



Implementation, Challenges and Opportunities in 8D BIM for Safety and Health of Oil and Gas Industry (Gas Station)

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Implementation, challenges and opportunities in 8D BIM for safety and health of oil and gas industry (Gas Station)

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Abstract. 8-Dimension Building Information Modelling (8D BIM) is a modern technology used in the construction industry which works as a tool to manage the physical and functional characteristics in the form of digital representation for safety and health parameter. However, recent studies for 8D BIM show that the application and execution of this technology are still low for most sectors, including the oil and gas industry. The literature review shows the evaluation of the previous study on 8D BIM. The survey questionnaire illustrates the analysis using SPSS with three tests: frequency, chi-square, and cross-tabulation. 3D modelling of a gas station displays an oil and gas industry building. From the survey questionnaire, it is found that 52% of respondents agree that the safety and health in construction are low in Malaysia. The top 3 challenges in implementing 8D BIM are lack of enforcement, complex BIM software, and lack of training programs. 3D model of the gas station. The benefit of 8D BIM based on questionnaires is it can improve coordination and communication. The challenges and opportunities obtained from the result significantly impact the collaboration of training and software between the academic field and industry.

1. Introduction

In construction, new technologies are evolving fast to keep up with the times. New work-flows are replacing traditional ones. Construction is noted for its sophisticated methodologies and processes. AEC (Architecture, Engineering, and Construction) is a modern construction sector. These three key sectors are segregated since they're unrelated. When building technology progress, Architecture, Engineering, and Construction are integrated to benefit the modern construction business [15].

In AEC Sector, one of the method and tools used to assist the 3 main sector is BIM. Building Information Modelling is a process of creating intelligent 3D model that replaces a 2D sketch model, enabling document management, coordination, and simulation throughout the life of the project [6][20]. The technology aims to form and manage information of the building's life cycle [9] [17][18]. Building Information Modelling method is divided subsequently into many dimensions. The dimension of BIM shows the level of information and data needed with the aid of 3D model using modelling software such as AutoCAD, Revit, Civil 3D and Navisworks. Currently, there are 8

dimensions of BIM with each dimension focuses on different information in a project. For this thesis, 8th Dimension is utilized which consist of safety and health parameter. This dimension adds safety information to the geometric model of the building throughout the design and execution stages. The construction industry's occurrence rate for workplace injuries has continuously stayed at nearly twice that of all other sectors [1]. The purpose of utilizing 8D BIM is to have an overall image of the building site already at the planning stage in order to eliminate probable dangers and hazards for employees [12]. Many construction sectors use Building Information Modelling (BIM) for its orderly flow and new emerging technologies that can reduce cost and time. Oil and gas industry is regarded for safety and health competence [EY]. This industry prioritizes worker safety and building design. Before entering the oil and gas business, workers need training.

Petronas, Shell, Esso, Caltex, and ExxonMobil design and build gas stations in Malaysia. Each company's general laborer, project manager, engineer, architect, and safety officer have various safety rules. Oil & gas sector developed a gas station to supply vehicle fuel and lubricants [19]. In Malaysia, gas stations sell petrol and diesel and their construction require high safety requirements. This is due to the significant risk of toxic compounds during construction [14]. Implementing BIM in oil and gas industry will further enhance and upgrade the safety and health parameter.

2. Methodology

Research methodology is a technique or practise used in a journal, report, or thesis to determine a study's result. In this thesis, a mixed method is used to further understand and identify the three main elements used for this thesis which are implementation, challenges, and opportunities. Mixed method is an emergent and integration of different methods in which it produces either single or many outcomes. This thesis uses mixed method research as a technique in collecting and presenting the data. There are 3 methods used which are literature review, survey questionnaire, and 3D modelling. Each method is different in term of collecting and representing data but similar in term of functionality which is to produce a final result for this thesis.

2.1. Literature Review

For this method, there are 10 main journals used for this thesis. The journals are collected from a well-established publisher such as ScienceDirect, Springer Link, and Research Gate. Each journal has its own functionality based on each what scope it focuses. The foundation to write the literature review consist of three main scope which are BIM in Oil and Gas Industry, 8D BIM for safety and health, and Safety Measurements in Gas Station Modelling. By conducting a literature review, a more detailed understanding is achieved as it consists a variation of previous studies regarding the topic and scope.

2.2. Survey Questionnaire

Survey questionnaire comes in many forms either made via online or physical. This thesis uses online survey questionnaire because it can reach people easily with the help of online platform and gives the flexibility to the respondents to answer the form. There is one questionnaire constructed which is the industrial survey questionnaire. Similar to Al-Ashmori et al. (2020), this survey questionnaire is used to fulfil the objective of this research paper which is to implement the BIM system in construction industry.

2.3. Sampling Technique

Sampling technique is used to select either individual or subset of a population to produce a statistical inference. Different sampling technique have different population target. Sampling technique is a cost-effective and time-convenient as it helps researchers to develop a systematic approach to the

respondents. There are two characteristics of sampling which are probability and non-probability sampling. Sampling helps in determining the accuracy of data that can be used as results [3]. Sampling techniques can be done in a software for optimum result

2.3.1. Systematic Sampling

Systematic sampling is a technique used to select a member of a population at any regular intervals. This type of sampling allows researchers to save time because it has a predefined range [5]. For this thesis, systematic sampling is done for industrial survey. It is known that industry uses a quite similar requirements when it comes to safety. Hence, this sampling technique is used to represent the industry

2.4. Data Analysis

Data analysis is important in producing a good result for research. For this research, survey questionnaire needs to undergo data analysis because it needs to further interpreted with statistics. SPSS (Statistical Package for Social Science) is a software used to analyse the result from the questionnaire. SPSS enables users especially beginners to analyse and develop a result using the tests provided by the software. For the analysis of questionnaire, there are 3 tests will be used in providing a statistical data which are frequency test, chi-square test, and cross tabulation test.

2.4.1. Frequency Test

Frequency test is a test of uniformity. It measures the number of occurrences in each variable of distinct classifications and groups. This test compares any sample and produces ranges and limitations [13]. Frequency test format is easy to understand and organized raw data.

2.4.2. Chi-Square Test

Chi-Square Test is a statistical hypothesis test to determine the significance of statistical difference between an observed frequency and the expected frequency in either one or more categories [10]. It analyses the statistics when the test statistic is chi-squared distributed under the null hypothesis. There are 2 advantages in using this test which are the detailed information can be produced and derived from the test and it is easier to compute compared to other statistic test.

2.4.3. Cross Tabulation Test

Cross Tabulation Test is a method to analyze the relationship between many variables and to identify the categorized data [11]. This type of statistical test allows researchers to perform a precise and impactful result from a large population sample. Due to the classification variables are typically nominal or character variables rather than numeric or integer variables in the actual world, these variables were changed to numeric before the crosstabulation programs began. This test aids in determining how correlations, such as trends, patterns, and probabilities, alter when raw data is passed from one variable grouping to the next variable.

2.5. 3D Modelling

The third method used in this thesis is 3D modelling. BIM uses virtual modelling in which it is created by using computer software such as AutoCAD, Navisworks, and BIM360. The software used for this research is Autodesk Revit. Revit can give a clear representation on 3D Modelling of BIM [16]. Gas station is chosen for 3D modelling in oil and gas sector as it is easier to design and gives better representation of a commercial building than any other building. In Revit, safety measurements and requirements are inserted and tagged to provide an understanding to 8D BIM in a construction project.

3. Results and Discussions

This section includes the findings from the survey questionnaire and 3D modelling stated in the preceding chapter. Online survey platform JotForm was used to collect and manage data for the survey questions. Data is analysed via IBM SPSS. Approximately, 50 industrial respondents of varying ages and backgrounds complete the questionnaire out of 100 sample size. Construction and oil and gas industry workers were surveyed. The gas station building is modelled in Autodesk Revit. With existing drawings as a guide, the gas station modelling uses the 8th dimension of BIM which is the safety and health considerations. The safety and health tags are placed prior to the civil engineering job breakdown structure. Figure below shows the profession of respondents by percentage for companies in oil and gas industry

Table 1. Profession of Respondents

Profession	Frequency	Percent (%)
Architect	4	8.0
Chemical Engineer	3	6.0
Civil Engineer	11	22.0
Contractor	11	22.0
Manufacturer	1	2.0
Mechanical & Electrical	10	20.0
Petroleum Engineer	9	18.0

3.1. Survey Questionnaire

Online form survey data is analysed. This analysis uses frequency, crosstabulation, and chi-square. Friedman Rank Test is used for multiple-choice questions. Statistical tests are helpful for analysing data. The test also reveals underlying patterns and tendencies. This survey has 5 sections focusing on different parameters. The key findings from questionnaire are shown in figure below.

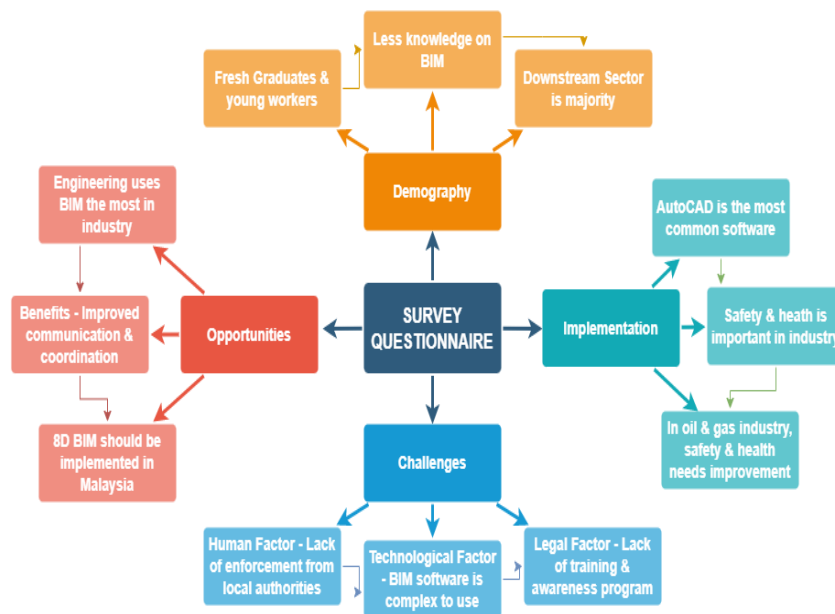


Figure 1. Key Findings in Survey Questionnaire

Based on the mind map above, most young graduates and workers don't know about BIM. Lack of BIM industry and project experience. Adding more experienced oil and gas personnel as respondents can improve the survey questionnaire. BIM implementation is difficult. According to questionnaire results, there are 3 most challenging factors. Local authorities don't enforce BIM, making it impossible to adopt. Technologically, BIM software is difficult to utilise. Respondents have less than 5 years of experience, thus they may connect to technology challenges. Experienced personnel won't find this problem difficult because they already know most BIM software. Legally, a lack of training and awareness programmes hinders BIM implementation. Few university or corporate programmes can produce and spread BIM for safety and health (8D BIM).

Despite all of the challenges in implementing BIM in oil and gas industry, there are many benefits that can be used as a stimulus and inspiration to further implement the BIM system. The main benefit resulted from the survey questionnaire is BIM can improve communication and coordination between construction parties. This is because BIM software can detect the collision between elements and coordinate with efficient the project's workflow, and in this case, the safety measures in a construction project.

3.2. 3D Modelling

The second part of the result is producing 3D modelling of respected building by referring the third objective of thesis. The modelling is done by using Autodesk Revit version 2022. Revit is one of the famous BIM software and had been widely used in both industry and academic. It can also undergo interoperability among other BIM software, not only with Autodesk, but other software as well. Figures below show the overall safety tagging used in the gas station modelling and one of the examples of safety tagging in a component.

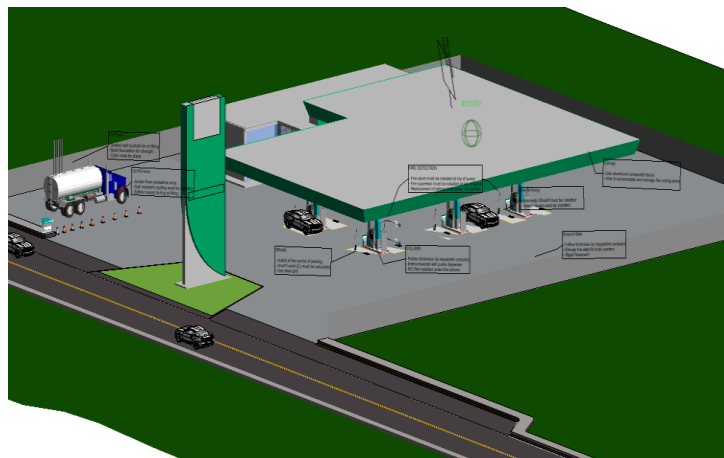


Figure 3. Safety Tagging of Gas Station Using Revit

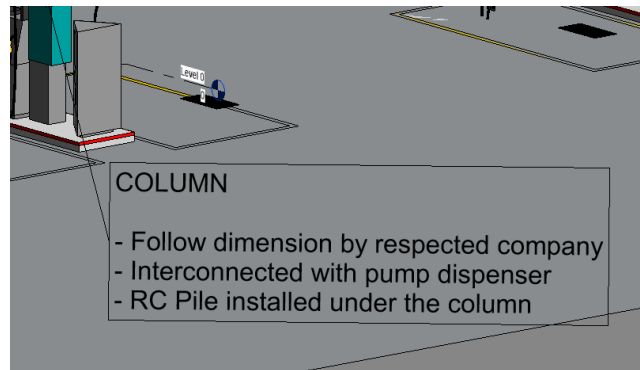


Figure 4. Component in Safety Tagging of Gas Station

In this thesis, 3D modelling of a gas station has been done and key findings are found during the process and the result of modelling. Basically, 3D modelling helps in visualising the drawing and design into a more presentable format. Information and data also can be enhanced through modelling. There are many software in BIM that can be used in industry and this thesis uses Revit for modelling. Figure below shows the key findings in 3D modelling.

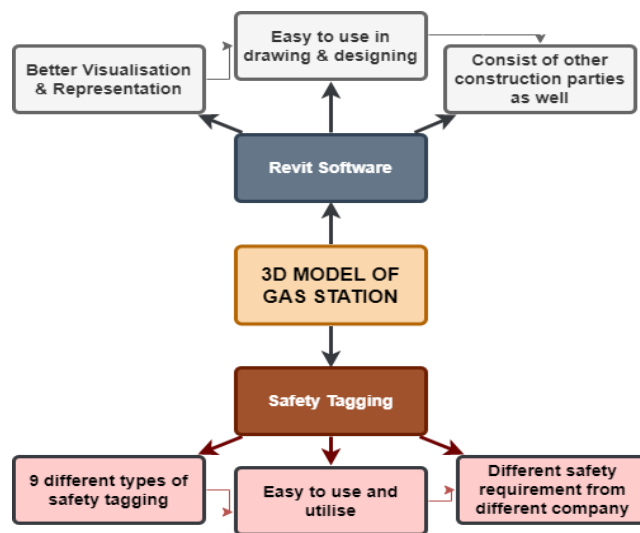


Figure 5. Key Findings in 3D Modelling

4. Conclusion and Recommendations

In conclusion, the implementation of 8D BIM of oil and gas industry in Malaysia is still low and it require attention from both industry and academic. Figure bellow shows the summary of findings based on objectives of the thesis.

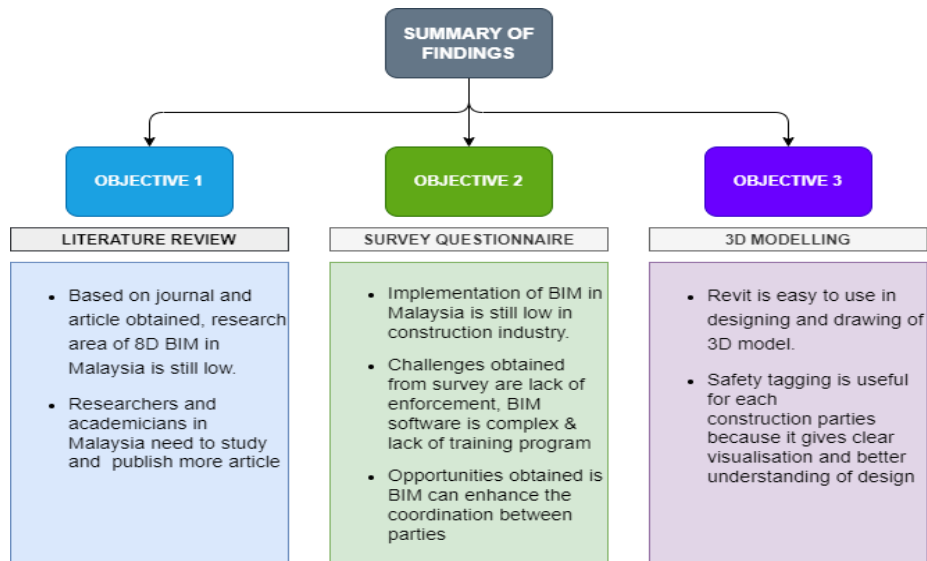


Figure 5. Summary of Findings

This thesis makes 3 recommendations on how to improve future study. First, interview some responders about BIM in Malaysia's oil and gas business. By interviewing, we can better engage respondents and provide a result that helps comprehend BIM. Second, industry and academia should collaborate. This includes journal article writing and oil and gas industry updates. This will enhance both sides' adoption of 8D BIM. The final recommendation for this thesis is to expand the respondent's demographic to include the construction industry. This will enhance the BIM usage in terms of software and utilisation across the construction industry.

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