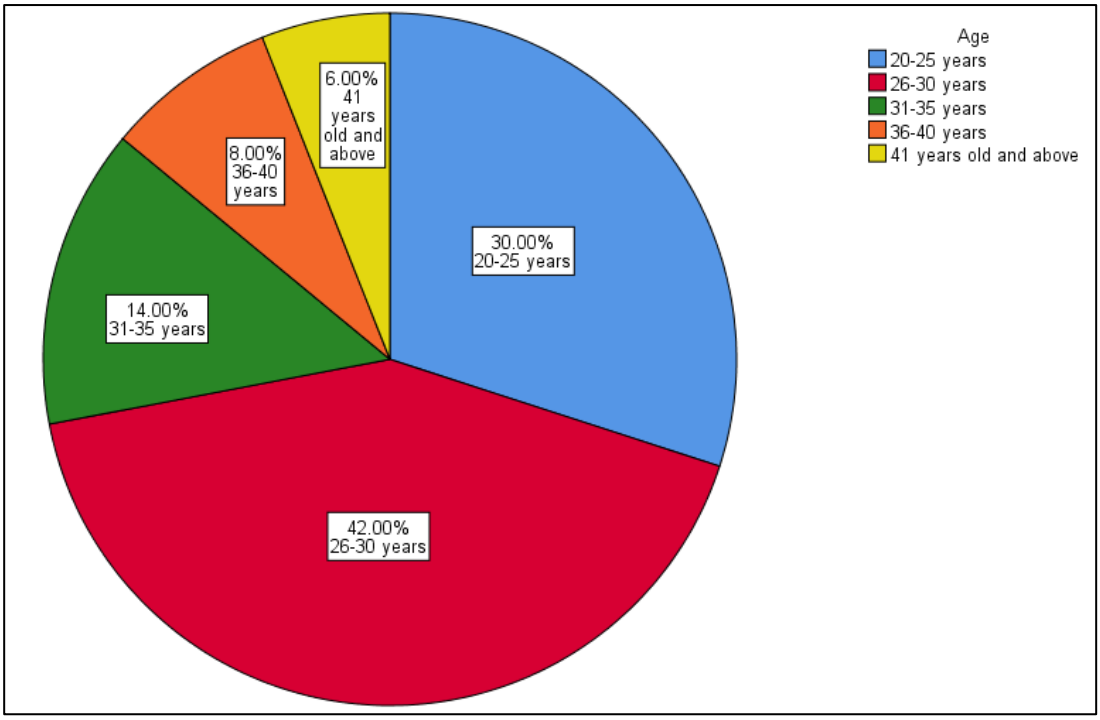

Figure 5 Age of the respondents who take part in the questionnaire

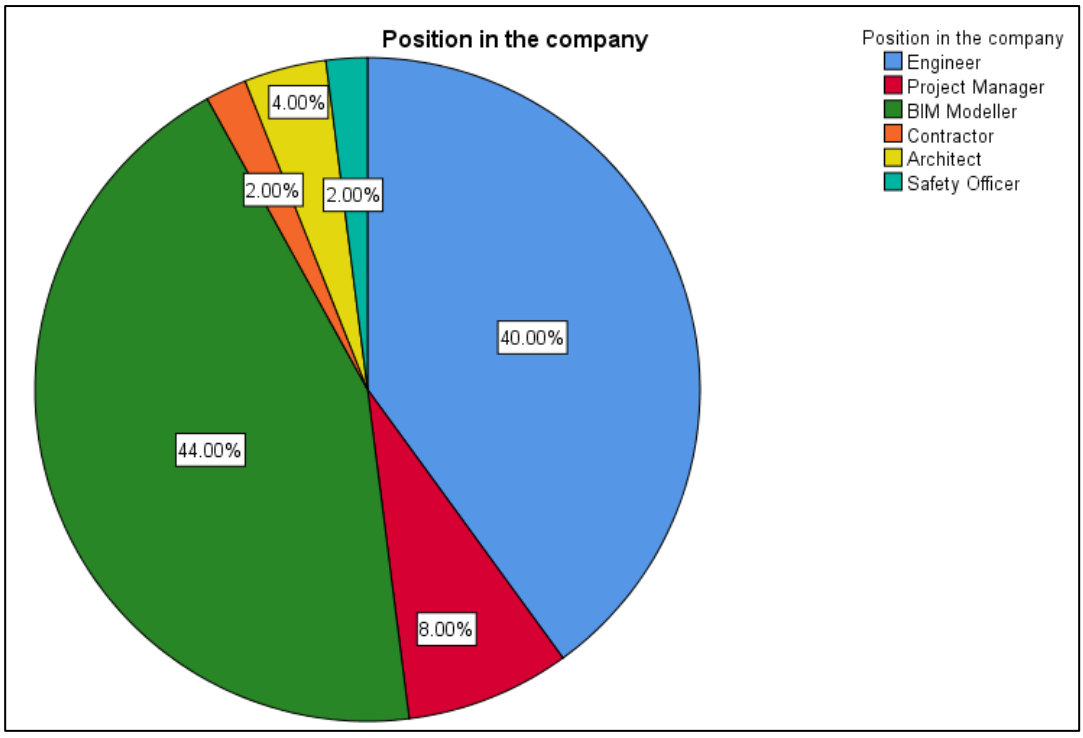

Figure 6 Position of respondent's in current company

From the data collection of the survey, the current position of respondent in their company was summarize as illustrated in Figure 6 above. From the pie chart, the author can conclude that 44% from the total of the respondents were BIM Modeller, 40% were Engineers and followed by others job position from the respondents.

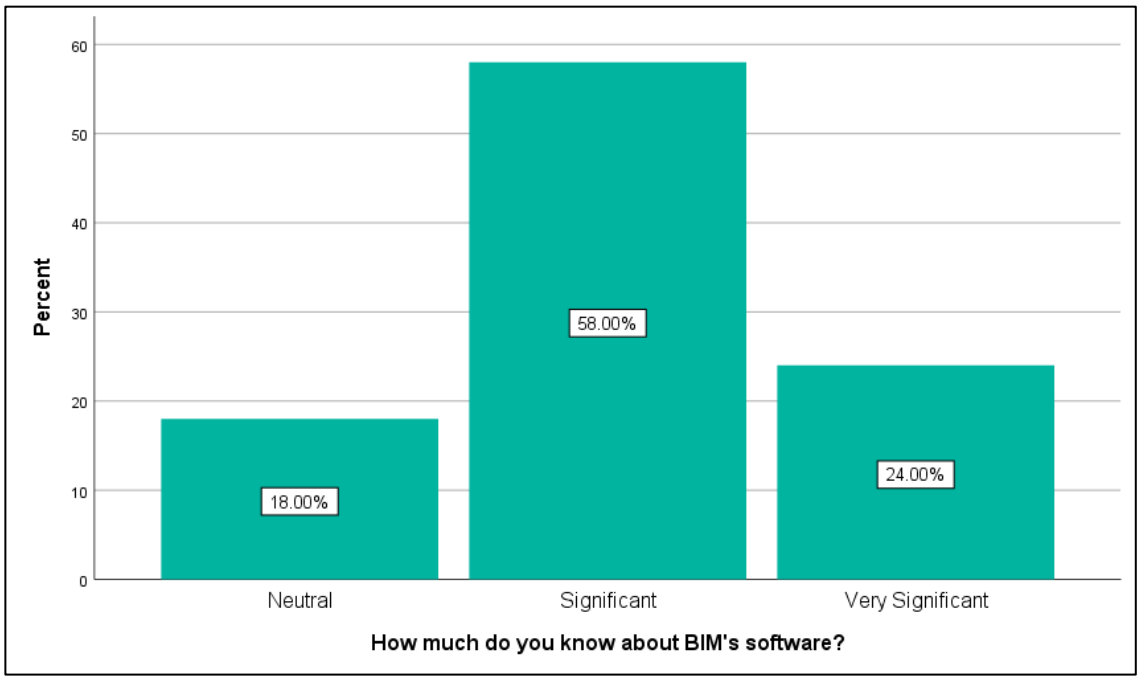

Figure 7 Knowledge of the respondents towards BIM software

Figure 7 is the result of the last question from Section A of the survey. From bar chart above, the author can conclude that the respondents were aware and have an essential knowledge about BIM software as they are using this software as an alternative tool to design the project planning flow. From this data result also can conclude in Malaysia, they currently emerging the BIM software as one of the significant tool and mechanism in every project particularly for mega project. The increases of level adoption of BIM software among stakeholders in construction industry in Malaysia is mainly coming from the collaborations with government agencies such as CIDB, JKR and other private company aligned with the enforcement of laws and regulations to make sure the BIM implementation in Malaysia are at competitive levels as other pioneer country (Kamaruzzaman, Mamter et al. 2016).

4.5 Data Analysis through SPSS Software

Analyzing data using SPSS software is a completely robust method because it can use any information to generate tabular data. Nevertheless, properly organizing the data ahead would make it much clearer when it is time to complete the final report. From the feedback of the questionnaire, in this part, the author will present the analysis data using SPSS software from Section B which is consist of two parts from the survey.

4.5.1 Relative Importance Index (RII)

When two variables are highly corresponds to each other, of the way to measuring and predict its relative value by using the Relative Importance Index (RII) tools. It is an alternate approach to do multiple regression method and solved the multicollinearity issues while aiding in the estimation of the priority ranks of the parameters.

Table 3 Summary of RII for factors contributing of BIM on minimizing safety issues

Factors contributing of BIM on minimization of safety issue	**RII**	**Rank**
Deficient elements inspection	0.816	1
Clash elements inspection	0.780	2
Health accidents inspection	0.752	3
Inspection for falls	0.744	4
Preliminary cost estimation	0.712	5
Space program inspection	0.696	6
Fabrication simulation	0.680	7
Collision inspection	0.640	8
Concrete deposition simulation	0.632	9
Inspection for fires	0.592	10
Excavation simulation	0.584	11

Data shown in Table 3 above is the summarization of the factors contributing of BIM on minimizing safety rules that have been ranked based on RII's result. The highest factor that has been ranked as Rank 1 has RII value of 0.816 whilst the RII value of 0.584 is the lowest rank which in this case the factors has least impact towards the purpose of this research. All this result data was based on the response from the respondents towards the minimization of violation of safety rules by using the BIM software.

The objective of this study is to find what are the factors that contributed to the minimization of the violation of safety rules using BIM. Therefore, the factors listed above is one of the ways of BIM application can control the violation of safety rules in the building construction. Utilizing BIM as mention in above factors will eventually give the users/stakeholders not only understanding the process of the project but it can be used to locating the possibly risky areas in which we can reduce the violation safety rules to provide a safe construction site for workers as well as to improve the constructability of the project. The integrated system in BIM such as design safety tools analysis that featured hazard recognition, risk assessment and construction visualization can helps to identify the hazards in early design stages.

Analysis on Top 5 Factors Contributing of BIM on Minimizing Violations of Safety Rules

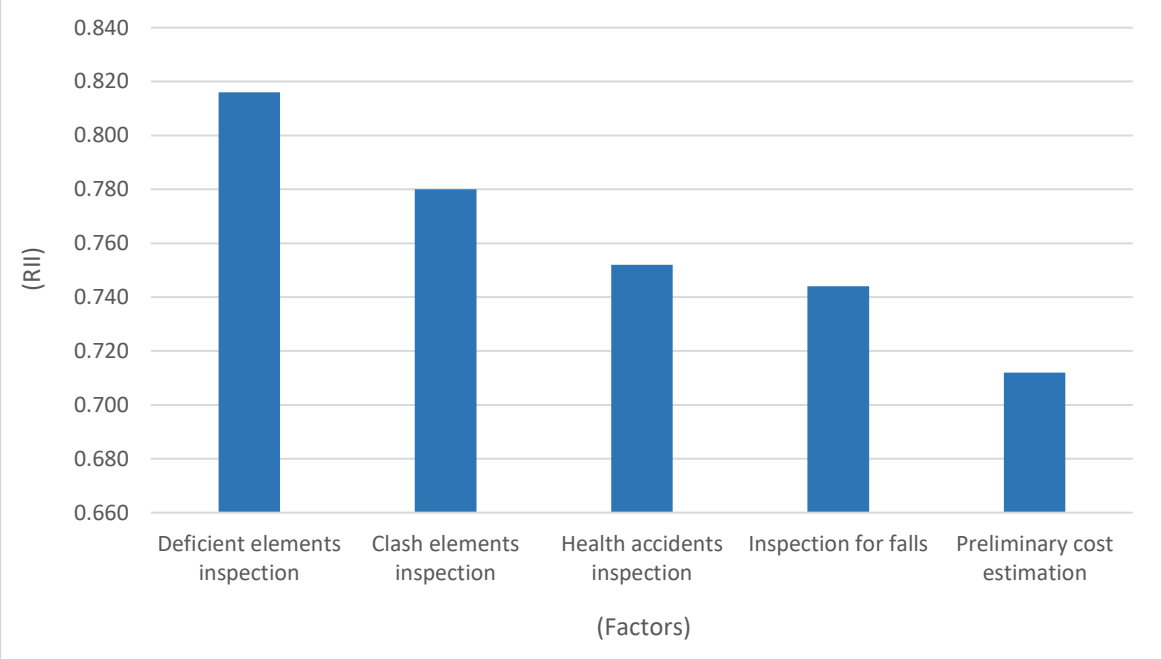

Figure 8 Top 5 factors contributing of BIM on minimizing violations of safety rules

Subsequently from the Table 3, the author come out with the graph of top 5 factors contributing of BIM on minimizing violations of safety rules as shown on Figure 8 above. These top 5 factors will be discussed in the following paragraph below.

Deficient Elements Inspection

According to the findings of the survey and the responses from the participants, the most significant factor influencing of BIM towards minimization of violation safety rules is deficient elements inspection with RII value is 0.816. Highest RII represent that this factor affects most towards the minimization of violation safety rules. From the feedbacks of the respondents from consulting firms, during the design stages, it is important for the engineers to check any missing elements in the building model inside the BIM software through visualization. Any missing elements can be easily detected to ensure that any possible harm towards construction workers as well as structural safety during construction stages can be prevented in the early phase. Thus, the model will be subsequently revised when the missing elements is recognizes and any possible high-risk accident can be avoided through the modelling revision.

Clash Elements Inspection

The second factor influencing of BIM towards minimization of violation safety rules is clash elements inspection with RII of 0.780. From the survey conducted, most of the engineers from the consultant companies agreed that clash detection during the design phases using BIM software can help to reduce the risk of human error during the execution phases. This factor will aid in the rapid detection, verification, and monitoring of project design intrusions. Clash elements inspection is vital because most of the design model such as structural layout and MEP layout were integrated together in one model. For instance, in Revit software, when the users attempt to put a slab on a set of the wall, the software will give a warns of clashes elements showing that the structure did not make a connection to each other. Else, the user also can used additional software like Naviswork to carry out the clash detection in the building model. Hence, by using BIM software, this will reduce the clashes elements mistakes on the site that will eventually lead to a high cost needed and make the project delayed in order to do the re-works process.

Health Accidents Inspection

The third factor influencing of BIM towards minimization of violation safety rules is health accidents inspection with RII of 0.752. As BIM has toward the 8-D, which is

7D+safety in recent years, the author believe that the ability of the BIM software towards the improvement in safety concern can helps to save the most important resources in building construction industry which is human lives and health. From the feedback of the questionnaire given to the respondent, the advancement of the technologies and digitization in the BIM software will assist the project managers in making smarter decisions at any point with the assistance of BIM, thus reducing the likelihood of health and safety injuries on the construction sites.

On the other hand, in architects' point of view, using BIM software will helps to examine any bizarre situation of an accidents. In facts BIM will help architects to plan for emergencies and determine the most effective alternative routes for optimum contingency planning.

Inspection For Falls

The fourth factor that most influencing of BIM towards minimization of violation safety rules is inspection for falls. After doing the analysis the RII value obtained is 0.744. This showed that among top major factors, inspection for falls contributes to minimization of the issues. Construction workers are often exposed to the falls accidents particularly when they are working at the edge of the floor or roof opening. So, the most effective way to avoid falls is to remove the danger, followed by replacement and developing the potential risk out. Hence, using the BIM software, this problem can be prevented by advising the installation of protective guard rails around the openings or dangerous area.

In addition, mitigating fall hazard in planning stages is important before starts any major works progress. There a few scenario cases that frequently happened associated with fall incidents such as slippery, working or walking in unstable surfaces, misused personal fall protection. Therefore, the features that provided by BIM software especially the digital visualization helps the engineers to revise the model automatically by creating the precise architectural components such as railing and fall protectors in the building model during design phase.

Preliminary Cost Estimation

The fifth factor that most influencing of BIM towards minimization of violation safety rules is preliminary cost estimation. The RII value that is obtained from the analysis is 0.712. According to the responses from the survey, a lot of engineering information is still in undecided in the early stages of the projects. Nevertheless, due to scarcity of the information, there are some common preliminary strategies in order to get a initial cost estimation. With the help of digital visualization from BIM model, the engineers can present a comprehensive cost estimating by identify the possible risk hazard that could prevent the time delays also cost wasting. Engineers are agreed that for a complex building structure like shopping malls or healthcare facility will have a huge amount of money needed to build this building. and this huge structure have many possibilities of risk associated to safety issues. Hence, by adapting the model-based estimation inside the BIM software can support the engineers and contractors in making a good decision to prevent any violation of safety rules that will lead to the additional cost for this building construction.

Table 4 Summary of the RII value for the importance of controlling the violation of safety rules

Importance of controlling the violation of safety rules using BIM	**RII**	**Rank**
Produce a complete schedule and cost estimation in design phases	0.892	1
Provide an early identification during design phase	0.876	2
Create a good relationship between stakeholders	0.872	3
Having a good, practical and communication of safety with all stakeholders	0.864	4
Provide an effective safety planning	0.792	5
Prepare a clear, comprehensive, and practicable safe construction plan	0.780	6
Doing safety inspection by safety specialist frequently.	0.744	7
Developed an automatic inspect 3D models	0.740	8
Can measured the safety risk through modelling	0.724	9
Provide site hazard prevention and safe project delivery	0.672	10
Using authorized or qualified equipment.	0.664	11

Data shown in Table 4 above is the summarization of the importance of controlling the violation of safety rules using BIM that have been ranked based on RII's result. The highest element that has been ranked as Rank 1 has RII value of 0.892 whilst the RII value of 0.664 is the lowest rank which in this case the element has least impact towards the purpose of this research. All this result data was based on the response from the respondents towards the minimization of violation of safety rules by using the BIM software.

Analysis on Top 5 Importance of Controlling the Violations of Safety Rules Using BIM

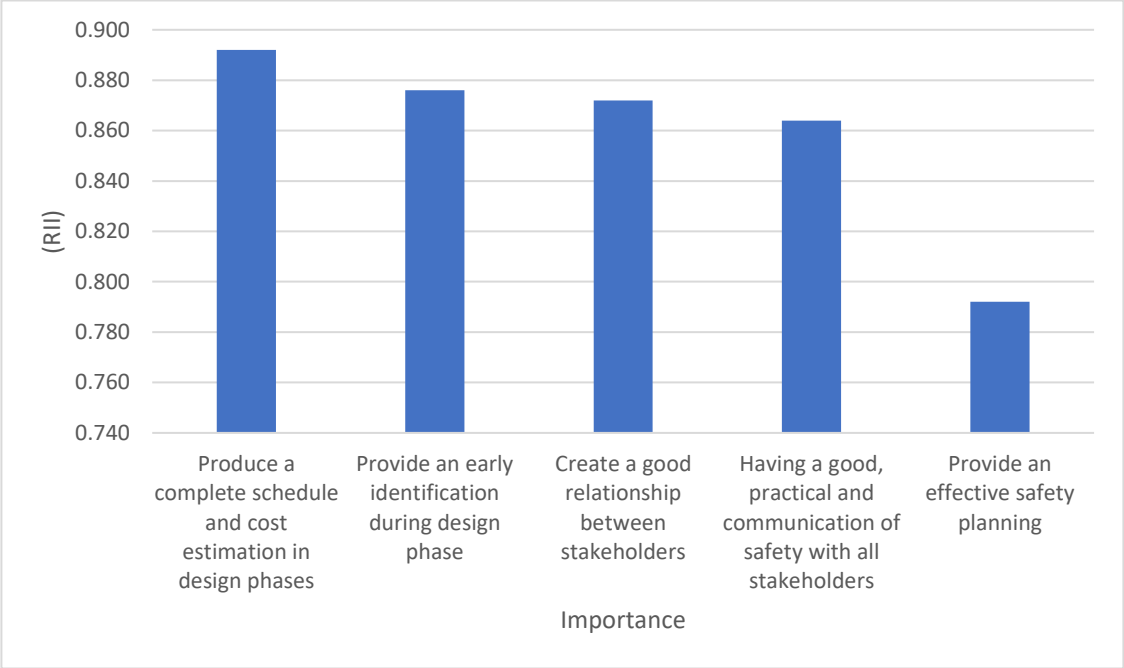

Figure 9 Top 5 of the importance on controlling the violation of safety rules

Subsequently from the Table 4, the author come out with the graph of top 5 of the importance of controlling the violation of safety rules using BIM as shown on Figure 9 above. These top 5 of the importance elements will be discussed in the following paragraph.

Produce a Complete Schedule and Cost Estimation in Design Phase

According to the findings of the survey and the responses from the participants, the most importance elements on controlling the violation of safety rules using BIM is produce a complete schedule and cost estimation in design phase, with RII value is 0.892. Highest RII represent that this element contributes most towards the minimization of violation safety rules. From the response of the respondents particularly engineers and project managers, there are acknowledge that the reliable features such as visualized cost estimation schedule provide by BIM software actually helps them to prevent any costly errors during the execution of the projects. For instance, factor of elements clashes can be identified during design stages which leads to saving time and cost overruns also avoids the possible risk hazard or accident happened during the execution stages later.

On the other hand, cost estimation plays an important part to reduce the violation of safety rules in building construction. Not only machinery and materials that included in cost estimation but manpower also contribute to the cost estimation in a project. If undesired events occur in the construction, such as unsafe workplace environment, OSHA and other regulatory agencies can give fines and penalties if they caught the contractors not following the safety regulations. If accidents happened, all the works on the site immediately stop and investigations will underway to search the causes of the accidents. Therefore, in this situation the overall cost of the project can immediately increase because company should compensate the injured workers and repairing the damaged equipment and supplies.

In conclusion, the application of BIM on reducing violation safety rules is important because it can keep the construction site safe by limiting the risk using the tools inside BIM and project can finish on time within the propose budget.

Provide an Early Identification During Design Phase

The second importance aspects that influencing of BIM towards minimization of violation safety rules is provide an early identification during design phase with RII of 0.876. From the survey conducted earlier, engineers are mostly believed and agree that any possible accidents scenario that will happened on site construction industry can be predicted and prevented using the features embedded in BIM software through design reviews, simulation also other BIM-based extension in design phase. On the other hand, the nD model that provided in BIM software can helps the architects and engineers automatically visualize and determine the appropriate risk threshold and analyze based on previous record of the safety program of all stakeholders and produce a good contingency plans.

Create a Good Relationship Between Stakeholders

The third importance aspects that influencing of BIM towards minimization of violation safety rules is create a good relationship between stakeholders with RII value of 0.872. From the Architects, Engineers and Consultant (AEC) industry perspective, utilizing BIM as mechanism to create a good relationship between stakeholders can be seen through the necessity to use this collaborative environment. In this way, all stakeholders can easily access and share the knowledge to each other even though each of them has different individual workflow and demands for each building construction. Hence, it is important to keep a good relationship to ensure that if any problem related to safety concerns arises, the stakeholders can sit down together solving the problem with aid from BIM without pointing fingers towards each other.

Having a Good, Practical and Communication of Safety with All Stakeholder

The fourth importance aspects that influencing of BIM towards minimization of violation safety rules is having a good, practical and communication of safety with all stakeholders. After doing the analysis the RII value obtained is 0.864. In the author perspective, different roles of specialization of stakeholders will serve different critical issue of interoperability between the software. Hence, it is important to have a better understanding of design intent in all stages of a project for each of the stakeholder. For

instance, contractors usually perceive to have an efficient project delivery with optimum cost required to avoid any mistake happened during the execution process. Meanwhile for architect and engineers they usually wants to have a better design process to easier the design changed as well as to reduced conflicts and changes during the construction happened. Therefore, to have an efficient safe delivery project, having a good practical and communication about safety between the organization is important as it will improve the safety performance and achieve the overall organizational performance to produce a better outcome.

Provide an Effective Safety Planning

The fifth importance aspects that influencing of BIM towards minimization of violation safety rules is provide and effective safety planning. The RII value that is obtained from the analysis is 0.792. According to the responses from the survey, engineers agree that 4D model features that available in BIM software are can helps to simulate temporary situation and current site views can supports safety concerns in building construction. A few approaches to produce safety planning is by adopting BIM to planning and reviewing building sequencing and associated safety arrangements facilitates risk management and the detection of special safety risks at the same time. Coordination, clash prediction, and assessment of the adequacy of space for performing job activities safely should all be achieved at the same time. In addition, another way to reducing the violation of safety rules using the 4D model to communicate project development, future work, current work and associated safety plans as well as problems that needing extra consideration from workers.

4.5.2 Average Index (AI)

In this paragraph, the survey form results will be evaluated using Average Index (AI) method. The average index data is gathered dependent on the weighting provided by the participants in relation to the total number of participants.

Table 5 Summary of the AI value for factors contributing of BIM on minimization of safety issue

Factors contributing of BIM on minimization of safety issue	**AVI**
Deficient elements inspection	4.080
Clash elements inspection	3.900
Health accidents inspection	3.760
Inspection for falls	3.640
Preliminary cost estimation	3.560
Space program inspection	3.480
Fabrication simulation	3.400
Collision inspection	3.200
Concrete deposition simulation	3.160
Inspection for fires	3.080
Excavation simulation	3.040

Table 6 Summary of AI value for the importance of controlling the violation of safety rules

Importance of controlling the violation of safety rules using BIM	**AVI**
Produce a complete schedule and cost estimation in design phases	4.460
Provide an early identification during design phase	4.380
Create a good relationship between stakeholders	4.360
Having a good, practical and communication of safety with all stakeholders	4.320
Provide an effective safety planning	3.960
Prepare a clear, comprehensive, and practicable safe construction plan	3.900
Doing safety inspection by safety specialist frequently.	3.720
Developed an automatic inspect 3D models	3.700
Can measured the safety risk through modelling	3.620
Provide site hazard prevention and safe project delivery	3.360
Using authorized or qualified equipment.	3.320

From the survey that have been conducted and examine using Average Index method, the result for the factors and importance towards the controlling the violation of safety rules were tabulated as shown in the Table 5 and Table 6 respectively. These Average Index value, were analyzed from the ranged of strongly disagree to strongly agree. As a result, based on the Average Index (AI) data, the research's questionnaire can be considered a reliable collection of questions for factors contributing of BIM on minimization of safety issue and importance of controlling the violation of safety rules using BIM and the value of safety management systems in the construction industry, since all of the participants agree with the majority of them in the tables as illustrated above.

4.5.3 Cronbach's Alpha using SPSS Software.

Table 7 Summary of Cronbach's Alpha Value for factors contributing of BIM on minimization of safety issue

Reliability Statistic		
Cronbach's Alpha	Cronbach's Alpha based on Standardized Items	No of the items
0.887	0.880	11

Table 8 Summary of Cronbach's Alpha value for the importance of controlling the violation of safety rules

Reliability Statistic		
Cronbach's Alpha	Cronbach's Alpha based on Standardized Items	No of the items
0.897	0.890	11

According to data obtained from the SPSS software above, Cronbach's Alpha value is about 0.887 in Table 7 and 0.897 for Table 8. It is considered to be strong internal accuracy for the items that has been displayed in the survey questionnaire. A high importance means that the information obtained is accurate and consistent, so it cannot be disputed by anyone.

4.6 Discussion on Open Ended Question

In this section, the author will be discussed about the responses from the respondent regarding the implementation of BIM minimizing the violation of safety rules in building project. Below are the open-ended questions on survey questionnaires:

- opinion towards BIM implementation on the violation safety rules.
- possible barriers of BIM towards the minimization of violation safety rules.

The data from obtained from the open-ended question was at a low level with 22% from the total response. The predominant opinion towards BIM implementation on the violation safety rules in building projects that mention by eleven respondents was the needs of developing more on utilizing BIM on all kind of project including small scale of project and improving the utilizing of additional tools like using drone survey, augmented reality and virtual reality.

For the possible barriers that adopting BIM towards the minimization of violation safety rules, out of 50 respondents, only 11% (nine people) who are answer this question. Most of the respondents said that, the availability of skilled professionals who have knowledge on safety part, high initial cost of BIM implementation on small company construction and the absence of contractual requirement for BIM implementation for middle and low risk building construction.

Chapter 5

CONCLUSION & RECOMENDATION

5.1 Conclusion

Adopting BIM software as a mechanism to control the violation of safety rules in building project is one of the most effective way with the evolving of the current technologies in order to ensure the execution of building construction in optimum level with low accidents rates.

The main objectives of this research is study and analyze the factors and importance of BIM on controlling the violation of safety rules in building construction. The data collection methods has been done by circulating the a set of questionnaire towards the professionals that working related to the building construction industry in Malaysia.

There are eleven factors of BIM were considered on contributing towards controlling the violation of safety rules. However, there are five main factors that have been chosen from the data obtained from the feedback of the respondents, which are deficient elements inspection, clash elements inspection, health accidents inspection, inspection for falls and preliminary cost estimation.

Meanwhile for the importance of BIM on contributing towards controlling the violation of safety rules also have eleven elements stated in the survey. However, there are five main importance that have been chosen from the data obtained from the feedback of the respondents, which are Produce a complete schedule and cost estimation in design phases, provide an early identification during design phase, create a good relationship between stakeholders, having a good, practical and communication of safety with all stakeholders and provide an effective safety planning.

From the result obtained at chapter 4, the author can conclude that the objectives of this research were successfully achieved achieve.

5.2 Recommendation

From the researched that has been conducted, a lot of the respondent agreed that utilizing BIM as a tool to preventing the potential hazard toward the mitigation of violation safety. However, the operability of the BIM should be widened not only for clash detection and falls accidents but for other aspects as well such as excavation simulation or concrete deposition simulation. The more aspects that can be simulate in the software will give more beneficial on improving the safety issues on the construction site. In addition, utilizing additional tools such as drone or virtual reality can also help to improve and validate the safety performance during the execution process in building construction site.

According to results of the survey obtained, existing performance on the controlling the violation safety issue in building construction is commonly practices on the high-risk construction such as high-rise building or complex building construction. Meanwhile the low-risk building such as low-rise residential building are infrequently used this BIM software as they might think that it may not cost effective for a small building projects. Therefore, from author the perspective this kind of concern need to reconsider towards the goals of the organization which is to provide a safe building construction site with a minimum violation safety issue.

In the meantime, in order to achieve a better result for future research regarding the implementing the BIM as tools to minimize violation safety issues in building construction, it is recommended to develop a 8D modelling architect layout from a specific and carry out the analysis of the modelling to assess the risk and generate the risk profiles which it will be validate with the objective of the research.

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APPENDICES

Draft Questionnaire for Pilot Survey

UNIVERSITI
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QUESTIONNAIRE

"THE STUDY OF BIM ON CONTROLLING THE VIOLATION OF SAFETY RULES IN BUILDING PROJECT"

Objectives:

1. To highlight the factor contributing of the BIM on controlling the violation safety issues in building project.
2. To analyze the importance of controlling the violation of safety rules using BIM in building project.
3. To investigate the level of perception among the professional industries of BIM on controlling the violation of safety rules in Malaysia.

Instructions:

1. Please fill in the space available and tick (✓) in the respective box.
2. All information will be treated as CONFIDENTIAL and shall be used for academic purposes only.
3. All the data information will be on aggregated basis and no individual data will be published.

Do you think these factors are contributing of BIM towards the minimization of violation safety issues in building project?						
No	**Factors contribution**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1.	**Space program inspection** (Finding unallocated area and arrangement)					
2	**Clash elements inspection** (Removing duplicated elements)					
3	**Deficient elements inspection** (Modelling revision)					
4	**Collision inspection** (Securing enough space)					
5	**Inspection for falls** (Adding safeguards)					
6	**Inspection for fires** (Securing firewalls and evacuation routes)					
7	**Health accidents inspection** (Securing MEP safety)					
8	**Preliminary cost estimation** (Effective budget planning)					
9	**Excavation simulation** (Planning work period and path)					
10	**Concrete deposition simulation** (Concrete QTO calculation and deposition plan)					
11	**Fabrication simulation** (Steel pipe cutting and welding)					

Questionnaire Form

QUESTIONNAIRE

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Instructions:

1. Please fill in the space available and tick (✓) in the respective box.
2. All information will be treated as CONFIDENTIAL and shall be used for academic purposes only.
3. All the data information will be on aggregated basis and no individual data will be published.

SECTION A: RESPONDENT'S PARTICULARS

Instruction: Please write or place a tick (✓) at the space provided below.

1. Gender: ☐ Male ☐ Female

2. Age: ☐ 20-25 ☐ 26-30 ☐ 31-35
   ☐ 36-40 ☐ 41 and above

3. Company's specialization:
   ☐ Construction ☐ Consultant ☐ Architecture

4. Position in the company:
   ☐ Engineer ☐ Project Manager ☐ BIM Modeller

   ☐ Contractor ☐ Architect ☐ Safety Officer

5. Working duration in current company:
   ☐ 1-10 years ☐ 11-20years ☐ 21 years and above

6. How much do you know about BIM's software?

No significant	1	2	3	4	5	Very significant

SECTION B: FACTORS AND IMPORTANCES OF CONTROLLING THE VIOLATION ISSUES USING BIM

Instruction: Based on your knowledge and your opinion, please tick (✓) at the provided box below.

Part 1: Factors contributing of BIM on minimization of safety issue

Please answer the following question with 1. "Strongly Disagree" 2. "Disagree" 3. "Neutral" 4. "Agree" 5. "Strongly Disagree"

Do you think these factors are contributing of BIM towards the minimization of violation safety issues in building project?						
No	**Factors contribution**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1.	**Space program inspection** (Finding unallocated area and arrangement)					
2	**Clash elements inspection** (Removing duplicated elements)					
3	**Deficient elements inspection** (Modelling revision)					
4	**Collision inspection** (Securing enough space)					
5	**Inspection for falls** (Adding safeguards)					
6	**Inspection for fires** (Securing firewalls and evacuation routes)					
7	**Health accidents inspection** (Securing MEP safety)					
8	**Preliminary cost estimation** (Effective budget planning)					
9	**Excavation simulation** (Planning work period and path)					
10	**Concrete deposition simulation** (Concrete QTO calculation and deposition plan)					
11	**Fabrication simulation** (Steel pipe cutting and welding)					

Part 2: Importance of controlling the violation of safety rules using BIM

Please answer the following question with 1. “Strongly Disagree” 2. “Disagree” 3. “Neutral” 4. “Agree” 5. “Strongly Disagree”

Do you think these factors are important in contributing of BIM towards the minimization of violation safety issues in building project?						
No	**Statement**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1.	Prepare a clear, comprehensive, and practicable safe construction plan					
2	Having a good, practical and communication of safety with all stakeholders					
3	Create a good relationship between stakeholders					
4	Using authorized or qualified equipment.					
5	Doing safety inspection by safety specialist frequently.					
6	Can measured the safety risk through modelling					
7	Provide an early identification during design phase					
8	Developed an automatic inspect 3D models					
9	Produce a complete schedule and cost estimation in design phases					
10	Provide an effective safety planning					
11	Provide site hazard prevention and safe project delivery					

SECTION C: RESPOND FOR THE IMPLEMENTATION OF THE BIM ON THE VIOLATION OF SAFETY RULES

Instruction: Please specify your answers at the space provided below.

1. Can you explain your background and your exposure towards BIM?

2. What is your opinion towards BIM implementation on the violation safety rules?

3. What do you think are the possible barriers of BIM towards the minimization of violation safety rules?