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Challenges and Drivers of BIM Implementation in Sarawak Construction Industry

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Abstract: Building Information Modelling (BIM) is a process established to enhance the construction project efficiency. It has been used in Malaysia and globally especially in the construction sectors. There has been a gradual acceptance of Malaysia construction industry stakeholders especially in the Peninsular in the uptake of BIM implementation. However, in Sarawak itself, this point turns out to be much more burdensome as the development projects in the state turns out to be more branched out and complex. Research shows on BIM uptake in Sarawak and Sabah lagging at a low 6% as compared to Peninsular of 78% in the central region only. Thus, this research objectives are to investigate the challenges faced by industry stakeholders in implementing BIM and also to explore on the drivers that increases the usage of BIM Sarawak construction industry. The virtual semi-structured interview sessions target the policy makers such as Public Works Department (JKR) and contractors from G6 to G7 in Kuching, Sarawak. The data obtained will be analysed using a qualitative content analysis technique supported by matrix table method. The challenges to BIM implementation are lack of readiness in BIM implementation, lack of manpower and special equipment's for BIM and lastly, BIM training, courses and software are costly. The driving factors of the BIM implementations are to improve organizations collaboration, to boost and enhance company capability in technology and mandatory rule imposed by the government to implement BIM. This research is significant to spearhead initiatives by tackling the challenges and generate better driving factors for BIM implementations especially in Sarawak construction industry.

INTRODUCTION

The arrival of the fourth industrial revolution or IR 4.0 has significantly risen the transformation in the construction industry. The industry will adjust more digitally in a progressive trade. However, the construction sector is still in the slow phase compared to other industries and IR 4.0 is still in its premature phases in terms of the automation of progressions and the level of digitalization in construction [1]. Building Information Modelling (BIM) is one of the technologies used as a tool in the construction industry and it has also evolved with the IR 4.0.

BIM is one of the processes highly emphasised in Malaysian construction industry. Exposure of BIM in Malaysia was executed by Public Work Department (PWD) since the year 2007. Malaysia is a fast-developing country, and the Malaysian Government recognizes and encourages the usage of BIM alongside supporting the visions of the Construction Industry Development Board (CIDB) on BIM implementations in the national construction industry [2]. Implementations of BIM in Peninsular Malaysia are known to be above average but in Sarawak, it is still below average even though it is considered a fast development state [3]. In the state of Sarawak, even though the construction sector has gradually diversified and grown, the level of BIM implementation is still below the satisfaction level [4].

The low satisfaction level of BIM implementation in Sarawak can be caused by several challenges in adopting this advanced technology. Among the challenges that cause the low implementation level of BIM in Sarawak and among the listed challenges are the high cost of BIM implementations, high cost of maintenance and technical support issues, difficulties in the employment of skilled BIM manpower and lack of national BIM Guidelines and Standard [5].

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Previous research papers stated that implementations of BIM in Peninsular Malaysia are known to be above average but in Sarawak it is still below average even though it is considered a fast development state [6]. The objectives of this research are to investigate the challenges and unravel what are the drivers that encourage the usage of BIM in Kuching, Sarawak construction industry. The targeted respondents are policy-makers such as Public Works Department (JKR) and contractors from Grade 6 to 7. This research is to be conducted specifically in Kuching district in the Sarawak state. The location of research was chosen because the district's construction industry exposure to BIM is still at an early level.

BIM IMPLEMENTATION IN MALAYSIAN CONSTRUCTION INDUSTRY

The Malaysian construction sector is one of the least digitized industries in the country. It is still catching up on digitalizing existing processes that include data collection, communication, and collaboration [7]. The Malaysian government, according to some research reports, encourages construction players to use BIM in their construction projects because it can solve construction problems such as delays, design clashes among various professionals and overrunning construction costs [2].

In the state of Sarawak, the government is encouraging all stakeholders to move forward in line with Industry Revolution 4.0. The mindfulness level of BIM is gaining momentum; however, the application of related software in the Sarawak construction industry is still very low, where the uppermost mean is for "BIM- ArchiCAD" and the lowermost mean is for "BIM TEKLA structure". JKR Sarawak has established the BIM Transformation Strategy in order to boost and achieve the target of BIM implementation in Sarawak's construction industry. Their organizations collaborated with CIDB to formulate a Memorandum of Understanding (MoU) for BIM training. This memorandum's key collaboration includes upskilling existing manpower and also the conversion of 2D to 3D in their work processes [3].

CHALLENGES OF BIM IMPLEMENTATION IN MALAYSIAN CONSTRUCTION INDUSTRY

Among the top 5 most challenging BIM adoptions in which are Malaysia staff resistance, selection of software and hardware, lack of knowledge and information of BIM and lack of data on investment in BIM technology [8]. The issues and challenges faced by SMEs in adopting BIM in the construction industry in Malaysia are [9]:

i. The cost to implement BIM in the company is too high.
ii. The SME's contractors do not have the technology (hardware and software) and capability to implement BIM.
iii. BIM is a new tool that many have little or no knowledge about it.
iv. The in-house technical staff are not ready to be trained.
v. Readiness to change from traditional to BIM requires a high cost of investment and a clear consensus on how to implement and use BIM.

In any event, present BIM practice in Sarawak state shows that construction professionals are not fully using BIM in the construction business, and in ongoing development projects that use BIM, most capacities are still being used, which increases the risk of errors and reduces the effectiveness [5]. The high investment cost of BIM technology is also one of the reasons why they are not interested in this technology [8]. T can be seen that more efforts are needed for both government and construction firms themselves to successfully transition to BIM. Furthermore, the transition to BIM has been difficult, indicating that steps must be taken to facilitate this transition and make the process easier and more efficient [3].

DRIVERS OF BIM IMPLEMENTATION IN MALAYSIAN CONSTRUCTION INDUSTRY

From the perspective of the government, the most important approach that can be applied is the mandatory implementation of BIM by the government, which will help increase the interest of AEC companies to implement BIM [2]. Visualizing project information through a BIM model perhaps cultivates more understanding amongst estimators in developing more accurate and reliable cost estimates.

The process is further enhanced by the assistance of a BIM reliable database and coordinated data to make the process more effective. With the BIM model prototyping the actual building design and construction views, it could generate sufficient information needed by the users. Additionally, the coordinated data from the BIM mechanism possibly accommodate a better platform for all disciplines in the project team to share and integrate information throughout the project cycle. Therefore, it creates a more interactive environment for achieving the goal of inaugurating more reliable information among the stakeholders [10].

Research Gap Analysis

The research gap from Table 1 shows that most past research was focused on construction players but not the government or policy maker's perspectives.

TABLE 1. Research gap analysis

No	Author	Title and Year of Publication	Findings
1	Zaini et al. [11]	Implementation of Building Information Modelling (BIM) in Sarawak construction industry: A review (2020)	Reveals the top ten (10) ranking of BIM awareness, BIM benefits, BIM challenges and BIM strategies for the industry player to implement and adopt BIM in the Sarawak construction industry.
2	Yii et al. [5]	Barriers in adopting Building Information Modelling (BIM) among construction players in Sarawak (2019)	The construction industry subjects itself to a great deal of risk by investing time and money in BIM, during the economic recession.
3	Othman et al. [12]	The level of Building Information Modelling (BIM) implementation in Malaysia (2020)	BIM implementation in Malaysia in both private and public construction sectors is still at a very low level. The most surveyed organizations are not using BIM and the team is not practicing its concept which causes the delay in BIM implementation.
4	Ibrahim et al. [13]	The barriers factors and driving forces for BIM implementation in Malaysian AEC companies (2019)	Driven forces to overcome the BIM implementation issues, proper BIM guidelines or standard for BIM requirement has been identified as a crucial factor for successful implementation. Furthermore, BIM Fund also has been found as one of the driving forces for successful BIM implementation.
5	Babatunde et al. [14]	Comparative analysis of drivers to BIM adoption among AEC firms in developing countries: A case of Nigeria. (2020)	The findings from factor analysis categorized the identified drivers into two major factors to include: cost and time savings, improved communication; and BIM awareness and government supports.
6	Al-Zwainy et al. [15]	Diagnostic and assessment benefits and barriers of BIM in construction project management (2017)	The results were discussed in a Facebook global group, and many agreed that the findings do not represent the level of BIM adoption in the Middle East, as they are acceptable for a slowly-developing country such as Iraq.
7	Gamil et al. [16]	Awareness and challenges of Building Information Modelling (BIM) implementation in the Yemen construction industry (2019)	The results show that the most critical challenges to adopting BIM are financial restrictions, lack of BIM knowledge, improper introduction of BIM concepts, lack of awareness of BIM benefits and no governmental enforcement.
8	Rodgers et al. [17]	Building Information Modelling (BIM) within the Australian construction related small and medium-sized enterprises: Awareness, practices and drivers (2016)	The most influential drivers for BIM turned out to be all associated with economic gains for the business of the companies alongside clients' demands. Furthermore, it was revealed that practices associated with BIM and awareness of BIM are similar across different sizes of SMEs.

This results in most of the research found highlights mostly on awareness, barriers and drivers of BIM implementation among construction players such as contractors, AEC companies and related small and medium-sized enterprises (SMEs). Besides, it is also found that another research gap is lack of the research on investigating drivers in BIM implementation among construction players and policy makers in Sarawak being compared to other countries' research.

METHODOLOGY

Research methodology is the specific procedures or techniques used to identify, select, process, and analyse information about a topic. The methodology comprises the flow chart of the research. It is essential to let the research be critically evaluated for overall validity and reliability. Figure 1 explains the flow chart of the research methodology.

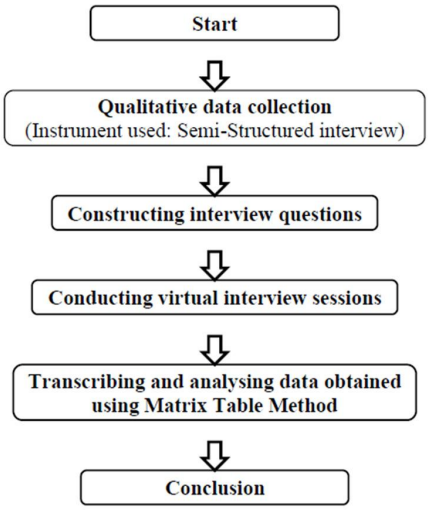

FIGURE 1. Research methodology flow chart

Qualitative Approach

This research instrument uses a qualitative approach where it is suitable as it comprises of data assortment and study of non-numerical statistics or information to comprehend notions, views and experiences.

Semi-Structured Interview

This research involved semi-structured interviews via virtual meetings or e-mail invitations. The interview questions were established mainly from sources and references to previous research. This method is much easier and provides flexibility to accommodate hours since some people are working from home nowadays.

Population and Sampling

In this research, the target population for the qualitative approaches was those who are involved in the Sarawak construction industry regardless of whether they implemented BIM or not. The sampled population was divided into three categories, which are policy makers, G6 contractors and G7 contractors in Sarawak. Amongst the respondents, the policy makers were the top management personnel in the Public Works Department (JKR) of Kuching branch. Policy maker is selected as one of the respondents due to their vital role in the construction hierarchy and their participation represents the government perspectives. At the same time, the contractors in grade 6 (G6) and grade 7 (G7) were also selected for the sample population as they are prominent or most likely to adapt BIM in construction projects. Currently, the number of Grade 6 contractors based on the CIDB CIMS portal is 99 and Grade 7 contractors are 511.

Data Collection

The interview questions were established mainly from sources and referring to previous research. This method is much easier and suites the time flexibility as now some people are working from home. The interviews will be conducted part by part according to the sections of questions such as Part A: Demographical data, Part B: BIM Challenges and lastly, Part C: BIM Drivers. The data were then transcribed and analyzed using Matrix Table. With the collected results, literature review, and previous research as references, the objectives are attained.

Data Analysis

The data analysis method used in this research is qualitative content analysis. It addresses a precise and objective method for portraying and evaluating peculiarities as a research strategy. This method enhances the execution of research to achieve the objectives and helps better comprehension of BIM implementation in Sarawak construction industry. The data obtained from the semi-structured interview by sections of questions will be

analyzed using Matrix Table. This is a tool that arranges the data accordingly and systematically by making it easier to search or make a summary of the data.

RESULTS AND DISCUSSIONS

This section outlines the finding and discussion of the challenges, and drivers of BIM implementation of the contractor and policy maker in Kuching, Sarawak's construction industry. In this research, the source of information is obtained through semi-structured interviews as clarified in the methodology section. Most of the semi-structured interviews were done through the online platform and only one submitted a response by filling in the interview question form.

Background of Respondents

The respondents obtained for this research were divided into three organizations which are G6 contractors, G7 contractors and JKR Sarawak. The following respondents represent their organization consisting of executive and non-executive positions such as Managing Director, Project Engineer, Civil & Structural (C&S) Engineer, Architect and BIM modeler. The details of the respondents are shown in Table 2. The interview respondents consist of three target populations which are the policy maker, G6 contractors and G7 contractors. Respondent R1 is policy maker who was represented by an architect from JKR Sarawak and in charge of handling BIM projects in JKR Sarawak. Respondents R2 and R3 are C&S engineer and BIM modeller respectively from G7 contractors' organisations who are implementing BIM in Sarawak. Both Respondents R4 and R5 were represented by Managing Director whereas Respondent R6 was represented by a project engineer. For Respondents R4, R5 and R6, these organisations have no relevant experience in BIM due to a lack of awareness of BIM implementation in their organization. Therefore, the variety of respondents' background is appropriate to attain the research intention and objectives.

TABLE 2. Respondent's information

Respondent	Organization	Grade	Company Name	Designation	Experience in BIM (years)
R1	Policy maker	-	JKR Sarawak	Architect (Building branch- Building sector)	5
R2	Contractor	G7	Empayar Setia Sdn. Bhd.	C&S Engineer	3
R3	Contractor	G7	Uptrend Technology Sdn. Bhd.	BIM Modeller	1
R4	Contractor	G7	Kurnia Technology Resources Sdn. Bhd.	Managing Director	0
R5	Contractor	G6	KH Communication Sdn Bhd	Managing Director	0
R6	Contractor	G6	Depaul Commerce Sdn. Bhd.	Project Engineer	0

Challenges of BIM Implementations in Sarawak Construction Industry

The following sections discuss more the challenges of implementing BIM in the respondent's organizations and how they were addressed. Table 3 elaborates the challenges faced by the respondent's organizations in BIM implementation in Sarawak construction industry.

Based on the respondent's feedback on challenges, there are 10 challenges combined obtained regarding BIM implementations in their organizations. From the table summary, there are three challenges obtained 100% similarity agreed by all respondents which are lack of readiness in BIM implementation, lack of manpower and special equipment for BIM and lastly, BIM training, courses and software are costly. This is supported by Marzouk et al. [18] that stated low understanding of the aspects of BIM implementation, low IT-literate practitioners, as well as lack of proper knowledge of BIM aspects and high cost of implementation are among the challenges in BIM implementation. Respondent R4 (17% of total respondents) noted that there is no user-friendly BIM software, as it required special operation skills to operate and not everyone can master complicated things. I require more time to develop operation skills in BIM-related software.

TABLE 3. Challenges of BIM implementation

Description	Respondents						Percentage
	R1	R2	R3	R4	R5	R6	
BIM training, courses and software are costly	√	√	√	√	√	√	**100%**
BIM training and courses are limited to some specified quota	√			√			33%
BIM software are not user-friendly				√			17%
Lack of manpower and special equipment for BIM	√	√	√	√	√	√	**100%**
Lack of exposure in BIM implementation				√	√	√	50%
Lack of readiness in BIM implementation	√	√	√	√	√	√	**100%**
Lack of revenue to implement BIM	√			√	√	√	67%
Reception from contractor is unfavourable	√		√	√	√	√	83%
Perception of BIM best suited for consultants only	√	√		√	√	√	83%
Preference of conventional way in construction method	√			√	√	√	67%

Respondents R1, R3, R4, R5 and R6 (representing 83% of total respondents) agreed on BIM challenges that "Reception from the contractor is unfavourable'. It is supported by another challenge obtained from respondents R1, R2, R4, R5 and R6 that the perception of BIM about BIM is best suited for consultants only. It is because the consultants are those primarily involved in the design stages, which leads to the unfavourable use of BIM by contractors.

Drivers of BIM Implementation in Sarawak Construction Industry

This section provides a detailed explanation of the drivers for enhanced BIM implementation in respondent organizations. Table 4 shows the drivers including the future collaborations to enhance BIM implementation in Sarawak construction industry.

TABLE 4. Drivers of BIM implementations

Respondent	Drivers of BIM Implementation
R1	• Shifting everchanging technology contributes to the drivers of BIM implementation. • Collaboration with CIDB HQ and ABM Sarawak to create and improve the training modules. • To achieve goals of 5-year road map in implementing BIM fully in project delivery.
R2	vi. To boost and enhance company capability in technology.
R3	vii. To improve BIM collaboration with other companies.
R4	viii. Mandatory rule imposed by the government to implement BIM.
R5	ix. Collaboration with other party that requires BIM implementation.
R6	x. Increasing number of staffs with BIM knowledge and capability.

It is obtained that there are three main drivers that most of the respondents mentioned in BIM implementations. Among the drivers are to boost and enhance company capability in technology, to improve BIM collaboration with other companies and mandatory rule imposed by the government to implement BIM.

Based on Table 4, Respondents R1 had a better drive for BIM implementation, as these organizations expressed their willingness to improve their company's competitive capability in the industry in order to keep up with current technology in the construction industry and current market trends. Respondent R2 stated their organization has not implemented a full BIM process. The driver to implement BIM in their organization is the intention to boost and enhance their organization's capability in technology by ensuring keep up with the current technology like BIM. It will be the main target of their organization in the next 5 years. Respondent R2 also added that the BIM training and course have been conducted in their organizations through a BIM consultancy company. Furthermore, Respondent R3

had fully implemented BIM to improve the collaboration among project stakeholders in their project delivery. This also ensures more BIM collaboration takes place in the future of their company's engagement. This also means anticipating with BIM tools such as enabling file sharing data which enhance a time-wise process in their project's delivery.

Respondents R4 and R5 indicated that these organizations would implement BIM if only the government mandated BIM in the project delivery. Respondent R6 said they would work on BIM implementation if they obtained more staff or absorbed any graduates with BIM knowledge. Government interventions, academics, and researchers are likely to play a huge role in educating and raising awareness of the importance of BIM implementation among undergraduate and postgraduate students in related fields in higher education [13]. The biggest driver of BIM implementation cited by all respondents was primarily to improve their organization's construction performance, with others stating that they would implement BIM if it were mandated by construction policies.

Shortlisted Challenges and Drivers of BIM Implementation in Sarawak Construction Industry

Table 5 shows the shortlisted challenges and drivers as these statements were mostly supported and frequently mentioned by the respondents.

TABLE 5. Shortlisted challenges and drivers of BIM implementation

Challenges	Drivers
BIM training, courses and software are costly	To boost and enhance company capability in technology.
Lack of manpower and special equipment for BIM	To improve BIM collaboration with other companies.
Lack of readiness in BIM implementation	Mandatory rule imposed by the government to implement BIM.

There are three main challenges that all the respondents faced in BIM implementations. Among the challenges is lack of readiness in BIM implementation, lack of manpower and special equipment for BIM and lastly, high initial cost for BIM training, courses and software.

Most respondents were challenged by a lack of readiness for BIM implementation, as these organizations lacked BIM knowledge and were not ready to convert current methods to new ones. This was supported by Anuar & Abidin [19] as their research found that lack of readiness for BIM implementation is the reason most organizations prefer traditional methods to BIM, which involves significant venture capital investment, and a reasonable consensus on how to carry out and utilize BIM.

The lack of manpower and special equipment is the second most challenging factor of BIM implementation. Some of the organizations have small revenue, therefore, they think that implementing BIM is not a wise option as they require BIM-capable staff and BIM is not required yet in their work delivery. AlMashjary et. al. [20] support the challenge which is lack of manpower in BIM implementation is due to requirements for more adjustments and changes related to the professionals' working patterns and routines.

BIM requires special equipment and data storage. Yii et. al. [5] utter the issues of leasing rather than possessing equipment and stressing over maintenance. It is centered around using new and not out-of-date equipment to upgrade the benefit of construction projects. Georgiadou [20] mentioned that BIM requires concentration in software and training just as the ability to run and operate software licenses, including mindfulness and knowledge for improved network safety. This is frequently tough because of the absence of resources, especially for SMEs.

Other challenges are existing BIM training, courses and software are costly. Zainal et. al. [11] utter those noticeable difficulties to the implementation of BIM relate to the high beginning expenses, absence of knowledge and training. This is also supported by Mohammad et. al. [8] that mentioned the cost of buying the appropriate programming and equipment just as the preparation that should be given to its staff obstruct the association from taking on BIM.

It is obtained that there are three main drivers that most of the respondents mentioned in BIM implementations. Among the drivers are to boost and enhance company capability in technology, improve BIM collaboration with other companies and mandatory rules imposed by the government to implement BIM.

To boost and enhance company capability in technology is one of the frequent drivers identified in this research. Latiffi et. al. [2] support this and mentioned that BIM implementation can increase the quality of projects. This is also supported by Al-Ashmori et. al. [21] as they mentioned BIM technology can improve productivity and efficiency, enhance constructability, minimize errors, and save time and cost.

To improve BIM collaboration with other companies is the second most frequent driver mentioned by the respondents. BIM is known as a great tool that increases collaboration in project delivery. This is supported by Georgiadou [20] and she mentioned that BIM's most noteworthy commitment is the capacity to refresh models continuously, take out conflicts, examine cycles from the get-go in the planning cycle and trade significant task data over the lifecycle. This empowers viable correspondence and compromise inside an association and with the different stakeholders involved.

The third frequent driver of BIM implementation is the mandatory rule imposed by the government to implement BIM. Government agency holds a vital role in making policy and standard guidelines in order to ensure the smoothness of BIM implementation. Al-Ashmori et. al. [21] mentioned that government arrangement is seen to be in accordance with the development partners' view of the worth acquired by the BIM execution. This is also supported by Zainal et. al. [11] who mentioned having solid government sustenance is vital to guaranteeing BIM is implemented in the construction industry.

CONCLUSION

In conclusion, the purposes of this study were to investigate the challenges faced by the Kuching, Sarawak construction industry stakeholders in implementing BIM and to explore the drivers that increase the usage of BIM in Kuching, Sarawak construction industry. There are various challenges obtained from the research. The three main challenges of BIM implementation are lack of readiness in BIM implementation, lack of manpower and special equipment for BIM and lastly, BIM training, courses and software are costly. The three main drivers of BIM implementation are to boost and enhance company capability in technology, to improve BIM collaboration with other companies and mandatory rules imposed by the government to implement BIM. These objectives were achieved and convey the challenges and drivers of BIM implementation in Kuching, Sarawak construction industry.

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