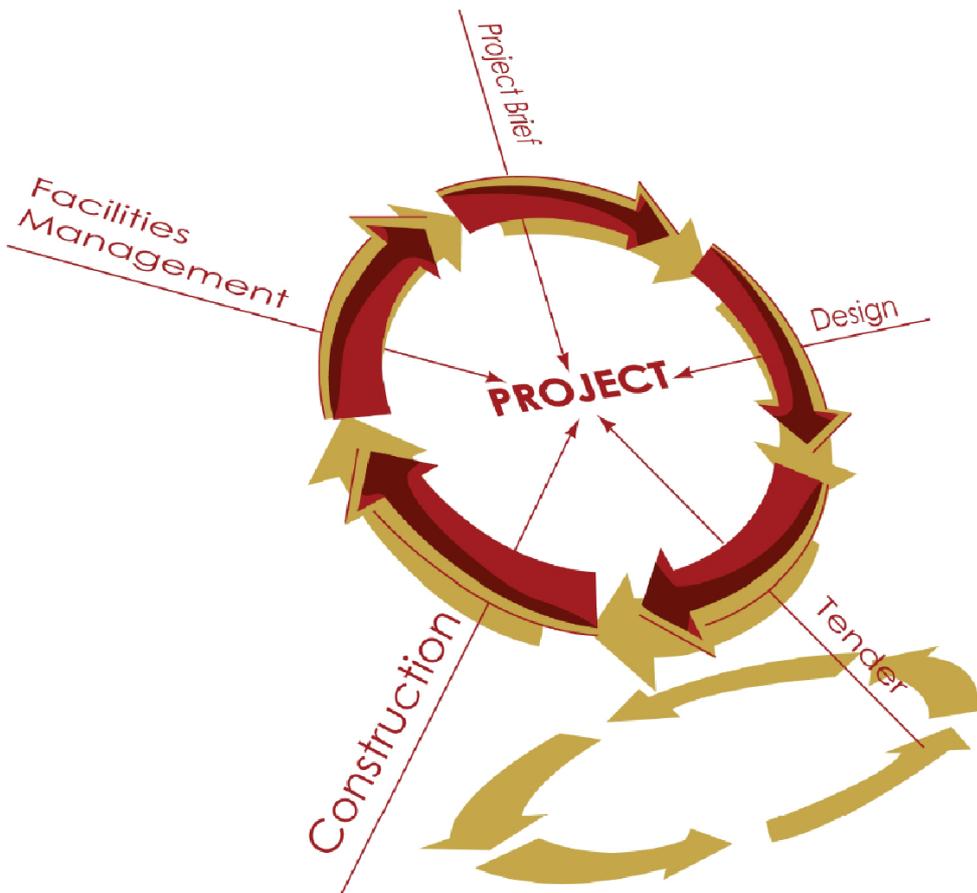


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Introduction

Welcome to this special issue in Malaysian Construction Research Journal (MCRJ) for the RISM Research Conference 2019 (RPgC1.0). This conference has been successfully organized by the Royal Institution of Surveyors Malaysia (RISM) and jointly with Faculty of Engineering and the Built Environment, SEGi University.

This Special Issues of MCRJ for the RPgC1.0 consists of 20 selected papers by conference scientific committee and expert reviewers. The conference having main theme as Future-Proofing QS Profession for Sustainable Built Environment with five (5) sub-theme: Construction Industry Revolution 4.0, Contract and Legal Matters, Sustainable Development, Retrofitting, Information Technology and QS Profession.

This special issue is consistent with the Construction Industry Transformation Plan agenda to gear the professional practices and sustain within the industry. Beside the practices, the discussion toward technology implemented and adopted which to in-line with the Construction Revolution 4.0 which Malaysia construction industry try to be coped with are also discussed in this special issue.

Hence, it is believed that these special issues may contribute to promoting QS profession and as professional practices in Malaysia to deliver the professionalism as well as to sustain in Malaysia construction industry. The aspect of the main concern should be taken by the QS Profession are highlighted thru the sub-theme. Therefore, one of the initiatives to publish with the Special Issues volume to shows that QS Profession are coping with the current construction issues as well as to contribute in enhancing knowledge among not only QS Profession also to the all construction players.

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Editorial

Welcome from the Editors

Welcome to this special issue in Malaysian Construction Research Journal (MCRJ) for the RISM Research Conference 2019 (RPgC 1.0). We would like to express our sincere gratitude to our contributing authors, reviewers, organizers and readers.

This Special Issues of MCRJ for the RPgC1.0 contains twenty (20) interesting papers covering the theme of “Future-Proofing QS Profession for Sustainable Built Environment” with five (5) sub-theme: Construction Industry Revolution 4.0, Contract and Legal Matters, Sustainable Development, Retrofitting, Information Technology and QS Profession. It is hoped that the readers would greatly benefit from the scientific content and quality of papers published in this issue:

Brief introduction of each article is given as hereunder:

Angela Ting Mee Yii et al., have explained about Building Information Modelling (BIM) influences on the common way of collaboration, including the roles of different participants. The research objective it's to identify a barrier to implementing Building Index Modelling among construction's practitioners in Sarawak. The methodology has been used for this study its quantitative where 300 sets of questionnaires has been set and distributing to 300 respondents from Kuching, Miri and Sibul. Perhaps, the outcomes of the research may answer the highlighted objectives and as well as the construction practitioners able to maintain and increase the contribution on construction industry in the Sarawak's state. Also, it's may help Sarawak's construction practitioners to fully gaining a benefit by implementing and using BIM into their project to be meeting the global need even the field of construction in Sarawak its niche.

Angela Ting Mee Yii et al., have discussed how Building Information Modelling (BIM) influences on the common way of collaboration, including the roles of different participants. The participation includes all the parties who involve in construction project during pre and post construction. The research objective it's to investigate the readiness in applying BIM concept among Quantity Surveyor in Sarawak. The methodology has been used for this study its quantitative where 292 sets of questionnaires has been set and distributing to 292 respondents whom practising Quantity Surveying as per record provided by the Board of Quantity Surveyor Malaysia. Perhaps, the outcomes of the research may answer the highlighted objectives and as well as the construction practitioners able to maintain and increase the contribution on construction industry in the Sarawak's state. Also, its may help Sarawak's construction practitioners to fully understanding the benefit by implementing and using BIM into their project to meeting the global need even the field of construction in Sarawak its niche also to let the Quantity Surveyor in Sarawak to fully utilise the concept of BIM in their daily task without affecting their professionalism.

Mashanim Mahazir and Hor Yong Jing, have presented on the Construction is a competitive, ever-changing, and challenging industry. Therefore, the majority of construction professionals suffer from occupational stress and there is no exception for the quantity surveyors. This study aims to summarize the effects of occupation stress currently being faced

by Quantity Surveyors in Malaysia. This could be done through achievement of the discovering the effects of occupational stresses towards the well-being of Quantity Surveyors. Besides, the research was carried out in two stages: extended literature review and questionnaire survey. A total of 61 questionnaires have been sent out. Descriptive analysis was used to analyse the findings. As a result, this research provides a clearer picture of the actual origins of the workplace stresses being experienced by Quantity Surveyors. Therefore, both authorities and individuals are able to develop better stress-coping strategies for the betterment of Quantity Surveyors.

Jafrey Hisham et al., have outlined about here are numerous considerations that present themselves to firms that plan to expand into foreign markets. Firms need to identify and map out the appropriate strategies for how it will plan its objectives, configure its growth and structure its procurement method. A firm also needs to understand how to leverage itself in new markets using its competitive advantages, in order to overcome issues that are faced in when venturing overseas. Therefore, this paper will to discuss the challenges faced by Quantity Surveying firms when expanding their business abroad. The structured questionnaire, which was derived from descriptive study of literature review are the two sources of methodology, used for this study. The research will focus on active Quantity Surveyors Consultant Practices that are registered with Board of Quantity Surveyor Malaysia (BQSM) and are situated within the Klang Valley. Data will be gathered through the use of an online questionnaire that will be sent to the sample size of 134 consultancies within the target population. The finding of this study aims to further the field of knowledge within this subject matter.

Myzatul Aishah Hj Kamarazaly et al., have presented about as the quantity surveyors begin their foray into the Fourth Industrial Revolution, there is a need to adapt to changing landscapes within the construction industry. The objectives of this research are; 1) To determine if the traditional QS is still relevant in the modern times and to explore the consequences of stagnation. 2) To discover the routes of evolution that the QS has taken as a profession so that future pathways may be established. 3) To establish a more wholistic, interdisciplinary role for the QS to play. This research was carried out qualitatively based on interviews which were based on readings and review of relevant literature in order to gauge the possible routes of expansion, and perceptions about evolution of the profession. The research yielded results favouring a need for the profession to create more avenues for satisfying clients' needs, through greater involvement in interdisciplinary project management, contracts administration, and whole life cycle costing with control, along with expansion into business minded strategic management of assets.

Azrina Md Yaakob et al., have analysed about the scare resources and the constant fighting of global warming, human has become eco-friendlier conscious and eco-oriented these days, where slogan "go green" is seen everywhere. There is no exception for the construction industry. With the rising of green building ratings, many countries are trying to promote sustainable building development that provide better healthier living environment. To achieve this, technology is always brought in to achieve the desired outcome. Hence, BIM is the right platform that provides such features and capabilities that will enhance the process of the project throughout its cycle. This paper seeks to explore the capabilities and benefits of BIM for sustainable building development in the perspective of quantity surveyor. Where

quantity surveyor plays an important role especially in cost relating matters, and how BIM deliver its features and capabilities relating to this job scope of a quantity surveyor.

Lam Tatt Soon et al., have showed about the 3D modelling is promoted as a systematic innovation that improves the efficiency of quantities take-off in the construction industry. However, this advanced technology requires changes to almost every aspect of a firm's business. The effects and efficiency of 3D modelling are always a consideration for the quantity surveying in adopting this new technology. Therefore, this paper focuses on measuring the effects and effectiveness of 3D modelling in Quantity Surveying Profession based on the RIBA plan of work 2013. Semi-structured interviews have been adopted to collect the research data for this paper. Eleven respondents accepted the semi-structured interviews to share their 3D modelling experience. The analysis result indicates that quantity surveying job scopes are significantly affected at concept design, developed design and technical design stages when 3D modelling is implemented. Additionally, majorities of the respondents agreed that 3D modelling manages to improve the efficiency of the measurement work task in the quantity surveying profession. This research outcome serves as a guidance for quantity surveyors who are interested to adopt the 3D modelling in future.

Kai Chen Goh et al., have explained about the implementation of Building Information Modelling (BIM) in the construction industry is getting more and more frequent and it is starting to penetrate into the Malaysia construction industry. BIM software is a dynamically linked interface designed to take the place of redundant computer aided drafting (CAD) work. The implementation of BIM will bring significance changes into the design process in construction thus this research aims to identify the impact of BIM towards the design process in construction industry. The data collection was conducted through semi structured interview and literature review. The target respondents are architects and consultants who have applied BIM in their projects located at Klang Valley. Thematic analysis is applied in this study to allow elements in literature review to be developed as themes for analysing purpose. The data collected shows that BIM had advantages over traditional design with clash detection, 3D modelling stimulation and better collaboration of work which improves the efficiency, design and quality of a project. BIM has great impact towards the design process in the construction industry.

Siti Fatimah Subki and Mashanim Mahazir, have outlined about there are countless issues regarding unsustainability activities from irresponsible bodies, where, sustainable development is needed in the event of global climate changes, air pollution, water pollution and others. Due to that, construction industry has taken this issue seriously and has come out with an idea of "green building". Along with the existence of modern technologies, it is true that technological innovation does play an important role in both short and long term in societal, economic and also environment. In order to enhance the performance of Green Building construction, the construction industry can apply Building Information Modelling (BIM) in their project. The aim of this paper is to enhance the existing knowledge towards green building. For this paper there are about 15 research papers published within the past 7 years which are used in abstracting all the relevant literature, analyzing and coming out with the findings on what are the indicators in identifying the benefits and factors of BIM application towards green building project.

Syed Abdul Haris Syed Mustafa et al., have discussed on how few decades before December 2004, Malaysia is known as a country which free from earthquake hazard, unlike Japan and Indonesia. However, the fact has changed after the great Mw9.1 Aceh earthquake in December 2004. Recently, the government has decided to implement seismic design on new buildings. Soil Type is one of parameters that influencing the seismic design and structural performance. This study presents the influence of different Soil Type on the total weight of steel reinforcement of four storey reinforced concrete building. The building has been simplified and modelled as building in important class IV. The reference peak ground acceleration, α_{gR} was assumed as equal to 0.07g. The building had been repeatedly designed on five different type of soil namely as Soil Type A, B, C, D, and E by referring to Eurocode 8. Based on result, the Soil Type is strongly influencing the total weight of steel reinforcement. The latter is higher for softer type of soil. In this study, the buildings with seismic design require around 1.16 to 2.11 times higher amount of steel reinforcement compared to the nonseismic building. Therefore, the Soil Type will influencing the cost of steel reinforcement.

Dzanaria Malek and Nadzirah Zainordin, have presented about the urban centres growing population and the urbanization contributions to global environmental change have been make it increased the attention to the sustainability of cities and led to the emergence of the “Forest City” concept. Forest City also known as Green City is using the same meaning with “Sustainable city” or “Eco-city” which also count in sustainable development category. Forest City represented as a role model for future cities because it has a lot of benefit which have been extensively studied in recent years especially in environmental sustainability and its application of green technology. From the extensive study of literature review from the past 10 years until updating year of publication. This study it's to identify the challenge factors in implementing forest city concept. The structured questionnaire been sent out to all the construction players in Johor Bahru as this to complement the project of forest city itself located in that particular location. About 100 construction players from different background responded to the questionnaire. The expecting finding its to contribute in enhancing the existing knowledge especially for Malaysia's construction players.

Woon Will Lee and Nadzirah Zainordin, have studied about the building maintenance can be used for services, facilities, facades, elements and structures and each maintenance activity is different in their classification. All buildings require maintenance to allow buildings to continue to operate, keeping their value as high as possible and extending their lives. Building maintenance is also important to provide a safe and better working environment and to maintain the aesthetic value of the building. However, its less concern on building maintenance towards green building residential project. Therefore, this paper its to study and identify the building maintenance criteria towards green building residential project. The extensive literature review from the latest 10 years of publication has been use to run this study. Perhaps, the expecting finding may contribute and enhance the existing knowledge towards this issue.

Kenn Jhun Kam et al., have analysed about the vast property development in Malaysia has causing the construction industry to generate tons of construction waste. However, it seems like Malaysia players are still weak in managing construction waste and sustainable construction waste management initiatives are often ignored by Malaysia construction players throughout most of the construction stages. There are unclear initiatives and policies that shall

be complied by the construction players which resulting a uncertainty among the construction players and causing the matter of sustainable construction waste management to remain unresolved. This study is to further understand the sustainable construction waste management practice trends and obstacle faced by the construction players in Malaysia. The data collection was carried out through the distribution of questionnaires. It shows a trend between the Independent variables and the dependent variables which could conclude an interesting and statistically significant finding on this sustainable construction waste management subject matter in Malaysian construction industry.

Kai Chen Goh et al., have explained about the environmental and climate impact vary significantly due to large amount of carbon dioxide, CO² emitted from cement industry into the atmospheres. Lots of alternative materials were used in global cement industries to obtain positive environmental achievements as it avoids the release of CO², but much more has yet to be done in Malaysia. Hence, this study intends to identify the barriers of alternative material utilisation in cement production. Consequently, a case study with structured observation and semi-structured interview were conducted. The case study plays a central role in Malaysia's cement industries such as promoting development for sustainable construction techniques and technology. Based on the reflection of the case study legislative condition in Malaysia is considered as the most influential barrier in cement production. The results indicate the difficulty of practicing alternative material approach in cement production is by obeying all the regulatory permitting and legislative condition. Therefore, this barrier must take into account of other cement manufacturers for further development towards alternative material utilisation in cement production and hence maximising the alternative materials utilisation in cement sector.

Ho Khay Siang and Nadzirah Zainordin, have showed about the quality of transportation service it's a main factor to increase the level of economic and social in Klang Valley. By increasing the system may buzz-up all sector and may contribute the benefit to the community. This research will be conducting in Klang Valley. The reason to choose this location it's because of the role that the location plays in contributing to the economic sector in Selangor state itself. Methodology to be used to conduct this researches its quantitative method. Where, 200 set of questionnaire to be distributing to get a perception on the concept of sustainable transportation among respondents. Questionnaire distributing to those who has knowledge towards sustainable transportation and it's limited to those who have experience in construction sector only. The objectives of this research it's to investigate the construction player's perception towards sustainability transportation in Klang Valley; and to identify the barriers factor to implementing this concept. Expecting distribution from this research it's to create awareness by implementing this concept it's beneficial to the routine activities as well as can generate and increase awareness to the public.

Nurzalikha Sa'adi and Nadzirah Zainordin, have outlined about the higher demand for new developments in Sarawak has led to the increase in construction activities, which result in a significant impact towards the environment. Since the application of green technology towards development in Sarawak is still low, thus, it is important for the Sarawak government to address this issue. The aim of this research was to assess the adoption of green technology among the contractor in Central Region of Sarawak. In order to achieve the stated aim, the objectives outlined in this research had been cascaded to identify the current level of awareness on adoption of green technology and to investigate the level of readiness

construction players to adopt green technology in development of Sarawak. Quantitative research design by way of questionnaire was adopted. There is a gap in terms of what has been planned and actions in particular application of green technology we have. Hence, it can be anticipated that this research will generate interests from green technology researchers as it will provide fundamental elements towards development in Sarawak. The obtained results indicated that most of Sarawak's construction players were knowledgeable pertaining to green technology. Unfortunately, only few of them applied it into practices because of ignorance to adopt, financing issue and lack of expertise.

Loo Seong King et al., have presented on how the construction is a complex and high-risk industry as it involves multiple parties in its implementation. Disputes are common occurrences that arise due to disagreements between parties in a contract both in the public or private sector projects. In order to mitigate the risk of disputes and minimize the possibilities of it arising, all parties in a contract need to take precautionary steps by identifying the common factors or issues that can trigger construction disputes. Disputes often lead to negative impacts such as time-consuming, harmful to a contractor's reputation or worse, it can damage the good relationship between client and contractor. Therefore, the main purpose of this study is to establish which dispute resolution method most preferred by the industry players in terms of time, cost and satisfaction. This study is carried out through quantitative surveys among the key players in the industry. The findings from this research will hopefully give an insight to parties in a contract to be wary of the common issues that contribute to disputes arising and thereafter to be able to decide which dispute resolution method that is most beneficial and most commonly resorted to in dispute resolution in the industry.

Kai Chen Goh et al., have explained about the construction is one of the high risk industries among others. Risk assessment and management practice (RAMP) was found to be helpful in controlling the risks. Implementation of new technology; Industrialized Building System (IBS) will undergo distinct risks. Unknown risks in IBS implementation lead to the project failure tendency. This leads to the low adoption rate of IBS in Malaysia. IBS was introduced and practiced in Malaysia serves to increase the performance of construction industry to solve the issues of high intake of non-certified foreign labours and high housing demands. Therefore, specific study on RAMP of IBS becomes crucial to identify the potential risks, significant level of the risks and its relative controlling method in order to increase the project success. The research aimed at G5 to G7 contractors in Malaysia whom practice IBS project in residential, commercial, industrial and other types of development. 19 risks factors related to IBS were identified and the significance level for each risk was calculated using risk significance index (RSI). The top significant risks highlighted by the respondents are related to economic risks. The risks control methods mostly practiced by the contractors are risk avoidances and risk reduction method. The novelty of this study is that the RSI were explored in regards to IBS in Malaysia Construction industry which are more sophisticated in Malaysia's study, and the RSI findings differed from other Asia countries such as China.

Kai Chen Goh et al., have discussed about the trust, being one of the missing links in construction highlights the need of construction collaboration. Although practices have been conducted, there are still issues with the current construction collaboration. Collaboration in the form of tender, document control, drawings still potentially arises arbitration or litigation matters. Newer approach to solve the current construction collaboration issues is needed. Blockchain technology relies on the mistrusts between nodes of users in the network to

validate and reach consensus between one another to create the trust links. Such terminology is exquisite for construction, as mistrust is the main issue, and the mistrusts disadvantage can be used to create trust link between construction parties. The study reflects the construction collaboration issue and limitation of implementing technologies in construction industry versus the blockchain terminology and advantages to solve those issues. More advance technological change is definitely needed in construction industry, more so ever with the emergence of new technologies.

Leong Boon Tik et al., have elaborated on Pakatan Harapan (PH) government pledged to work together with developers and state government to build one million affordable homes across Malaysia within two terms (2018–2027 years). According to Property Stock Report published by National Property Information Center (NAPIC), for Q1 and Q2 in 2018, the industry completed 40,710 residential property. If the productivity of the industry maintain throughout the year, there will be a forecast of 81,420 of residential units completion in year 2018. With this rate, there is a deficit of 18,580 units to reach 100,000 houses a year. In the effort of reducing foreign workers, how the construction industry can catch up with the productivity at the same time maintain the cost and the quality of the construction of affordable houses? This paper review if Design for Assembly and Manufacturing (DfMA) is the answer to current condition. This paper also reviewed the current condition in term of productivity and capacity of the construction industry and the current economy condition, social expectation and housing affordability. Hence examine if DfMA is the answer to the question. The finding also propose the optimal condition to optimize benefits of DfMA toward construction industry in Malaysia.

BARRIERS IN ADOPTING BUILDING INFORMATION MODELLING (BIM) AMONG CONSTRUCTION'S PLAYERS IN SARAWAK

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Abstract

In construction projects, Building Information Modelling (BIM) influences on the common way of collaboration, including the roles of different participants. The demand of BIM is increasing recently as much international organization and government taking the initiative to promote BIM in building life cycle particularly in construction industry. Although the implementation of BIM is not an easy thing, BIM promising to benefit of efficient Information Management in construction and development industry. Therefore, this research objective it's to identify a barrier to implementing Building Index Modelling among construction's practitioners in Sarawak. The methodology has been used for this study its quantitative where 300 sets of questionnaires has been set and distributing to 300 respondents from Kuching, Miri and Sibul. Perhaps, the outcomes of the research may answer the highlighted objectives and as well as the construction practitioners able to maintain and increase the contribution on construction industry in the Sarawak's state. Also, it's may help Sarawak's construction practitioners to fully gaining a benefit by implementing and using BIM into their project to meet the global need even the field of construction in Sarawak its niche.

Keywords: *BIM; Barriers; Building Information Modelling*

INTRODUCTION

The demand of Building Information Modelling (BIM) is increasing recently as much international organization and government taking the initiative to promote BIM in all industry life cycle. The life cycle in BIM is primary sets it apart from preceding digital technologies, which were designed in specific phases of the building life cycle for specific sectors of the building industry, such as design and construction stage (Azhar et al., 2012; Smith & Tardif, 2009; Takim et al., 2013). In macro life cycle, BIM provide benefit: overlap, reduce real project risks; irrelevant document eliminated; waste reduces; productivity increase; costs decrease; profit increase as improve product, improve services deliver, or expand market share (Smith & Tardif, 2009). The fundamental of BIM implementation are cash flow, productivity, profit and revenue though different types of businesses use BIM for different purpose (Smith & Tardif, 2009; Weygant, 2011). The success of BIM implementation will depend on how well streamline the workflow and information flow BIM are widely use in design and construction; the benefit of the parametric modelling technology that enable to store semantic information about the facility (Akcemetet et al., 2010; Barlish & Sullivan, 2012; Smith & Tardif, 2009). The goal of BIM improves product delivery, which includes quality, reliability, timeless and consistency of the process made (Ani et al., 2015). Most information created during the design and construction stage that is of value to construction practitioners can only be found elsewhere and in scattered sources: in written construction specifications, warranty certificates and operations and maintenance manuals (Smith & Tardif, 2009).

However, the current practice BIM in scope of Sarawak state, construction's practitioners are not entirely implementing BIM in construction industry and in current construction operations that applied BIM, most functions still done that can increase chance of errors and decrease efficiency (Becerik-Gerber et al., 2012; Motamedi et al., 2014). Adopting BIM in mainstream in facility management (FM) that encompasses multiple discipline to ensure higher functionality of the built environment by integrating people, place, processes and technology. Essentially, BIM mostly used for operations phase and commercially available technologies focus on transferring information from the design and construction phase to the operation phase by enabling creation and capturing of digital facility information throughout the facility lifecycle (Akcemetet et al., 2010; Volk et al., 2014).

There will be the improvement of the quality of life (QOL) if the building owner and all construction's practitioners willing to adopt BIM in the design and construction stage. The concept of QOL is a broad notion and is difficult to have the single definition (Subramaniam et al., 2013). Although sustainability concerns both the achievement of human needs satisfaction and the preservation of environmental resources, in the last two decades, the environmental impact of human products and processes has received a growing attention, while few researchers have addressed the consequences on human satisfaction of product modifications conceived for a lower consumption of resources (D'Anna & Cascini, 2016). The job satisfaction in the workplace among construction employee will increase when the adopting BIM in their activity. One of the examples that integrated BIM for better QOL in workplace is working flexibilities evolving as professionals spend less time at their desk and require mobile or flexible working models and technologies for communications and collaborative working (Shelbourn & Bouchlaghem, 2012). The necessity of BIM in design and construction stages should be apparent to attract the interest of BIM adoption. Organizations involved in this implementation have the opportunities to use BIM as a knowledge repository to document evolving facility information and to support the decision made by the facility manager during the operational life of a facility. Even though BIM able to improve QOL in the workplace, resistance to change is a result of perceived different in ideas, motives, plan or priorities that found related to five areas: the need for change, risk, goal and targets, leaders and treat of status (Takim et al., 2013). Although the implementation of BIM not the as easy thing as the worksheet, BIM promising to benefit of efficient resource management in design and construction stage.

RESEARCH BACKGROUND

BIM is deploying in the construction, FM and design to be one of the new emerging technologies in which a digital representation of the building. It is being formed to support the interoperability of data and exchange in digital format. Structured approaches used in developed countries to approve their industry thoroughly approve the BIM in terms of communicating tools during the construction process. However, the projects that constructed, planned and design using BIM was established that come across the client's expectation, in terms of completion time, cost and quality. (Ismail et al., 2014).

Interoperability is used the equipment or part of another system or an ability of a system to work with. Interoperability is observed with both broad and narrow perspective by the construction industry. Interoperability is considered as the facility that communicates and manages electronic project and product information among the collaborating firms from a

purely technology-based view. Therefore, most of the build team members had recognized interoperability in the social level. Other than that, interoperability definite as an advantage, which manage, and implement collaborative relationships between members of cross-disciplinary build teams that allow integrated project execution. Thus, these perspectives can be associated and those are interrelated. At a practice level, interoperability of technology allows efficiency. Every team member can integrate the project delivery better if all build team members can easily exchange data across different platforms and applications (Jr. et al., 2007). Therefore, the aim of this research is to study the barriers factors in implementing BIM.

RESEARCH METHODOLOGY

This research will be conducting in three selected locations consist of Kuching, Miri and Sibuluan. The reason to choose these three locations it's because of the role that each location plays in contributing to the economic sector in Sarawak state itself. With the centre of attraction city to conduct business, these three places have been selected for research area. In general, the methodology uses to conduct this research its quantitative method. Where, 300 sets of questionnaires to be distributing to that stated three locations. Questionnaire question has been designed after doing pilot test where selected person whom having strong background and a number of experiences in construction industry has been chose to validate the fact getting from literature review. Likert scale with 5 points has been chosen to be answering the question set in a questionnaire. The survey set of questionnaires going to be send in hardcopy form to the respective respondent right after the pilot test has been successfully conducted.

RESULTS AND FINDINGS

Table 1 shows the result from 300 questionnaires has been responded by the respondents. The barriers have been classified into five main barriers; lack of information, unfamiliar, unawareness, cost and time.

Table 1. Barriers in Adopting Building Index Modelling

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Lack of Information					
1. The need of suitable data sharing standards	20	25	50	100	105
2. The need for well-defined commercial business process models	20	20	10	130	120
3. The need to draft BIM specific contracts	20	25	50	100	105
Unawareness					
4. Benefits that BIM brings to company/ organisation	20	20	10	130	120
5. Benefits that BIM brings to project	20	25	50	100	105
Unfamiliar					
6. Lack of skilled personnel	20	25	50	100	105
7. People refusal/ reluctance to learn	20	20	10	130	120

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
8. Step learning curve for those unfamiliar with technology	20	20	10	130	120
9. Lack of training/ workshop	20	20	10	130	120
Cost					
10. Client limitation due to high cost	20	20	10	120	130
11. Cost of training existing staff	20	20	10	120	130
12. Cost of model copyright	20	20	10	120	130
Time					
13. Time required training existing staff	20	20	10	115	135
14. Time taken to implement BIM	10	20	20	110	140

BIM can be utilized to decide proper locations for the construction set down of materials and the delivery times of materials due to the dynamic planning capacity that BIM has to offer. Coordination gets to be easier, and as built drawings turn out to be more precise. Construction site design involves things, for example, equipment, materials and so on. These things are basic for increases in productivity. Due to the 4D and 5D opportunities that BIM offers as a feature of its database. Capacity to render time lapse studies into a project will help in anticipating better more productive approaches to use time and enhance planning.

Poor communication at a jobsite prompts to low profitability and retry work. A BIM will have the capacity to expand communication between the Architect/Engineers and the jobsite administrator. There should be learning of BIM on both sides, so communication is through the program. A BIM can likewise be utilized to document a career and to keep all included parties free from issues, delays, and builds advance and accomplishments. This is not important to BIM; it identifies with the issues of renting as opposed to owning equipment and worrying over upkeep. It is focus on utilizing new and not obsolete equipment to enhance profitability on a jobsite.

Obviously, a safe jobsite is a more beneficial jobsite, help to keep worker's motivation. A BIM can give early hints about potential risks that may happen on the jobsite. About the advantages of advancing interoperability, it was observed that productivity, coordination and reduction in labour were the most generally identified attributes. Issues of interoperability between different software vendors were recognized. Besides, the respondents showed that there were a lot of efforts undertaken by software organizations to enhance this issue. The respondents have additionally recognized the utilization of BIM in promoting visualization, information sharing, coordination, cost adjustment and forecast of delay.

From the dissertation above, it is observed that the construction industry subjects itself to a great deal of risk by investing time and money in BIM, during economic recession. Other than that, the advantages of BIM as well as a lack of awareness of value added of BIM are identified. The problems associated with BIM interoperability as well as the degree of information acquired from BIM is clearly comprehensible. With the increase in governmental efforts to integrate BIM into the construction industry, there will be more user of BIM in Malaysia.

CONCLUSION

Several recommendations that can be speed up to overcome the stated issues; providing knowledge and training like organizing seminar, talk or workshop and conferences to educating the and offering to the public and potential buyer for green principles on the concept and the benefits can be generated from implementing this concept in their project. Actions must be initiated to enable this concept to be applied efficiently in future construction projects in order to meeting up with the current industry needs. Provide as assistant to stakeholders, contractors and consultants in incorporating the Building Index Modelling at the project conceptual stage and planning stage. Even this practice it's a slightly higher investment at initial stages, but then, it is still a good in-vestment to be consider for long-term and by practicing this concept it brings different character and interpretation from conventional project.

Finally, stakeholders' actions are influenced by the market situation and demand from the buyer. To increase the efficiency in practicing Building Index, a wave of pushing factors must be acting upon to the project owners and also contractors to improve the efficiency by adopting the platform. The modern and modest design and practices must be play with the current platform for the construction project.

In summary, more efforts are necessary to enhance the level of awareness and consciousness among the Sarawak's construction practitioners to adopting Building Index Modelling in the future project. These are the point that should put into an account to make them ready to be implementing this concept. It's should start from the most important people in that particular state so that this concept can be successfully implementing in their area.

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READINESS IN APPLYING BUILDING INFORMATION MODELLING (BIM) CONCEPT AMONG QUANTITY SURVEYOR IN SARAWAK

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Abstract

In construction projects, Building Information Modelling (BIM) influences on the common way of collaboration, including the roles of different participants. The participation includes all the parties who involve in construction project during pre and post construction. The demand on applying the BIM rapidly increase year-by-year in Malaysia. Malaysia can be divided into two main land call as peninsular and east Malaysia which may include Sabah and Sarawak. The implementation and application of the BIM in Peninsular Malaysia are rapidly increase but a big question for East Malaysia particularly at Sarawak. Therefore, this research objective it's to investigate the readiness in applying BIM concept among Quantity Surveyor in Sarawak. The methodology has been used for this study its quantitative where 292 sets of questionnaires has been set and distributing to 292 respondents whom practising Quantity Surveying as per record provided by the Board of Quantity Surveyor Malaysia. Perhaps, the outcomes of the research may answer the highlighted objectives and as well as the construction practitioners able to maintain and increase the contribution on construction industry in the Sarawak's state. Also, it's may help Sarawak's construction practitioners to fully understanding the benefit by implementing and using BIM into their project to meeting the global need even the field of construction in Sarawak its niche also to let the Quantity Surveyor in Sarawak to fully utilise the concept of BIM in their daily task without affecting their professionalism.

Keyword: *BIM; Understanding; Quantity Surveyor; Building Information Modelling.*

INTRODUCTION

According to the Economy of Malaysia retrieved from Wikipedia, Malaysia has a substantial construction trade of more than RM102.2 billion (US\$32 billion). The greatest percentage stake was interjected by construction of non-residential buildings which recorded 34.6 per cent. This was trailed by civil engineering sub-sector (30.6%), residential buildings (29.7%), and special trades (5.1%). Some of the project players that contributed in construction industry are Contractors, Engineers, Designers/Architects, Quantity Surveyors and Project Managers.

Quantity Surveyors star as an influential role as a qualified, trained and proficient in dealing with glitches relating to construction expenditure, supervision and consultation in construction industry (Aje and Awodele 2007, A.E. Oke et al., 2010). The role of a Quantity Surveyor includes preliminary cost advice, approximate cost estimate, cost planning, Bills of Quantities, procurement/tendering process, cost control and measurements & quantifications (Fanous, 2012).

BIM influenced in improvement performance of quantity surveying practice (Mr. Vineeth Raphael, 2014). BIM is the advancement and practice of a computer software exhibit to replicate the construction and manoeuvre of a facility. The subsequent prototype, a Building Information Model is a data rich, object adapted, intellectual and parametric illustration of the

facility from where interpretations and data applicable to numerous users' essentials can be obtained and evaluated to produce data that be able to be exploited to make resolutions and develop the procedure of producing the facility (American General Contractors, 2006; Evelyn Ai Lin Teo et al., 2015).

The utilisation of BIM in construction industry has been studied and it has proven to provide more benefits in order to improve productivity in the industry (Evelyn Ai Lin Teo et al., 2015). Alas, there are several factors that are stopping BIM from being implemented as the universal tool to be widely used in the construction industry in Malaysia.

Based on the RICS BIM survey, numerous quantity surveyors are still unconscious of what BIM is and only insignificant amounts (10%) retrieved to have benefit from BIM (Matthews, 2011b). Hence, quantity surveyors need more exposure into this new technology which will help them to keep up with the pace of other industry experts to conserve their competitiveness within the industry. Quantity surveyor consultant firms can expose their employees with new technology and adopt them into the quantity surveying practice.

Apart from that, substantial extent of information has been issued on the challenges of BIM adoption and implementation. Hurdles such as expense, guidance, interoperability and modifications in the whole design process are found often all over the numerous information and as such appear substantial in setting back the implementation of BIM in the industry (Yan H. & Damian P., 2008; & Liu R. et al., 2010). Therefore, large scale projects with long time frame and high amount of contract will be prioritized in the usage of BIM application. Also, big firms will be more prioritized in the usage of BIM application rather than small firms with small projects that generate small incomes.

However, the complexity of building works is putting quantity surveyors through hassles and clients turn out to be discontented with the orthodox ways of quantity surveyors' practice. It is critical for quantity surveyors to move away from uneconomical methods. Detailed quantities can be quickly extracted directly from BIM (Mr. Vineeth Raphael & Mrs. Jennifer Priyanka, 2014). Along these lines, quantity surveyors should understand the concept of BIM and its' abilities. Quantity surveyors should also be aware of client needs which is to move on from the conventional method of quantity surveying practice to the utilisation of BIM concept in the industry in order to increase the productivity of the industry.

There is always room for improvement in minimizing the difficulties of adopting BIM application in quantity surveying practice. Sarawak construction industry needs to be parallel with other successful countries which have implemented the usage of technology in their industry. Quantity surveyors' practice in Sarawak must expose themselves with technology in order to increase the productivity among them which will lead to a better performance in the industry.

LITERATURE REVIEW

BIM concept is considered as a new concept that should be introduced to the construction practitioners as it is not widely used in Malaysian construction industry. It is a contemporary evolving methodology which simplify the design and construction process by using digital illustration (Baba, 2010). BIM is a preparation and process of simulated model and structure all the way through its lifespan (Hergunsel, 2011). The application of BIM can be utilized on

every phase of construction activity starting from planning right until operation. Unluckily, the application of BIM in Malaysian construction industry is very slow. This slow application is initiated by the individual itself and methodological difficulty, known as internal and external difficulty. Internal difficulties are initiated by individual itself and expenditure, typically to discover contemporary tools and practice of the software (Pena, 2011). Whereas external difficulties are interrelated to the deficiency of confidence between the contemporary software applications. Therefore, this study intends to evaluate proper image of BIM applications in Malaysian construction industry and the benefits experienced by the usage of BIM implementation are identified. Criteria of BIM will be further discussed in this research. Nevertheless, there are problems that withhold BIM concept from being widely implemented in Malaysia's construction industry.

By referring to Table 1.3 below, it shows the criteria of BIM concept which help to increase the productivity of quantity surveyors in quantity surveying practice in Malaysia. The most popular criteria that the authors mentioned is cost estimating which is referred 4 times by Exactal Technologies (2010); Muzvimwe (2011); Chung et al. (2012); Mitchell (2012). Then, followed by system coordination which is referred 3 times by Chung et al. (2012); Mitchell (2012); Thurairajah & Goucher (2013). After that, design assistance and constructability which is referred 3 times by Azhar et al. (2012); Thurairajah & Goucher (2013); Wong Phui Fong et al. (2014). Last but not least, fast and accurate cost estimation which is referred 3 times by Exactal Technologies (2010); Azhar et al. (2012); Mitchell (2012).

BIM has the ability to extract the costing of a construction project from the earliest design which explains project scope at fundamental stage and determines budget (Exactal Technologies, 2010). The application of BIM can make the cost appraisal be prepared briefly from feasibility stage (Mitchell, 2012). The preliminary cost plan can be obtained by extorting quantities from model (Chung et al., 2012). BIM also adopts 5D which means 4D plus "cost". It combines design with costing, scheduling and estimating which accelerates the production of Bills of Quantities, derived output rates and worker costs (Muzimwe, 2011).

BIM allow the changes of construction design and generate precise cost estimations for a variety of design options without difficulty (Mitchell, 2012). The brilliant information organisation permits data to be accumulated in a dominant synchronized model (Chung et al., 2012). BIM also offers cost implication of design transformations which can be produced effortlessly without the needs to do remeasurement (Thurairajah & Goucher, 2013).

BIM ensures that the designs can be constructed within the time and budget given. It allows the visualization of the illustrated construction project in order to get a better understanding of the whole construction project. (Azhar et al., 2012; Thurairajah & Goucher, 2013). Apart from that, BIM also helps in identifying possible problems in simulated environment before it comes to real construction (Wong Phui Fong et al., 2014).

BIM has been demonstrated as an advantageous system in construction industry which has empowered experts in lowering improbabilities and accomplishing successful accomplishment of a project. Cost checking can be performed briefly to guarantee all items are captured (Exactal Technologies, 2010). Parametric modification technology which synchronizes transformations & sustains regularity at all times (Azhar et al., 2012). Permits

quick and precise evaluation of various design alternatives for client to select best possible design that meets their requirements (Mitchell, 2012). Based on the list of criteria mentioned, we can conclude that BIM application helps practitioners in making construction industry smoother and less complicated. BIM offers more detailed, fast and precise cost estimates for the construction industry. It assists construction practitioners with good system coordination and better construction design and constructability.

THE POSITIVE SIDE OF BUILDING INDEX MODELLING (BIM)

By implementing BIM concept to increase the productivity of quantity surveyors in quantity surveying practice in Malaysia. The most popular advantage that the authors mentioned is time saving/better time management which is referred 4 times by Colleen (2009); Azhar et al. (2010); Olatunji et al. (2010) & Autodesk (2013). Then, followed by money saving and avoid budget overruns which is referred 4 times by Colleen (2009); Shaw (2010); Azhar et al. (2010) & Olatunji et al. (2010). After that, better design which is referred 3 times by Ballesty (2007); Eastman et al. (2008) & Shaw (2010). Last but not least, accurate visualization which is referred 2 times by Ballesty (2007) & Shaw (2010).

Timing is very important in managing a construction project. Plan must be made and followed in order to ensure the construction project to be completed within the timeframe. The implementation of BIM can save time and offer a better time management as it can help in producing measurements and costing quickly (Ballesty, 2007). Accurate quantities can be obtained and the complication of traditional take off method can be eliminated. Hence, it can save time and offer a better time management (Colleen, 2009; Azhar et al., 2010; Olatunji et al., 2010; Autodesk, 2013). It is important to keep track with the costing to ensure that the construction project is within client's budget. BIM is able to extract more precise quantities to be compared with the traditional taking of method (Colleen, 2009). This brilliant platform can cut down the possibility of inaccuracies and omission (Autodesk, 2013). As the negative impacts can be eliminated through the adoption of BIM, money can be saved and budget overrun can be avoided (Colleen, 2009; Shaw, 2010; Azhar et al., 2010; Olatunji et al., 2010).

As the years pass by, every construction player is very competitive in designing innovative construction. BIM has the ability to create an accurate visualization of a construction based on the CAD drawing. The ability to extract an accurate visualization may help the construction players to create a better design for construction (Ballesty, 2007; Eastman et al., 2008; Shaw, 2010) and also produce a higher quality of construction information (Shaw, 2010) which will lessen the complication of a construction design.

Certain construction players may have good imagination of construction project by looking and understanding the drawings while the rest may not have good imagination and understanding of construction drawings. BIM act as an innovative tool which can produce an accurate visualization of a construction which is better than the current 2D drawings that require construction players to imagine the construction themselves (Ballesty, 2007; Shaw, 2010). This can help in designing better construction. Based on the advantages mentioned, we can conclude that BIM is the perfect benchmark to reduce improbabilities and increase the proficiency of construction process. It provides a transparent visualization of design to verify all potential improbabilities so that the design can be enhanced at initial stage to save time, cost and produce better quality.

METHODOLOGY

This study begins with a broad literature review, due to limitation of research review on the related issue, the literature search is stretched out to quantitative research by selecting a group of people to be responding to associated research in order to get the study done. This study aims Registered Quantity Surveying Consultant firms in Sarawak. According to the official website of Board of Quantity Surveyors Malaysia, there are 292 registered Quantity Surveying Consultant firms as per data of 2018. This study targeted to make a survey on 292 persons from different. The other criteria of the respondents include years of experience in the industry. Quantity Surveying Consultant firms would be the most suitable group of people to answer questionnaire survey for this study. The registered Quantity Surveying Consultant firms are very well proficient to the quantity surveying practice and services. Therefore, by choosing Quantity Surveying Consultant firms to be the respondent may help in getting the most consistent answer and higher accuracy of the exploration of readiness Quantity Surveyors by adopting BIM concept in Quantity Surveying Practice.

ANALYSIS AND FINDINGS

Figure 1 show the respondents understanding on the concept of BIM. Visualize what is to be built in a stimulated environment having 47 totally disagree, 45 disagree, 100 neutral, 50 agree and 50 totally agree. Create a digital parametric model which represents the physical & functional characteristic of a building in full detail having 50 totally disagree, 70 disagree, 100 neutral, 40 agree and 32 totally agree. Information representing the entire building & the complete set of design documents stored in an integrated database 47 totally disagree, 65 disagree, 80 neutral, 50 agree and 50 totally agree. Modelling the functions & behaviour of building systems and components 50 totally disagree, 100 disagree, 70 neutral, 40 agree and 32 totally agree. Parametric change technology which coordinates changes & maintains consistency at all times 47 totally disagree, 80 disagree, 60 neutral, 55 agree and 50 totally agree. Do cost plan automatically throughout the building elements 50 totally disagree, 75 disagree, 90 neutral, 45 agree and 32 totally agree. Quickly generate cost estimates to assist in decision-making & provide cost information about alternatives to owners early in the design phase & throughout the project lifecycle 47 totally disagree, 65 disagree, 75 neutral, 55 agree and 50 totally agree. Identify and correct errors in the model 50 totally disagree, 85 disagree, 70 neutral, 55 agree and 32 totally agree. Identify potential problems in virtual environment before it comes to actual construction 47 totally disagree, 45 disagree, 100 neutral, 50 agree and 50 totally agree. Cost geometry can be extracted from the earliest design to generate a basic costing which defines project scope at an elemental level and establishes budget 50 totally disagree, 75 disagree, 75 neutral, 60 agree and 32 totally agree. Enables fast and accurate evaluation of multiple design options for client to choose optimal design that meets his/her requirements 47 totally disagree, 65 disagree, 70 neutral, 60 agree and 50 totally agree. Cost appraisal can be prepared quickly at feasibility stage 50 totally disagree, 75 disagree, 85 neutral, 45 agree and 37 totally agree. Preliminary cost plan can be prepared by extracting quantities from model 47 totally disagree, 60 disagree, 75 neutral, 60 agree and 50 totally agree.

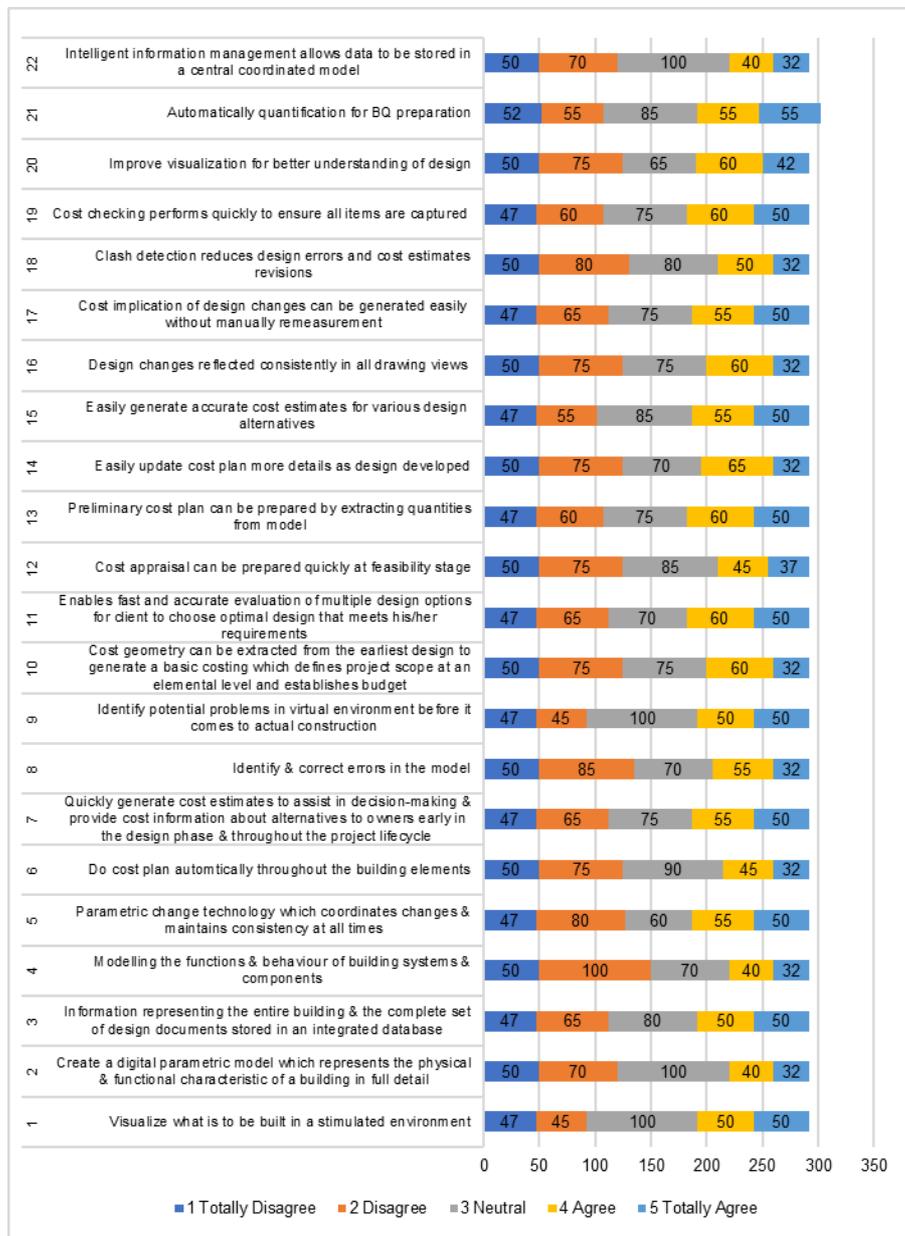


Figure 1. Respondent feedback on their understanding towards BIM concept

Easily update cost plan more details as design developed 50 totally disagree, 75 disagree, 70 neutral, 65 agree and 32 totally agree. Easily generate accurate cost estimates for various design alternatives 47 totally disagree, 55 disagree, 85 neutral, 55 agree and 50 totally agree. Design changes reflected consistently in all drawing views 50 totally disagree, 75 disagree, 75 neutral, 60 agree and 32 totally agree. Cost implication of design changes can be generated easily without manually remeasurement views 47 totally disagree, 65 disagree, 75 neutral, 55 agree and 50 totally agree. Clash detection reduces design errors and cost estimates revisions 50 totally disagree, 80 disagree, 80 neutral, 50 agree and 32 totally agree. Cost checking performs quickly to ensure all items are captured 47 totally disagree, 60 disagree, 75 neutral, 60 agree and 50 totally agree.

Improve visualization for better understanding of design 50 totally disagree, 75 disagree, 65 neutral, 60 agree and 42 totally agree. Automatically quantification for BQ preparation 52 totally disagree, 55 disagree, 85 neutral, 55 agree and 55 totally agree. Intelligent information management allows data to be stored in a central coordinated model 50 totally disagree, 70 disagree, 100 neutral, 40 agree and 32 totally agree. From the findings of this research study, almost all the respondents respond to neutral, totally disagree and disagree rate with a few falls in totally agree and agree rate. This shows that the conceptual of the BIM itself not really understandable by the respondents.

CONCLUSION

All parties in Malaysia construction industry should support each other to ensure the concept of BIM its transparent and smoothly deliver to all the construction parties especially in Sarawak. More afford should be conducted to make this concept fully delivery and lead to successfully implementing among the Sarawak construction player. Support should be from the main professional bodies up until the local authority and government with offering them a good exemption if they are playing their roles with implementing BIM in their project.

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OCCUPATIONAL STRESS IN QUANTITY SURVEYING PROFESSION: A PRELIMINARY STUDY

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Abstract

Construction is a competitive, ever-changing, and challenging industry. Therefore, the majority of construction professionals suffer from occupational stress and there is no exception for the Quantity Surveyors (QS). This study aims to summarize the effects of occupation stress currently being faced by QS in Malaysia. This could be done through achievement of the discovering the effects of occupational stresses towards the well-being of QS. Besides, the research was carried out in two stages: extended literature review and questionnaire survey. A total of 61 questionnaires have been sent out. Descriptive analysis was used to analyse the findings. As a result, this research provides a clearer picture of the actual origins of the workplace stresses being experienced by QS. Therefore, both authorities and individuals are able to develop better stress-coping strategies for the betterment of QS.

Keywords: *Occupational Stress; QS Profession.*

INTRODUCTION

Occupational stress has become a growing distress within numerous industries and is considered as a common workspace related health issue globally (Arrman & Björk, 2014). Besides, it is also known to adversely affect the productivity and also the satisfactions towards work in numerous occupations. Beside from stressors outside of the organizations such as individual stressors and also family-related stressors, there are various stressors related to organization that is affecting the employee (Sharma, 2015). Furthermore, there are proofs from study that suggested occupational stress had already manifested within hazardous working practices, diminishing of quantity and also quality of achievement at work as well as accuracy (Ibem et al., 2012).

Occupational stressors are considered numerous work-related stressors which would adversely affect the achievement and also the well-being of an employee as they exist in all organizations, however their degree could vary between each occupation and also individuals. Occupational stress is also believed to be a major contributing factor to low commitment, low morality and also absenteeism which directly implicated on the development of the organization and also its profitability (Leung et al., 2015). Therefore, ample organizations have then realized the significance of raising issues of work-related stresses. Besides, there is a concurrence that vivid, continuous and repetitive work stress could be unfavourable to the both the individual and also the productivity of the organization in work achievement thus deserving more researching considerations.

Throughout the few previous decades, the construction industry has observed the critical transformation globally of both organization and institutional. Constant alteration of building processes, complexity and pace of work and also increment of demand for greater productivity had become a basic yet compulsory factor within the construction industry. These are the outcome of globalizations of both the markets and economies, changes in consumer desire and also technological improvement. As a matter of fact, the progressive and complicated

nature, distinct backgrounds and aggressive approach of players are also considered to be contributing factors that notably influences the remarkable changes within the construction industry (Ibem et al., 2012). Therefore, as a result, the professionals and workforce in this particular sector operates in a tremendous competitive environment which projects are designed, constructed and also delivered in a rather tight period and also budget. When combining all of these, the construction industry is then made emotionally, physically and also mentally demanding and stressful. Approximately 80% of construction personnel suffered from anxiety, depression or pressure as a direct outcome working in the construction industry (R.Praveen & N.Nandhini, 2017).

LITERATURE REVIEW

All jobs are potentially stressful, although the stress varies widely. Some jobs are extremely boring, for example involving machine monitoring or property guarding. And others are over-stimulating and physically demanding, leading to exhaustion. Occupational stress is one of the most concern issues and is recognized world-wide as a major challenge to worker's health and the healthiness of their organizations (Shyuan, 2014).

In order to ensure the project is completed on time, within budget, and to specification, it is not surprising that QS are experiencing high stress level. This is due to long hours working, high workloads and most importantly is the high degree of accuracy required in the quality of work performed (Shyuan, 2014).

Roles and Responsibilities of Quantity Surveyor (QS)

Table 1. Roles and Responsibilities of Quantity Surveyor

Stage	Duties of the Quantity Surveyor
Feasibility Study	<ul style="list-style-type: none"> Initial cost indications based on similar and recently completed buildings Cost implications from site conditions
Outline Proposal	<ul style="list-style-type: none"> Preparing rough estimates based on client's needs and requirements Aid client in developing budget or cost limit
Preliminary Design	<ul style="list-style-type: none"> Preparing the preliminary estimates and initial cost plan Establishing group element cost targets Cost studying on the design options Comparison of client's budget and cost limits
Detailed Design	<ul style="list-style-type: none"> Detailed estimation Preparing of amplified cost plan and elemental cost plan Establishing group element cost targets Comparison of client's earlier estimates and budget Cost checks to acquire best resolution in each element while drawings are produced
Final Design	<ul style="list-style-type: none"> Preparing the tender documents (e.g. Bills of Quantities) Continue cost checking and acquiring quotations from specialists Pre-Tender estimate
Tender Period	<ul style="list-style-type: none"> Attending or addressing to tenderers' queries
Tender Evaluation	<ul style="list-style-type: none"> Evaluating the received tender Comparing tender sum with the estimated costs and preparing the reconciliation statement Advising the client on the selection of contractor and courses of actions that need to be taken
Award of contract	<ul style="list-style-type: none"> Preparing the letter of acceptance when client has already approved the tender Compiling documents and preparing the contract documentation (including the selection of forms of contract and drafting the conditions included)

Stage	Duties of the Quantity Surveyor
Construction	<ul style="list-style-type: none"> • Prepare valuations for payments on account at the intervals stated in the contract (usually once a month) and agree with contractor's quantity surveyor • Plot payments on account on "rate of spend" graph and report to architect on any significance divergence • Advise client on expenditure of provisional sums, measure and value work carried out by the main contractor against provisional sums (except where lump sum quotations have been accepted) and make necessary adjustment. • Prepare estimates of likely cost of variations on receipt of copies of architect's instruction • Measure and value, check and price the daywork voucher • Advise client on expenditure on prime cost sums, check nominated subcontractors' and nominated suppliers' final account and adjust contract sum accordingly • Prepare financial reports for architect and client at the same time as interim payments • Check main contractor's claims for increase in costs of labour, and materials etc., if applicable. Alternatively, apply price adjustment indices to amounts included in interim valuations • Measure projects based on schedules of rates or on bills of approximate quantities as the work proceeds, either on site or from architect's drawings, and value at contract rates • Advise client on contractor's claims (if any) for loss and expense payments. If accepted, negotiate claims with contractors
Completion of project and defects liability period	<ul style="list-style-type: none"> • Advise client on extension of time and imposition of liquidated damages • Finalize project accounts • Feedback on cost data and prepare cost analysis of completed projects. Contribute to cost database for use in future projects

(Shyuan, 2014)

Definition of Stress

Stress is being defined as a harmful emotional and physical response that would take place when the prerequisite of a job would not match the capabilities, needs and also resources of an employee (Patching & Best, 2014). (Patching & Best, 2014) also mentioned that stresses are being managed by a particular part of a brain that overlooks the emotional memories that regulates certain processes of the autocratic nervous system by concealing neurohormones.

Causes of Stress

Table 2. Seven (7) Major Causes of Occupational Stresses of QS

Job Traits	<ul style="list-style-type: none"> i. Amount of task undertaken, ii. Decision-making, iii. Deadlines, iv. Physical conditions & v. Responsibilities over another person (the most stressful jobs are commonly those that require one to be responsible over another one or knowingly of a great possibility of being in physical danger).
Role within Organization/Firm	<ul style="list-style-type: none"> i. Lack of Autonomy, ii. Role Ambiguity, iii. Conflict of Role, iv. Position of Influence & v. Remuneration level relative to others.
Interpersonal Relationships	With: <ul style="list-style-type: none"> • Superiors, • Subordinates, • Colleagues, • Friends & • Families.

Career Development Tension	When they are: <ul style="list-style-type: none"> • Unclear goals, • Lack of abilities, • Reaching ceiling for promotions, • Failing to satisfy personal desires of learning, uses of skills, challenges & variety.
Structure & Climate of Organization	<ul style="list-style-type: none"> • Predominant ethics, • Change of pace, • Bureaucracy levels & • Insecurities.
Interaction between Work & Private Life	The ever-conflicting necessities of: <ul style="list-style-type: none"> • Work, • Families, • Financial commitments or • Excessive needs from either side.
Internal Pleasures	<ul style="list-style-type: none"> • Inferior self-image, • Fear of failing; • Poor time-management & • Perfectionism.

METHODOLOGY

60 questionnaires survey collected. The respondents were junior and senior QS working with the consultant firm. The surveys forms were analysed sing statistical package for social science (SPSS) using descriptive analysis.

ANALYSIS AND FINDINGS

This section represents the findings from analysis and reviewing process of relevant literatures to identify the factors causing occupational stress. The work work-nature related factors been tabulated in the table below.

Table 3. Work-nature related factors mean ranking

Factors	Mean
1. I have high unachievable/tight deadlines.	3.77
2. I frequently find my job boring and repetitive.	3.66
3. I frequently spend my evenings and weekends finishing my work.	3.62
4. I am given very little responsibility.	3.33

Table 4. Organizational related factors mean ranking

Factors	Mean
1. I am not charged with sufficient authorities to perform my daily works satisfactorily.	3.84
2. Many of the rules/procedures make doing a good job difficult.	3.80
3. There is too little chance for promotion in my present position.	3.80
4. Fairly compensated for the work I do and the hours I devote.	3.79
5. I am working in more than one project and I find it difficult to assign fair effort to each of them.	3.67
6. My superior is not competent enough in his/her duties.	3.67
7. I feel insecure about my job. (e.g. fear of redundancy)	3.64

Table 5. Relationship related factors mean ranking

Factors	Mean
1. I don't feel easy with the way my superior handles his men.	3.82
2. My superior does not appreciate my effort.	3.72
3. The counter players of my project are difficult to work with.	3.72
4. I have a good relationship with my superiors.	3.44
5. I don't like the people (colleagues) I work with.	3.36

Table 6. Cronbach's Alpha Analysis on factors causing the occupational stress

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.919	.920	16

Based on the result produced using Cronbach's Alpha analysis on factors causing occupational stress, the variables in this section are able to achieve a coefficient of .919. In accordance to George and Mallery (2003) rule of output interpretation for Cronbach's Alpha, the coefficient that was acquired throughout this section is defined as excellent. Therefore, the data and results of this section are justified as highly reliable. Table 7 showed the effects of the occupational stress among QS.

Table 7. Effects of occupational stress

Factors	Mean
1. Job worries sometimes get me down physically.	3.92
2. I feel tired even with adequate sleep.	3.75
3. I feel frustrated in carrying out my responsibilities at work.	3.72
4. I am having difficulty concentrating.	3.69
5. I am moody, irritable, or impatient over small inconveniences.	3.67
6. Problems associated with my job have kept me awake at night.	3.61
7. I have unexplained and frequent headaches at work.	3.61
8. I feel little enthusiasm for doing my job.	3.57
9. I often "take my job home with me" in the sense that I think about it when doing other things.	3.52
10. I suffer frequent indigestion after meals.	3.46

Table 8. Section D Cronbach's Alpha analysis on effect of occupational stress

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.920	.921	10

Based on the results produced using Cronbach's Alpha analysis, the variables of this section are able to achieve a coefficient of .920. Based on George and Mallery (2003) rule of output interpretation of Cronbach's Alpha, the coefficient that is being interpreted for this section is considered as excellent. Therefore, the data acquired from this section is considered as highly reliable.

CONCLUSION

Critical areas in the researched have been highlighted which are, factors causing occupational stresses of QS and the effects of occupational stresses towards the well-being of QS. The factors of occupational stress could be categorized into three (3) different categories which is work-nature related, organizational related and also relationship related. Based on the result from the data, the common stressors under work-related stressors are having high unachievable or tight deadlines. The presence of such stressor has always been omnipresent in most occupation but rather common within the construction industry. Commonly, employee would be given heavy workload and be expected to complete it within a very short time frame and as the employee race against time a significant level of stress would arise. As mentioned in literature review, work overloading is considered as a major stressor for QS. Work overloading occurs when the employee experienced stress symptoms from having too much to cope with within a limited timeframe which eventually would lead to absenteeism and also lower self-esteem.

The results from the data has shown that not being charged with sufficient authorities to perform daily works satisfactorily is the common stress inducer under organizational-related stressors. As the employee is not given enough autonomy to execute the work independently, they might experience stresses due to the constraints and limitations being set. As mentioned in the literature review from a journal, the lack of autonomy is one of the stressors of QS. The journal has also mentioned that professionals would experience stress when there is an absence of control and discretion over their daily exercise which eventually would forsake their desire to complete the assigned task.

In addition, the results from the data has also shown that not being satisfied with superior handling his men is the most common stressor under relationship related stressors. As the employee experiences dissatisfaction of how the superior assign tasks to him or herself, the employee would be exposed to a certain extent of stress due to the dissatisfaction which would result from either being workload or underload and also role ambiguity. As mentioned in the literature review, experiencing work overload or underload and also experiencing role ambiguity is also the major stressors of QS. Due to experiencing role ambiguity, the employee would doubt their significance to the tasks assigned or assessments. Besides, the result from this section has gone through reliability analysis which could prove its degree of reliability.

The effects of occupational stresses frequently experienced being physically down sometimes due to job worries as the most common and frequent effect of occupational stresses towards their well-being. As employees are not able to cope with the stresses efficiently with proper guidance, they are prone to experience the effects of the stress which would vary in different stages of severity. Besides, the results acquired could also relate to literature review, as the results could be generalized as being physical and emotional fatigue, feeling vague, irritability and also experiencing sleep disturbances would also cause the employee to feel physically down. Furthermore, the results being acquired in this section has also went through reliability test which has proven its degree of reliability.

Besides, based on the data that had been analysed, there is a noticeable gap among the educational levels of the respondents. It could be concluded that majority of the respondent is only Degree holders. Based on this finding on a surface level, it could by hypothesized that the education levels of QS do not have any effect towards the stress levels they are experiencing as most of the respondent had broadly admitted to facing stresses at workplace. However, the severity of the stresses being experienced could not be determined through the data acquired. Therefore, an in-depth study could be done regarding the relationship of education levels and occupational stress levels being experienced.

Furthermore, based on the same data, there is also a protruding fact regarding the gap of the respondent's gender. It is concluded that there are more male respondents. Therefore, it could be theorized that there are more male QS working as consultants compared to other construction stakeholders' field. Based on the mentioned theory, it could also be hypothesized on a preliminary level that there is more male working as consultant QS as men are able to cope with stress better compared to women.

This is due to being working as a consultant would have to be responsible for the project the entire period. Therefore, having such a large job scope would induce a significant level of

stress. Nonetheless, further studies should be carried out regarding the relationship between gender and level of occupational stresses experienced.

In addition, there is also a significant gap between both the ages of the respondents and the working experience in regards of experiencing occupational stresses. A majority of the respondent's age is 29 or less with working experience of lesser than 5 years. Based on this finding, it could be concluded that there are more numbers of young QS within the industry compared to other older age groups. Besides, based on the same hypothesis, it could be hypothesized that the younger generations of QS are experiencing more occupational stresses as works are being pushed towards the younger QS. Furthermore, it could be theorized that the young QS are not able to cope or adapt to a new working environment thus inducing a great amount of stresses to themselves. Therefore, their psychological well-being is at constant threat without proper stress-coping strategies.

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CHALLENGES FACED BY QUANTITY SURVEYING FIRM WHEN EXPANDING ABROAD: AN INSIGHT FROM MALAYSIA'S QUANTITY SURVEYOR

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Abstract

There are numerous considerations that present themselves to firms that plan to expand into foreign markets. Firms need to identify and map out the appropriate strategies for how it will plan its objectives, configure its growth and structure its procurement method. It was found that diversifying into new markets or services was one of the main strategies used for expanding into developing markets abroad. A firm also needs to understand how to leverage itself in new markets using its competitive advantages, in order to overcome issues that are faced in when venturing overseas. Therefore, this paper will to discuss the challenges faced by Quantity Surveying firms when expanding their business abroad. The structured questionnaire, which was derived from descriptive study of literature review are the two sources of methodology, used for this study. The research will focus on active Quantity Surveyors Consultant Practices that are registered with Board of Quantity Surveyor Malaysia (BQSM) and are situated within the Klang Valley. Data will be gathered through the use of an online questionnaire that will be sent to the sample size of 134 consultancies within the target population. The finding of this study aims to further the field of knowledge within this subject matter.

Keywords: *Challenge; Quantity Surveying; Firm; Issues; Internationalisation.*

INTRODUCTION

The global construction industry is one of the fastest growing industries, with booming populations and sprawling urbanization fuelling development of bigger and bigger cities (Cook, 2015). According to the UN Department of Economic and Social Affairs and the World Bank, this trend will continue beyond 2030 with estimates forecasting the urbanization to account for 60% of the world's population (Cook, 2015) and the global construction industry set to grow to US\$17.5 trillion by 2030 (OEGCP, 2015). To facilitate increasing urbanization, investment in global infrastructure of approximately \$57 trillion will be required by 2030 creating ample opportunities for construction firms that can capitalise on these new international ventures (Cook, 2015).

The Malaysian construction industry is growing at a similar pace alongside the global market, with growth estimated at 4% of GDP for 2014 and forecasted to hit 5% of GDP by 2020 (CIDB, 2015). It is estimated that from 2011-2014 alone there was an accumulated value of RM500 billion worth of construction carried out in the market, with an expected increase of 8% per annum (CIDB, 2015), making it an attractive market for investment and development.

In order to capitalise on increasing global trade, the Malaysian government has been taking steps to liberalise the service sector under the ASEAN Framework Agreement for Services (AFAS) and General Agreement on Trade in Services (GATS) and the Trans-pacific Partnership Agreement (TPPA). This is done with the intention of improving capacity, productivity and efficiency of the services sector so that market openings can be exploited,

and further growth is facilitated (Abdul-Aziz 2013). With these changes, CIDB in conjunction with the Ministry of Works has embarked on a comprehensive and far reaching “Construction Transformation Programme” (CIDB, 2015). The long-term goal of this plan is to transform the construction industry by “Accelerating the development of the Malaysian construction industry and preparing it to meet the future demands of the economy” which will call upon the participation of various stakeholders within the industry (CIDB, 2015).

Such policy changes within the construction industry has facilitated the emergence of more foreign competition. This is having a notable impact on the construction market, where CIDB has tracked sharp increase in contract value awarded to foreign firms since the end of the 2008 financial crisis (CIDB, 2015). In 2008 foreign market share of contracts amounted to 9% of contract value awarded whereas it rose to 22% in 2014 to RM33 billion (CIDB, 2015). From 2013 to 2014 foreign contractors saw a 119% increase in private contracts and in 2016 foreign contractors acquired 37% of projects in the Malaysian market (CIDB, 2015).

On the other hand, Malaysia has been improving its presence on the global stage, acquiring construction projects around the globe with an estimated value of RM11 billion from the period of 2012-2017, with majority of the value of these contracts originating from ASEAN and the Middle East (CIDB, 2017). It is worth noting however that there has been a declining trend as in 2017 projects awarded to Malaysian contractors were valued at RM655 million, down approximately RM5 billion from 2012 (CIDB, 2017).

In summary, Malaysian construction industry is becoming increasingly globalized with the efforts of the governing bodies and market forces. One can surmise that expanding internationally is the next logical step for the industry to evolve, in order to keep pace with competition and to cater for the increasing complexity of projects.

LITERATURE REVIEW

Globalization has created pressure for governments to open up their nations to attract foreign capital and in turn allow investors access to their economies (Siddiqui, 2015). As a consequence of this it has forced local firms to adapt to increasing foreign competition due to markets that have been liberalised and deregulated (Wang, 2016). These changes have created pressures on Quantity Surveyors as foreign competitors begin to increase in presence and carve up more of the market each passing year with the award of more public and private contracts (CIDB, 2015).

It is imperative that the challenges for Malaysian QS expanding abroad be studied due to changes in the competitive landscape both globally and domestically. According to Abdul-Aziz et al. (2011) it was found that despite having the interest to review the possibility of venturing abroad these ambitions seem to fall short of their potential. Malaysian QS profession have continued to neglect international markets as only 21 QS firms were found to have been involved in overseas projects in 2015 (Professional Services Development Corporation, 2015) which continue to remain low compared to other major sub-sectors such as engineering and architecture (Wang, 2016).

The QS profession is governed by the BQSM, which oversees membership to the professional body. A QS must obtain the accredited qualifications as required and meet other

professional and technical requirements in order to be qualified to work within the industry. Registering also allows them to obtain professional recognition by granting them to attach certain prefix and postfix as given by the Board. There are currently 355 registered firms in Malaysia, of which are 825 registered consultants and 685 registered professional QS (BQSM, 2018). According to the Royal Institution of Surveyor Malaysia (RISM), some of the basic services a QS typically provides include advise on cost estimates, procurement and contract management, the preparation of Bills of Quantities (BQ), interim payments, valuating variations, as well as preparing and settling the final accounts. If required there may also be the provision of other additional services such as feasibility studies, prequalification evaluations, comparative cost studies, life cycle costing, auditing of contracts and so forth (RISM, 2018).

BQSM and RISM have outward looking visions and missions in respect of addressing globalization. One of the BQSM's mission is to "to promote the growth of a world class quantity surveying and cost engineering profession through regulation and continuous professional development" (BQSM, 2018). Whereas RISM's long-term vision is "to be recognized as an innovative and dynamic world-class professional surveying Institution" (RISM, 2018). Thus, it can be fair to say that the Malaysian QS profession has global ambitions.

Therefore, a need to look beyond our borders is required, to see where the profession is heading as technology and social trends move the industry forward (Lu et al., 2013). According to recent studies by the RICS (Cook, 2015), the profession is expected to undergo drastic changes in the future as the role and range of services typically provided by the QS will deviate from traditional work; transactional activity, administrative tasks, and residential valuations. Instead there will be a rise in demand for interdisciplinary work, integrated programme and cost management, change management, risk management and other services. There will also be the development of more specialised areas of work, that are centred around Building Index Modelling (BIM), Building Energy Modelling (BEM) and Sustainable Development (SD) (Cook, 2015). Whether Malaysian QS are willing to go abroad or not, the international market and its demands will impact the industry. The important matter is whether going forward, Malaysian firms decide to be proactive or reactive when it comes to opportunities and changes due to internationalisation.

METHODOLOGY

The research method that was applied was a quantitative analysis to help review the important challenges that need to be considered for foreign ventures. A Questionnaire survey was used to achieve the targeted aim and objectives which was supported by the framework and knowledge gathered from the literature review. On this basis, questions were designed to solicit the respondents view by emailing out the survey in the format of Google Forms. Responses are gathered from the consultant firms that have completed and submitted the questionnaire. The data is analysed to help discuss the outcome and conclusion of the questionnaire, which are followed up with recommendations that might help address the problem.

Questionnaire was the main means of surveying the population as it provides an efficient means of asking a large set of questions to large sample populations. The questionnaire was

designed based on the findings of the literature review and their demonstrated research methodologies and questionnaire approach. Reoccurring and important factors relating to the research objectives were identified from the literature and grouped into the constructs to form a theoretical framework in which to frame and conduct the study.

Although the ideal target respondent would have been the top managers as they are the decision makers for the firm, the questionnaire was also aimed at other respondents; i.e. directors, associates, managers and QS. This was due to the fact that not only would it be hard to limit the audience and expect top managers to have a good response rate considering their time constraints, but to also consider that the middle managers and consultants could be the executives of tomorrow (Llewellyn, 2012).

Once the questionnaire was finalised, it was prepared in Google Forms as a means of communicating the survey. The questionnaire was distributed via email to the target sample population. This also included a cover letter within the email, explaining the background; researcher, objectives and purpose of the study and assuring the anonymity of the respondent. As there are no reliable means of finding a list of firms that are international as no such data can be obtained, the questionnaire was circulated to all consultant QS firms within Selangor and Wilayah.

ANALYSIS AND FINDINGS

The questionnaire was randomly distributed according to the determined sample size, where QS Consultancies within Klang Valley were selected, and emailed the Google Form and Covering Letter. In order to counter the initial low rate of response during the first week, firms that had been selected were contacted via phone in order to request for assistance in relaying the survey appropriately. This was repeated on a weekly basis, in order to remind and request anyone in contact to complete or forward on the form. This helped raise the response rate and by the end of the 3rd week, the data collection period was completed. Refer to Table 4.1 on the summary of the data collection stages.

Out of the sample size that was required of 134 distributed questionnaires, only a total of 54 respondents managed to complete and submit before the end of three-week collection period. The rate of response therefore fell at 40% which was lower than what would have been ideal, but still within what would be considered an average rate of return for such surveys.

By referring to Table 1, the highest ranked challenges that were of concern were the “Political Stability” of the host country (3.91), “Rules and Regulations” that would apply (3.89) and determining if the “Market Growth and Size” were sufficient to warrant the risk (3.76). The least concerning challenge were the “Distance and Connectivity” to Malaysia (2.61) and the possibility of having “Higher Client Requirements” (2.63). Political climate and the respective rules and regulations are a major barrier that can make it risky or complicated to enter a foreign market. At the same time this might be outweighed by the importance of the market’s growth and potential for firms. Distance may be of little concern as travelling for business is more customary while at the same time being less frequent with the use of information communication technology. Firms may also be accustomed or capable of addressing any higher client requirements, making it less of a concern.

Table 1. Descriptive Statistics of Challenges faced in Foreign Markets

No	Important Challenges in Foreign Markets	Mean	Standard Deviation
1	Political Stability	3.91	0.680
2	Rules and Regulations	3.89	0.718
3	Market Growth and Size	3.76	0.823
4	Cultural Differences	3.57	0.721
5	Transparency and Corruption	3.43	0.716
6	Ownership and Investment Restrictions	3.32	0.754
7	Higher Client Requirements	2.63	1.121
8	Distance and Connectivity	2.61	1.054

By referring to Table 2, the reliability analysis for this data set was executed using Cronbach's alpha to check the credibility and consistency of the respondent answer. With the resulting calculating being .739, this placed the data as being reliable.

Table 2. Cronbach's Alpha Reliability Test for Challenges in Foreign Markets

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.739	.722	8

CONCLUSION

This research study discusses what challenges firms faced when entering into a foreign market. There were a variety of challenges that companies faced that were examined within the literature that was covered. From all these potential challenges, the most prevalent were organized into groups of challenges; Economic, Legal and Regulatory, Political, Socio-Cultural. The challenges were then posed through the questionnaire to see how they compared to the views of the respondents. The research findings corroborated the importance placed on having a host country that has "Political Stability". "Rules and Regulations" were also regarded as a challenge that should be considered sufficiently, as it can be a major barrier or deterrent when there is a risk or difficulty in understanding and adhering to unfamiliar rules and laws. Potential "Market growth and size" was found to be of a higher significance compared to the degree of importance it was placed in other studies. Perhaps this might be since the potential reward need outweigh the higher perceived risk. Foreign firms might be more willing to take risks compared to their Malaysian counterparts who in some cases may have comparatively less experience and are less entrepreneurial. This is also supported by the preference Malaysian firms have to expand into developing and emerging markets that have a higher rate of growth and that might be easier to gain leverage over less developed or experienced host firms. Although the percentage of firms that are currently engaged in foreign projects is still a small proportion, the attitudes towards expanding abroad are favourable and there is optimism in the face of the new government changes. In contrast, the perceived pressure from liberalization may spur more firms to take the chance abroad as foreign competition in our domestic market continues to increase.

In order to further improve the potential of QS firms expanding abroad, more measures need to be taken to raise awareness and support from government and institutions. Although government support was regarded as being a low factor of influence, (Abdul-Aziz, 2011) highlighted numerous initiatives that could be utilised more. More forums, conventions, delegations and conferences are also an avenue that is underutilised but can still help improve

networking, market intelligence and build up more foreign contacts for local firms, which are all important competitive advantages. By being proactive across the industry rather than being reactive to demand led procurement, the Malaysian QS industry will have a better chance of acquiring foreign projects.

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THE EVOLUTION OF QUANTITY SURVEYORS AND THE FORESHADOWING OF AMALGAMATING ROLES IN THE MALAYSIAN CONSTRUCTION INDUSTRY

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Abstract

As quantity surveyors (QS) begin their foray into the Fourth Industrial Revolution, there is a need to adapt to changing landscapes within the construction industry. However, to do so would require for the profession to first understand where it came from, where it has grown, and how it can grow as a result. One possible means of doing so is to explore interdisciplinary approaches at expansion of roles, and how this can achieve better results within delivering value to clients in the long run. The objectives of this research were 1) To determine if the traditional QS is still relevant in the modern times and to explore the consequences of stagnation. 2) To discover the routes of evolution that the QS has taken as a profession so that future pathways may be established. 3) To establish a more wholistic, interdisciplinary role for the QS to play. This research was carried out qualitatively based on interviews which were based on readings and review of relevant literature in order to gauge the possible routes of expansion, and perceptions about evolution of the profession. The sample frame was limited to professionals in the construction industry working within the aggressively developing region of the Klang Valley, divided between professionals who are involved in more traditional roles and those who are involved in expanded roles. The research yielded results favouring a need for the profession to create more avenues for satisfying clients' needs, through greater involvement in interdisciplinary project management, contracts administration, and whole life cycle costing with control, along with expansion into business minded strategic management of assets. Furthermore, it was found that while the future will hold more room for consultancy firms shared between the separate professions to blossom, as increased communication and collaboration proves to add value to the construction industry, challenges like lack of accountability will need to be addressed. Recommendations put forward from this research allows the QS to create a larger and more relevant role to play in a rapidly changing industry.

Keywords: *Quantity Surveyor; Evolution; Interdisciplinary; Collaboration; Industrial Revolution.*

INTRODUCTION

The delineation among practitioners of the basic components of QS profession is the taking-off of materials and cost estimation of construction (The Association of South African Quantity Surveyors, n.d.). Among the foremost authorities, the Royal Institute of Chartered Surveyors (RICS) proclaimed the basic QS services should consist of measurement and fair evaluation of a projects' cost for the purpose of cost control, planning, analytics and maintenance of accounts (RICS, 1971) which they updated in 1998 to include proficiencies in construction law, professional practice and general business skills (RICS, 1998).

As time progressed, the bargaining power behind the QS had plummeted at the end of the 20th century. Government policy in the UK reduced scale of standardized fees which the QS's relied upon, rendering project securement through open tendering and competition (Cartlidge, 2011). Several reasons perpetuated this fact including the rampant effects of cost overruns in projects. In addition, the construction bust which followed led to a market decrease in available projects and job opportunities for QS, being considered an imminent catastrophe (Cartlidge, 2011). Following these events, quantity surveyors searched for alternatives to

secure their livelihoods resulting in an expansion of the profession in wholesome in terms of differentiations which included arbitration and expert services, accounts management, business management, claims and dispute resolution, feasibility studies and financial auditing (Wanda et al., 2016).

Presently quantity surveying can be portrayed as the combination between the lawyer, the accountant and the engineer, being equal parts of these professions, but to specifically serve within the construction industry demonstrating a balance of power. However, with the introduction of new ideas, innovations and influences, existing models of work. Prime examples of these are Building Information Modelling (BIM), updated block chain systems and even artificial intelligence. Although the momentum of BIM in Malaysia has been slow because of misconceptions of rendering the profession irrelevant. Nevertheless, QS thrive with many differentiating themselves from the other. To the QS with experience and years of practice, roles of the architect as superintending officer and contracts administrator or even the role of engineer, as MEP quantifiers/ consultant are available to them.

The research aims to understand the pathway the QS has evolved from and to gauge the future paths that the profession may evolve towards bearing in mind interdisciplinary methods. The objectives are as such: 1) To determine if the traditional QS is still relevant in the modern times and to explore the consequences of stagnation. 2) To discover the routes of evolution that the QS has taken as a profession so that future pathways may be established. 3) To establish a more wholistic, interdisciplinary role for the QS to play.

Currently the many construction practices are observed to be separate in trade and practice. This division results in decreased collaboration, knowledge sharing and coordination, which serves only to reduce efficiency of the overall project as hypothesized by Blough (1983) (cited by Ramqvist, 2013) and manifests as detriments to time, cost and quality. In order to mitigate these effects, an interdisciplinary approach should be explored to encourage better cooperation within projects. Examining this approach from a QS standpoint may grant a notion of change as the profession itself requires revitalization.

LITERATURE REVIEW

The Background of the Profession

Evidence observe QS emergence resulting from the separation of architects from surveyors in 1834 due to a schism (Cartlidge, 2011). Pre-Victorian views suggest that architects were at the apex of construction performing the roles of builders, surveyor's designers and engineers (Crook, 1969). The perspectives lead to the conclusion that roles of quantifying works, estimating, cost management and management of payments are an integral part of the construction process. Smith (2004) lists certain typical services which has formed the core of Quantity Surveyors professional roles, henceforth known as traditional services. Procurement advice and cost control are also included to be traditional aspects (Moss, 2004).

The Present Day

For a time, as long as projects remained under single stage tendering with traditional based procurement, the competencies and core services would suffice (Cartlidge, 2011).

However certain parties express that stagnation of QS duties could cause irrelevancy of the profession as most professionals are able to perform mere multiplication and arithmetic. The Quantity Surveyors would have to remain dynamic to avoid extinction (Thayaparan et al., 2011).

Creating new value for clients through upstream and downstream diversification is a must for the QS. This upstream expansion refers to different routes of procurement and affects the client's decision. This concurs with the view held by Bass (2017) stating the combination of downstream and upstream processes will result in an integrated output.

Presently the QS has expanded from traditional services. With the addition of services of commercial management, adjudication and implementation of Green Building Index (GBI), firms in Malaysia are seeking to become more competitive. Another possibility is in value management whereby as value engineers the QS must understand a design question and integrate solutions to import maximum value to the project (Male & Kelly, 2008). Oke and Ogunsemi (2016) suggest this area be added to QS competencies because of the potential benefits to be obtained. In Project management, the QS discern the needs of the client with regards to the project as his/ her agent (Cunningham, 2014). This entails coordination of the parties to the project in order to ensure scheduled delivery of the product. QS are finding management roles such as these well suited to their skills (Nkado, n.d.). These expanded roles are further elaborated in Heading 2.3 "The Future of the Profession".

Wearing (Too) Many Hats

Olannewaju and Anahwe (2015) argue that QS are not able to perform cost estimation and budgetary control in civil engineering projects which incurs inaccuracies due to lack of formal education and training specific to civil engineers. However, Oluwatosin (2016) opined that the QS, given the right background and experience would be able to produce sufficient results. Furthermore, it elaborates on the QS role as an M&E quantifier with the individual's capacity. Osubur (2017) concurs that value for money and cost engineering in civil engineering projects must still be carried out by QS provided with proper training coupled with the expansion of the existing syllabus. QS have been identified to be best suited for management roles such as construction project manager due to their adept knowledge of cost control and contracts administration (Rolf & Chileshe, 2006). However, it should be noted that an issue with a focused view on project management as QS from the outset of the career path could result in a lack of competencies (Smith, 2014). In fact, the QS should be aware of the potential weaknesses and strengths in order to mitigate such an outcome. The strengths and weaknesses are listed in Table 1 below.

Table 1. A Synopsis of Strengths and Weaknesses the Quantity Surveyor Faces as a Project Manager

Strengths	Weaknesses
Good at balancing the books	No design training
Well suited to understand the commercial aspects of the development process	The QS is not normally responsible for driving projects forward
The financial acumen makes them prime candidates to head PFI teams	Little training in negotiating and management skills
A business training is well suited to the inception, bidding and construction stages of a project	Poorly developed people skills

(Source: Rolf, 2005)

The Future of the Profession

The QS is expected to shift in various ways in the future, Factors such as greater focus on client development, application of information and communication technology are driving the push forward (Thanyaparan et al., 2011). This is corroborated by Smith (2004), referencing computer aided design (CAD) as a major player in IT and relationship with the future QS. He also mentions interdisciplinary practices will become the norm where in-house services are rendered by QS rather than the split consultancies which are the norm today (di Castri & Ray, 2013). Wao (2015) relates these elements of IT advancements, representation of the employer and project management among other things that will enable the QS to be among the top in the construction industry.

Moving forward, Yeshwanth (2017) states that early engagement of QS at the development stage contributes to decisions and requirements in greater depths. A list of the QS possible evolved roles stated by Wanda et al. (2016) are listed in Table 2.

Table 2. Cross Comparison of the QS's Traditional, Evolved, & Future Roles

Traditional	Evolved	Future
Preliminary cost estimates	Insurance advice	Whole-life costing
Preparation of bills of quantities and other documents	Preparation of development appraisals. Facilities management and development	Strategic planning
Contracts administration	Cost-benefit analysis	BIM management
Specifications preparation	Value engineering	Auditing
	Project management	Project valuation
	Commercial management	Taxation advice
	Arbitration and adjudication	Due diligence
	Environmental impact analysis	

(Sources: Smith, 2004; RICS 2014; Wanda et al., 2016)

Challenges & Opportunities

In examining the future, it would be unwise to view new patterns of change without accounting for the possible challenges and opportunities. Free competition; at one point in time Quantity Surveyors used to rely on fee scales which were regulated by RICS. However, the average fee was pushed down to 1.7% of the total construction cost with the introduction of compulsory competitive tendering (CCT). Ling (2014) states the resultant effects were tighter profit margins on the everyday QS. This is completely opposed to the effect which shows that first rate market services are brought on by higher levels of remuneration (Hannah, et al. (2009). The worst thing is that it continues due to a feedback loop, where firms continue offering unsustainably low fees due to market conditions (Davies et al., 2006).

CAD and Software based Taking Off; there is delineation among QS of the threat of being side swept as technical measurer because of low adaptability and high cost of the software (Smith, 2004). In and of itself CAD based software is an extremely useful tool, relieving the QS of the technical aspects of the profession to handle more lofty aspects (Smith, 2014).

Traditionalism; Based on previous facts, traditional education systems within the construction and the industry itself being traditional by structure, QS find themselves afflicted by rampant traditionalism (Crowley & Hons, 2013). Competition between professions; as

previously mentioned the uptake of roles of other professions by architects still happens to a certain extent at the expense of the QS. Notably civil engineers engage in cost engineering and quantification in engineering projects bypassing the QS (Osubur, 2017). Frei et al. (2013) state unless collective action is taken to disavow the ideas that the QS is not crucial to project success, this could result in greater incursions by other professions into QS related areas.

Green Building; Cartlidge (2011) emphasizes accountability of our actions in built environment and that it must be regulated. Opportunity in this respect arises from for QS as 40% of the waste and greenhouse gases are produced by construction (Ametepey et al., 2015). Olayeni (2017) highlight several ways of that QS can be involved such as through quantification of water and wastewater savings, and energy consumption. **Career Specialization and broadening;** The QS, versatile in nature, may specialize into a particular field. Smith (2004) states a variety of diversification prospects which include project management, facilities management and supply chain management. Some areas mentioned by Akinola et al. (2017) include arbitration, Facilities Management, contracting and project management. **BIM Management;** With the advent of BIM, quantity take off becomes more automated (Davidson, 2008). The QS is no longer burdened with finding dimensions on sketch drawings and engage in cost management or less technical aspects of the profession (Zainon et al., 2016). Furthermore, should databases be linked openly, the QS becomes borderless, able to share documents and work through digital means.

New Procurement Models; Requirements for different procurements are expected as clients become increasingly knowledgeable (Geddes, 2005). According to Frei & Mbachu (2009), the QS shall be privy to this new manner of expansion and transactions from technical to more professional, management type functions. Models like Private-Public Partnerships are more geared toward economic value and cost management.

Interdisciplinary Relationships

In Commonwealth countries mostly, interdisciplinary relationships between professions are not a norm per se. The schism of 1834 encouraged segregation between architects and surveyors. Crook (1969) recounts the divide going back even further to when architects and surveyors formed their own exclusive clubs out of animosity to one another with each seeing the other as inferior. Nichol and Piling (2000) state an attempt by the Leed Metropolitan university at an interdisciplinary approach through inculcating a modular framework, encouraging cohabitation and collaboration between the professions which resulted in failure due to lingering animosity. This is in fact the major cause for non-collaboration along with pre-held misconceptions about other professions.

According to Price (1997) this occurs when communication between tradesmen and designers and contract administration are separated by goal. He also mentions the need for open office collaborations rather than partitioning to encourage crisp communication and focused aim. Price (1997) points out the good in interdisciplinary approaches:

- It provides a one stop point for client to pass on information. It is not diluted, and is promptly communicated to other professionals
- Overall vision was maintained close to the focus of programme and budget
- It liberates the separate professions to carry out their specialties further, in that architects are free to design as QS carry out contract administration.

RESEARCH METHODOLOGY

This section explains the methodology which was used in approaching this research. An examination was carried out into the selection of the sample population, the types of data, which was collected, the procedure behind the collection of data, and the approach for the analyses of all data collected.

Research Design

The paper utilized a qualitative approach to research in view of the more exploratory nature of the subject. The study topic weighs heavily on gauging perceptions and gathering opinions as well as ascertaining more “human” elements such as emotions and subjective opinions. Furthermore, by selecting a qualitative approach, primary data is better built up by analysing the thoughts and concepts and the effects of certain collective decisions made within the Quantity Surveying profession.

Research Strategy

The research strategy was carried out in stages respective to a degree level dissertation. Figure 1 below represents the structure of the aforementioned strategy.

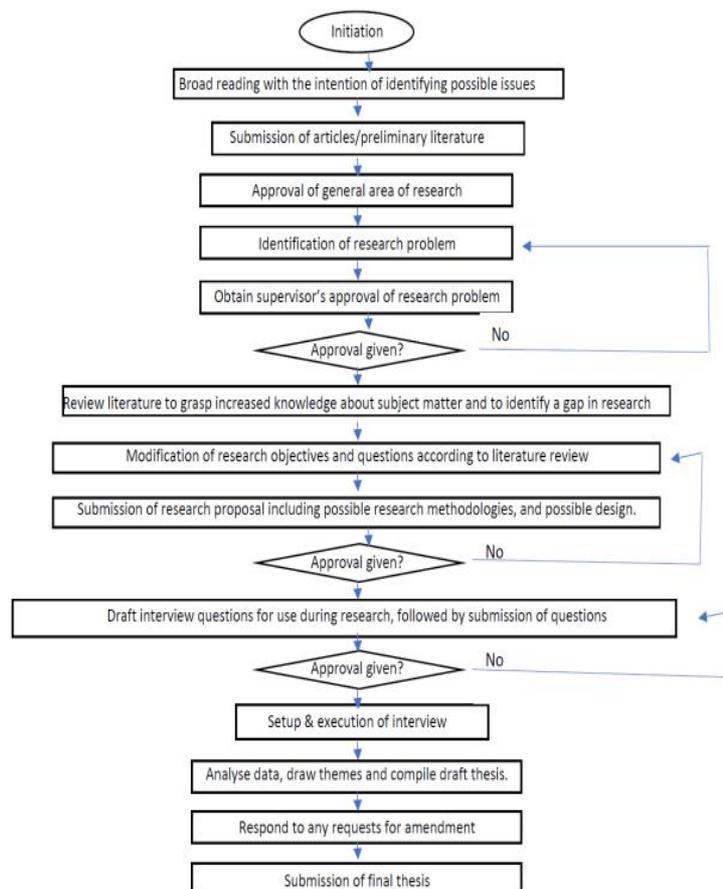


Figure 1. Diagrammatic explanation of the research process from initiation

Target Population & Research Sample

For this study, the target population and recipients for questioning were those within the intersection of the following:

- a) Professionals within the Malaysian construction industry.
- b) Those with experience relating to the discipline of quantity surveying.

In order to derive worthwhile data from the opinions and experiences of the individuals, purposive sampling was used. Interviews were then carried out, with preference to face to face format although telephone and written forms were considered as alternatives. The sampling ensured an even distribution between conventional and multi-disciplinary QS consultants with at least 5 years of experience to obtain quality responses.

RESEARCH & DATA COLLECTION METHOD

The manner in which data is collected is important as it grants an insight into how the data will be analysed, and as a result, the conclusions which are produced from there.

Library Research

The first approach of gathering data was library research. Such data gathering is considered secondary data, which data obtained from other authors works. However, these data banks formed the basis of the research, granting insight into the themes of the research question.

Field Research

Field research would produce the second form of data gathering in this study, which is primary data or data garnered originally by the author. A semi-structured format of interview was carried out with individuals described in Table 4. The questions are as follows in Table 3:

Table 3. Interview Questions and Associated Objectives

Question	Objective
What are the traditional roles of the QS?	Objective 1
What expanded roles do you think have grown within the QS profession?	Objective 2
Do you/ your firm carry out QS's expanded roles in your business operation?	Objective 2
How has the QS's role been encroached upon by other professions, if at all?	Objective 1
How effective is the QS at playing the roles of other professions/ expanded roles?	Objective 2
What is your opinion of interdisciplinary firms in construction?	Objective 3
How can interdisciplinary approaches be practically achieved in construction contexts?	Objective 3
What do you think is the perception of other professions towards the QS at the discussion table in terms of construction?	Objective 1
How can the QS take a more assertive and dominant stance in the construction industry?	Objective 1
Can there in the future be an amalgamated profession which combines the roles of engineer/ architect/S.O. /QS? How can this be?	Objective 3

Table 4. The list of interviewees

Interviewee Designation	Type of Practice
Director- Project Manager	Multi-disciplinary firm
General Manager- Property	Multi-disciplinary firm
Consultant QS – Expanded Professions, Contractor Based	Multi-disciplinary firm
Construction Consultant	Multi-disciplinary firm
Consultant QS	Multi-disciplinary firm
Consultant QS	Conventional QS firm
Consultant QS	Conventional QS firm
Managing Director	Conventional QS firm

DATA ANALYSIS

The data from the interviews were analysed in a manner consistent with thematic content analysis. This process involved transcribing into its original form, codifying, and then reducing it according to themes which appeared within the data. Following the reduction of data into themes they were analysed and compared for a conclusion to be drawn relating to the research objectives set out.

LIMITATIONS AND RESTRICTIONS

Certain limitations exist which pertain to this study. They are listed below for reference.

- Sample sizing – Due to the lack of support from industry participants in Malaysia, academic inquiry is limited by smaller sample size, in this case 8 interviewees. A larger sample size would grant more insight.
- Sensitivity of topic – The topic at hand may be considered sensitive to certain parties who have vested interests in maintaining the status quo or who are not familiar with new ideas.
- Qualitative research model – The research model used is exploratory and will not be able to answer the more technical questions and will not grant numerical insights into the matter.
- Locality – The research is conducted in the metropolitan area of the Greater Kuala Lumpur. Data may not apply to areas which are less developed, say like Perlis.

DATA PRESENTATION, ANALYSIS, AND DISCUSSIONS

The data obtained from the interviews was systematically examined according to the process as set out in the previous section. Utilizing thematic content analysis, the qualitative data from the interview was analysed and presented.

Presentation of Research Data

In this section, the author discussed the main themes and issues that have become emergent through the interviews with the respondents. These key themes that have been garnered through the interview have been related to certain key points in the literature review at times.

Difference in Opinion Depending on Positionality

One point that became emergent as time went by, was that the points of view that saw an outlook towards an expanding profession was usually held by those who were involved in these expanded functions themselves.

This could be seen as a function of professional involvement experience colouring perceptions. Involvement in firms practicing expanded roles such as project management or managerial roles rather than technical roles seemed to also come with the perception that the QS had much more room to expand towards in the future. For the individuals who practiced more conventional QS roles and saw an expansion in the profession, it was noted that the expertise & practices of the profession is mainly cost and measurement related and should not or could not become modified as there were very set pre-existing roles to fit into.

It should be noted that a recurring theme was also how the firm or organization's willingness to push its employees past a more conventional suite of services was mentioned several times as a key determinant in the expansion of roles. However, these could include business decisions such as choosing not to expand the business due to the existing suite of services being profitable enough.

QS Abilities Proven

For those who had admitted to, and personally experienced an expansion to the QS profession, it was noted that the QS had become proven as if through fire, in providing high quality of services.

The QS in seeking to fulfil roles that was traditionally no seen as part of the QS's scope of work was seen as more than capable, and at times, more desirable than other professions due to certain considerations the QS is more keen to make due to the professional background.

Changing Face of the Profession

For those who had seen an expansion in the profession, it was noticed that they saw a need to shift the focus of the profession away from certain more technical traits towards a different scope of services as time goes by and technology and the industry changes. This is also supported by the view of Thayaparan et al. (2011) who posit that client development and application of information and communication technologies will warrant these changes. The lack of ability to change may result not so much in the role of the QS being outmoded, rather the firms and individuals who cannot expand their suite of services to become so.

This sentiment was echoed by interviewees who had mentioned that the different players in construction are developing more and more each day, with one explicitly saying that the QS being a more conservative profession has been slow to adapt to certain changes.

Changes have to be carried out by heads of organizations and firms who realize this importance. Firms will have to focus on developing more professional pride and staking their claim in the industry. Furthermore, QS professionals would progressively become more specialized and diversified as they become more technically proficient in specialist services,

working more and more closely with specialist subcontractors. This is in accordance with the view of Dada and Jagboro (2012). Furthermore, the QS will begin to see a change towards more project management-based roles as time progresses. This is partly due to the fact that the QS is seen as a jack of all trades, having competencies in contracts administration, cost, documentation, understanding of construction, site management, and many more. Also, the QS is able to take on more roles as they have the technical base, which makes moving to managerial bases more realistic, rather than the opposite of managerial/conceptual, towards technical.

Value Creation as a Competitive Edge

It was mentioned several times the QS should move away from the tried and aged method of price point competition in their bid to secure projects. While this may be helpful during times of economic downturn, this practice is seen as unsustainable and even harmful to the profession. The question of exactly how long this practice can be carried out before businesses become undesirable to work in is a question which has to be addressed.

Additionally, a shift away from directors of firms purely focusing purely on business aspects of consultancies needs to occur, and more focus on creating a breed of juniors who can take up the mantle of the profession when required.

The ability of the future QS to survive and thrive has to be determined by their ability to create value for the client and prove their worth through service mindsets. Protection or intervention by the government or professional bodies would only be seen as perpetuating practices which should be reevaluated and changed.

Amalgamation Possible under Different Circumstances

The changing scene of the industry has seen an opening of possibilities of amalgamation as seen in emerging multidisciplinary firms. Amalgamation has been noted as a good force for change in the industry if practiced properly as pointed out by the data and by Price (1997). However, many have mentioned that further changes need to be made for this approach to become more viable.

A key change that needs to be made is a change in contractual arrangements, and a move away from protectionist, familiar practices. One interviewee mentioned the need to propagate different contractual arrangements that have better potential to serve the industry's needs. This was the same interviewee that mentioned that internationally, a shift away from the JCT is a prime example of this.

Furthermore, greater industry and client awareness on the possibilities that exist outside of familiar arrangements needs to occur with familiarity being a possible bane here. In the meantime, it was mentioned that the best individual to promulgate these changes would be the QS, who is familiar with contractual arrangements. Still, a shift in mindset within the profession is needed, from advising on existing systems, to creating new systems which may better serve the needs of the industry. This is also proposed by Frei and Mbachu (2009).

CONCLUSIONS

In essence, this study looked at the relevance of the QS as it has existed for the past century and how it needs to remain looking for ways to revitalize itself and to provide more avenues for creating value, through an interdisciplinary standpoint in a globalizing industry.

With regards to objective 1, which was to determine if the traditional QS is still relevant in the modern times and to explore the consequences of stagnation, it was found that for the meantime, traditional firms will remain relevant. However, this is seen as likely to change in the coming time (some say within 5-10 years) as firms which focus on traditional services only will find that client demands will require a greater suite of services.

The traditional suite of services will still remain required in some manner throughout construction, but the question of fulfilment of the role will be raised. This study has shown that encroachment into these more traditional, technical roles have occurred due to technology and certain overlap of roles by other professions, and that if firms focus on these purely conventional roles, they may become obsolete.

Another finding with regards to consequences is that the perception of external parties towards the QS would be less than desirable for the QS profession due to this stagnation. These will have to be fixed if the QS is to continue to play a vital role in delivering better value for clients at the end of the day. This is in concurrence with the literature, wherein the literature mentioned that there have been certain levels of encroachment in the past and that in other countries, the QS role is often taken up by other parties, such as project managers, building economists, or even playing a lesser role due to the existence of standardization of components and databases.

In view of objective 2, which was to discover the routes of evolution that the QS has taken as a profession so that future pathways may be established, it was found that the QS given its background and proficiencies, was well suited to fill certain needs that had developed in the construction industry. An overarching change that was seen was a move away from more technical roles concerning purely costing, quantification and contracts advisory roles to more managerial roles, such as project management, business and strategic advisory roles, specialization into technical areas such as specialist and MEP works and the like. The opinion held was that the QS is more than able to fulfil additional expanded roles which have grown within the profession. This was due to the QS's technical competency, the QS's ability to adapt and learn onsite, and the focuses that the QS has on certain elements which are more pertinent to client satisfaction, such as programming, handling of contractual affairs, attention to cost and detail, desire for commercial success of developments and overall familiarity with construction.

This shows that the QS can begin to take on more strategic roles, managing value chains, execution of the projects, and the business relevant aspects of projects and portfolios for more holistic client satisfaction. Firm willingness to allow expansion of the suite of services in individual professionals is a huge factor. Education of the client and markets is also seen as a factor contributing to more widespread expansion along with expansion of existing curriculum. In addition, the QS would have to shift mindsets from price point competition to

being able to create value in the future, as price competition proves to become unsustainable in a more demanding globalized economy.

Finally, for objective 3, which was to establish a more holistic, interdisciplinary role for the QS to play, it was found that the QS has much potential to become catalysts for these interdisciplinary roles to deliver value. Interdisciplinary solutions in construction were seen as potentially good, but not widely practiced in Malaysia due to lack of awareness amongst clients, and the general adherence to familiar modes of deliver in Malaysia which are more adversarial by nature. This concurs with the findings by Burland (1997) who conducted a case study on a multidisciplinary construction firm and found that these modes of delivery were able to provide value for clients over and above what was the convention.

This research showed that the QS was able to create better coherence in projects through raising queries and consolidating the design into a coherent deliverable, as they carry out cross checks of the various parties' contributions. Furthermore, the QS's focus on aspects of the project more pertinent to client satisfaction like budget and cost and to certain aspect quality, allows the QS to play a more holistic role. Commercial considerations also warrant a whole-life perspective to be held by the QS.

However, certain challenges exist in realizing this more holistic role. These challenges include adherence to antiquated contractual arrangements such as PAM, protectionism of the status quo, and lack of knowledge regarding alternative arrangements. Lack of communication and multidisciplinary training also contributes to this, which is in accordance with the findings by Nicol & Piling (2000). A proper adherence to client deliverables and unified standards of project success along with training are seen as ways to combat these barriers. In addition, this study investigates the possibility of individual level amalgamation occurring once technology and standardization allows for the consolidation of tasks under one individual.

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BUILDING INFORMATION MODELLING FOR SUSTAINABLE BUILDING DEVELOPMENT: IN THE PERSPECTIVE OF QUANTITY SURVEYOR

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Abstract

With scarce resources and the constant fighting of global warming, human has become eco-friendlier conscious and eco-oriented these days, where slogan "go green" is seen everywhere. There is no exception for the construction industry. With the rising of green building ratings, many countries are trying to promote sustainable building development that provide better healthier living environment. To achieve this, technology is always brought in to achieve the desired outcome. Hence, Building Information Modelling (BIM) is the right platform that provides such features and capabilities that will enhance the process of the project throughout its cycle. This paper seeks to explore the capabilities and benefits of BIM for sustainable building development in the perspective of quantity surveyor. Where quantity surveyor (QS) plays an important role especially in cost relating matters, and how BIM deliver its features and capabilities relating to this job scope of a QS.

Keywords: *BIM; Sustainable Building Development; Green Building; Quantity Surveyor; Traditional Method*

INTRODUCTION

Sustainable building development is often referred to green building. In order to label a building as green building, it must fulfil certain requirements like energy efficiency, water efficiency, reduction in waste energy, pollution, and etc. To achieve this, the building must be designed, constructed and operated in a way to fulfil the above-mentioned requirements. These buildings when being operated in the long run, have to bring benefits to the users of cost saving while increasing the comfort level and creating healthier environment through the improved indoor air quality, natural daylight and thermal comfort (Build Green, 2011). Thus, sustainable building development consist these main three elements: fairness, protection of the environment and economic efficiency (Legrand, 2017). To succeed in all that is mentioned, technology is best option, that is through BIM that will help enhance the design of a building, reduce cost and save energy (Akinade, 2017).

LITERATURER REVIEW

"BIM is a modelling technology and associated set of processes to produce, insert, share and manage the information in a centralised model to improve designs, constructions, operations and maintenance processes" (p. 195) as stated by Raphael and Priyanka, 2014. This might sound like a software, but it is a platform that extract information using technology that creates a virtual 3D building model before constructing an actual physical one (Azhar, 2011 as cited by Gardezi et al., 2014; Mathur, 2015; Raphael & Priyanka, 2014). Not only does BIM create virtual building during the design stage, it extracts the information to create virtual building, this information is being deployed during cost planning cycle and made available for building quality and schedule which is useful for all stakeholders. Furthermore, acting as a storage for the information regarding the whole building including the complete set of drawings store in the integrated database (Wong & Fan, 2013 as cited by Nagalingam

et al., 2013). All the available information is hence interrelated where any changes that occurs will automatically update the existing model and elements that are affected (Nagalingam et al., 2013). According to Azhar S. et al., 2008, detail purposes of BIM are as so:

- 3D model visualisation
- Fabrication drawings
- Code reviews
- Forensic analysis
- Facilities management
- Cost estimating
- Construction scheduling
- Conflict, interference and collision detection

Various Dimension of BIM

BIM does not only involved in one stage of the project but throughout the whole lifecycle of the project up till the operation of the building, providing features like 3D (object model), 4D (time), 5D (cost), and 6D (operation) that make available the data for the facilitate of post construction of the building. As suggested by Raphael & Priyanka, 2014: “Typically BIM uses real-time, dynamic building modelling software working in 3D, 4D (workflow) and, increasingly, 5D (quantity surveying) to increase productivity and efficiency, save costs in the design and construction stages, and to reduce running costs, after construction” (p. 195).

- 3D (Shared Information Model): Process of developing a graphical model with the integrated of non-graphical information that allows the sharing of information among the project parties involved (McPartland, 2017).
- 4D (Construction Sequencing): Process of providing additional dimension of information in the form of scheduling data (McPartland, 2017).
- 5D (Cost): Includes the capital cost of purchasing and installing component, running cost, renewal cost, et. Costs are linked to the model for better ease of viewing enabling notification for changes made and automatically updating related components. Enhance the efficiency and accuracy of providing cost estimates or cost planning by the Quantity Surveyor (McPartland, 2017).
- 6D (Project Lifecycle Information): Providing information such as manufacturer of component, installation date, required maintenance, energy performance, and so on for an effective management of building during its operation (McPartland, 2017). Components or machineries found in the building can be monitored and future plan can be altered when replacement or maintenance are required.

Overview of Traditional Approach

Before BIM came into the picture, the traditional approach would be Computer-Aided Drafting (CAD). In the engineering, architecturing and construction, CAD is normally the platform to develop designs or viewing the design drawings (Autodesk, 2013 as cited by Nagalingam et al., 2013). During pre-construction stage, CAD is heavily relied on to carry out the developing of design model (3D). It provides several benefits like the different perspective view of 3D model, dynamic simulation of construction operations and carrying

out taking-off quantities on materials by Quantity Surveyors. While 2D CAD is applied during construction stage in viewing of construction drawings by contractors (Mahoney et al., 1990).

Overview of Sustainable Building Development

Sustainable development is the development that works within the scarcity of resource without threatening the needs of future generations. Sustainable development embeds social, economic and environmental subjects which is called triple bottom line, consisting of two commonly accepted models: 'Three Pillar' model and 'Russian Doll' model (Saadatian et al., 2012; Fisher et al., 2007 & Dowsett & Harty, 2013). The 'Three Pillar' model integrated economic enterprise, social well-being and environmental integrity. Whereas the 'Russian Doll' model places the economic as the core basis of wealth creation as well as being constrained by environmental and social considerations (Fisher et al., 2007).

BIM and Quantity Surveyor (QS)

According to the Board of Quantity Surveyors Malaysia, 2012, "Quantity Surveyors (QS) is a professional working within construction industry concerned with building costs". QS is an important role that provides cost management services for the construction industry. The main job scope of a typical QS includes taking off, preparation of bills of quantities, estimating and pricing of construction project (Raphael & Priyanka, 2014). With vast amount of services provided that are required of QS, BIM comes into the picture that guarantees a higher accuracy rate and lesser errors with its built-in parametric information that enables easy capture of quantities when QS conduct taking off. BIM 5D is what enables the extracting of quantities from 3D model. 5D BIM incorporates 3D BIM model and 4D construction scheduling with contract pricing. This feature enables the auto to generate of quantities which reduces time and cost which preparing estimating or for the purpose of Bill of Quantities preparation. Even during the design stage of the project, BIM enables the QS to extract quantities like volume and total area that are sufficiently accurate for estimating purpose. When the model is built up with more details, more detail quantities are being extracted to form the basis that might be necessary for later use (Raphael & Priyanka, 2014).

Comparison Between BIM and Conventional Method in QS Practice

The conventional approach of quantity surveying in practise is by conducting measurement on each and every element found in the 2D CAD drawings and extracting all the quantities into the excel spreadsheet, which is tedious and time consuming, less efficient and prone to more human errors. Performing measurement using 2D CAD or designing using 2D CAD are more prone to errors. Any modifications altered in the drawings, editing is required for all other views likewise for the updating of measurement (Mitchell & Schevers, 2005) Whilst BIM is able to generate more efficient drawings with its added parametric change function that maintains consistency at all times (Azhar et al., 2010 as cited by Nagalingam et al., 2013). This will help removes many tedious tasks using conventional method by automating quantities, the production of BQ.

Sustainable Building Development and QS

In conjunction with the population of green building industry, QS as the cost expert will have to develop and equipped themselves with any necessary skills and competencies to accommodate with these changes to keep up with the ever changing sustainable building development (Seah, 2009; Wong, n.d.). While applying the principles of sustainability onto a building, changes such as design, procurement and management processes are bound to happen and incurs cost (Chau et al., 2010 as cited by Ma & Luu, 2013; Wong, n.d.). Which is important for the QS to advice on ways to reduce the cost escalations and construction time frames. Hence, QS should be equipped with the necessary knowledge on green technologies and innovations, constantly abreast with building materials that are able to achieve sustainability. Certain roles have to change to accommodate the changes that include sustainability strategy development, life cycle cost appraisal, consulting on green start system, advising on engineering services solutions, and valuing sustainability of a property (Ma & Luu, 2013).

BIM for Sustainable Building Development

Features of BIM that are needed for the efficiency of sustainable building development includes (Lu et al., 2017):

- Lifecycle of Green Buildings: supported design of green building, supported construction of green buildings. Supported operations of green buildings.
- BIM functions for green building criteria: energy performance analyses, carbon emission analyses, natural ventilation system analyses, solar radiation and lighting analyses, water usage analyses, acoustics analyses and thermal comfort analysis.
- Supported Green Building Assessment (GBA).

BIM and Traditional Method in Sustainable Building Development in Relation to Quantity Surveyor (QS)

The following table will summarise the application or capabilities of BIM and traditional method in sustainable building development in the perspective of QS.

Table 1. Summary of BIM and Traditional Method in Sustainable Building Development in the Perspective of Quantity Surveyor

Capabilities	BIM	Traditional Method (CAD)	Applied by Quantity Surveyor (Sustainable Building Development)
3D Model	/	/	/
Virtual Model	/		/
5D Cost Estimating, Cost Plan, etc.	/		/
Automated and rapid updating	/		/
Preparation of Bills of Quantities	/	/*	/
Exchange and Integration of Information	/		/
Building Energy Analysis	/	/**	/
Document Management	/		/
Construction Sequencing	/		/
Lifecycle Data	/		/
Cost Control	/		/
Conflict, Interference & Collision Detection	/		/
Forensic Analysis	/		/
Code Reviews	/		/

*The preparation of Bill of Quantities is not automated where quantities extracted are key into the excel spreadsheet (Raphael & Priyanka, 2014). Drawings lack interactivity and change in one view will result in re-measurement for other view (Nagalingam et al., 2013).

**CAD based method of energy performance analysis and assessment takes a substantial amount of time and effort for modelling (Ma & Luu, 2013).

Barriers of BIM Implementation

Regardless of the advantages provided by BIM, it is still relatively challenging to implement within the construction industry (Gardezi et al., 2014; Stanley & Thurnell, 2014). Cost is one of the primary barriers where high initial cost for setting up BIM that includes the investment of software and hardware. Leading to providing cost of training need to provide for the employees (Aibinu, 2012; Alhumayn et al., 2017; Gardezi et al., 2014; Liu et al., 2015; Stanley & Thurnell, 2014; Lymath, 2014; THE BIM, 2015; Silverio et al., 2015).

Due to its high software complexity, the development of new methods, new technology and tools, many users lack of knowledge in BIM that requires the transition of traditional work to BIM (Aibinu, 2012; Ismail et al., 2016; Lu et al., 2017; Nagalingam et al., 2013) thus prolong the learning curve (Azhar, 2011). Resistance to change and improve that mostly occurs in the older generation of QS also due to the pack of knowledge (Boon & Prigg, 2012 as cited by Stanley & Thurnell, 2014).

Legal matters on the licensing pertaining on the claiming of ownership of BIM data is an issue as the owner will be paying for the design whereas other stakeholder parties had contributed to the data (Azhar, 2011). Leaving the problem to the control of data entry and the accountability for any inaccuracies (Azhar, 2011; Stanley & Thurnell, 2014). Lastly is the lack of demand by client is one of the barriers to BIM implementation (Aibinu, 2012; Alhumayn et al., 2017; Ismail et al., 2016).

RESEARCH METHODOLOGY

Scope and Sampling

Quantitative method is adopted for this research with questionnaire as the survey instrument with 376 sample size calculated using random sampling method. A total of 3088 questionnaires was distributed via email and WhatsApp to targeted firms which were QS consultancy, contractor, civil and structural consultancy, developers, and multidisciplinary. There were total of 79 (21%) respondents with 6 invalid respondents. Therefore, the valid number of respondents would be 73 (19%).

This research only scopes down to quantity surveyors regardless registered or non-registered and working in any construction industry firm located at Klang Valley.

Design of Questionnaire

The design of questionnaire consists of the general demographic profile and following by the 3 sets of opinion questions and a set of open factual questions. Using nominal scale to categorise the demographic profile and number of respondents that uses BIM approach or conventional approach. Ordinal scale will be used for the attitudinal questions recording degree of agreement based on the Likert scale.

Data Analysis

Data collected from the questionnaire are being analysed using the descriptive statistics method where data are tabulated and presented in pie charts and bar charts. The data tabulated will then be further analysed using the average index to determine the ranking of each factor with the formula shown below (Al-Hammad et al., 1996) and categorised based on the following table.

$$\text{Average Index} = \frac{\sum \alpha_i x_i}{\sum x_i}$$

Where,

- α_i = constant represent the weight given to i
- x_i = variable expressing frequency of response
- $i = 1, 2, 3, 4, 5$

DATA ANALYSIS

Findings 1 reflects the first objective of this research, analysed based on average index analysis and categorised based on Table 2's ranking.

Table 2. Average index on level of agreement (Che Ahmad et al., 2014) for importance of BIM in SBD and barriers of BIM implementation

Average Index	Level of Agreement
$0.00 \leq \text{Average Index} < 1.49$	Strongly Disagree
$1.50 \leq \text{Average Index} < 2.49$	Disagree
$2.50 \leq \text{Average Index} < 3.49$	Neutral
$3.50 \leq \text{Average Index} < 4.49$	Agree
$4.50 \leq \text{Average Index} < 5.00$	Strongly Agree

Table 3. Average index on level of frequency for the usage of BIM in SBD

Average Index	Level of Agreement
$0.00 \leq \text{Average Index} < 1.49$	None
$1.50 \leq \text{Average Index} < 2.49$	Seldom
$2.50 \leq \text{Average Index} < 3.49$	Average
$3.50 \leq \text{Average Index} < 4.49$	Often
$4.50 \leq \text{Average Index} < 5.00$	Very Frequent

Table 4. Average Index Analysis on the Importance of BIM in SBD in Relation to QS

	Average Index	Category	Rank
Useful during feasibility study (preparation stage) while preparing cost plan	3.9863	Agree	1
Useful for storing detailed information of project during developed design stage	3.9863	Agree	1
Useful for conducting taking-off	3.9726	Agree	3
Useful during concept design stage while preparing preliminary cost estimating	3.9452	Agree	4
BIM is highly important in Sustainable Building Development	3.8356	Agree	5
Useful for cost monitoring during construction stage	3.7260	Agree	6
Useful for generating Bill of Quantities (BQ)	3.7123	Agree	7
Useful for bidding process during tender stage	3.6575	Agree	8

Based on the table above, generally all respondents agree that BIM is important in sustainable building development. In my opinion, generally the importance of BIM in sustainable building development is not a statement that will induce disagreement. Nevertheless, most respondents agreed that it is most useful in preparing cost plan during feasibility study and storing detailed information of project during developed design stage. Cost plan is a vital element in determining initial building cost that will stimulate the viability and undertaking of the project. BIM offers an adequate service that enables QS to auto-generate the cost plan for all building elements which ensure efficiency for a smoother design process (Raphael & Priyanka, 2014; Nagalingam et al., 2013).

Similarly ranking 1st is the usefulness of BIM in storing detailed information of project during developed design stage, BIM acts as a database storage that performs as a platform for sharing, exchanging and integrating of data for whole lifecycle (Hakkinen & Kiviniemi, 2008; Autodesk, 2012 as cited by Lu et al., 2017). Henceforth, it even allowing the incorporation of sustainability measures during design phase (Autodesk, 2012 as cited by Lu et al., 2017).

Findings 2 reflects the second objective of this research, analysed using nominal scale by tabulating the data-based number of amounts.

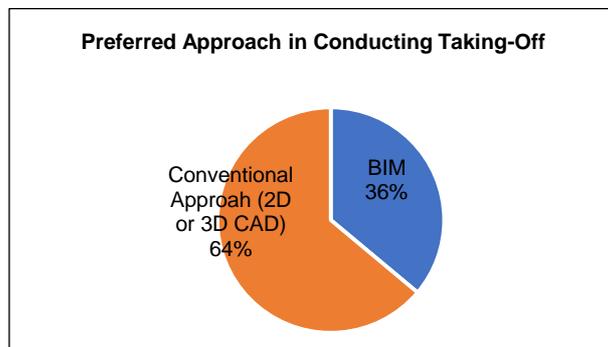


Figure 1. BIM or Conventional Approach Preferred in Conducting Taking-Off

Table 5. BIM or Conventional Approach Preferred in Conducting Taking-Off

Responses	Frequency
BIM	26
Conventional Approach (2D or 3D CAD)	46

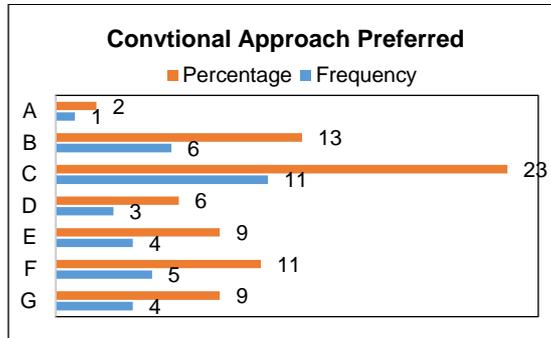


Figure 2. Reasons of conventional approach preferred

Table 6. Reasons of conventional approach preferred

Reasons	Frequency	Percentage over 47 respondents
A Each have their pros and cons	1	2.128
B Too familiar with conventional approach	6	12.766
C Unfamiliar with BIM software due to lack of knowledge and training regarding BIM	11	23.404
D Faster using CAD	3	6.383
E Direct cost variable	4	8.511
F Difficult to comprehend small changes while using BIM	5	10.638
G Lack of experts in BIM system	4	8.511

There are around 12 respondents that left this question unanswered that amount to 26% of the total respondents that preferred conventional approach.

From the previous findings, many had agreed that BIM is important in sustainable building development, however when asked which approach is preferred in conducting taking-off, there are fair amount of respondents that preferred conventional approach over BIM approach. The main reason stated by the majority of the respondents are the unfamiliarity with BIM software that is due to the lack of knowledge and training regarding BIM. The BIM software is highly complex that causes the lack of knowledge in transitioning from conventional approach to BIM approach (Aibinu, 2012; Ismail et al., 2016; Lu et al., 2017; Nagalingam et al., 2013).

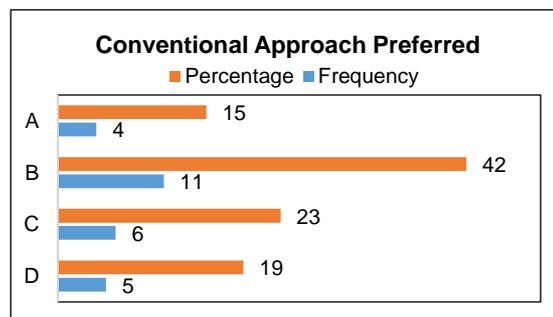


Figure 3. Reasons of BIM approach preferred

Table 7. Reasons of BIM approach preferred

Reasons	Frequency	Percentage over 26 respondents
A Easy to estimate cost for project	4	15.385
B Faster and more convenient	11	42.308
C Reduces time for measurement	6	23.077
D Quantities are more accurate and easily extracted and transfer to BQ	5	19.231

On the other hand, the minority that preferred BIM approach over conventional approach when conducting taking-off with the majority reason on its speed and conveniences BIM delivers. Which in my view is mainly due to the automation features provided by BIM? According to Ballesty, 2007, one of the benefits being identified is its automated assembly.

Findings 3 reflects the third objective of this research, analysed based on average index analysis and categorised based on Table 8's ranking.

Table 8. Average Index Analysis on the Level Usage of BIM in SBD among QS

	Average Index	Category	Rank
Usage of BIM for conducting taking off	3.5205	Often	1
Usage of BIM for storing information of project	3.4658	Average	2
Usage of BIM during bidding process (tender stage)	3.3151	Average	3
Usage of BIM to prepare cost plan during feasibility study	3.3014	Average	4
Usage of BIM to prepare preliminary cost estimating	3.2466	Average	5
Usage of BIM for generating BQ	3.2603	Average	7
Usage of BIM for cost monitoring	3.2603	Average	7

From the data obtained above, BIM is mostly used in conducting taking-off being in the category of 'Often' and ranking one. Whereas the other tasks performed using BIM are in the category of 'Average'. Ranking second is the usage of BIM for storing information of project followed by 3rd: bidding process during tender stage, 4th: preparing of cost plan during feasibility study, 5th: having the same rank 7th are generating BQ and for cost monitoring. Based on this data obtained, the capabilities of BIM are still not fully recognised based on my opinion. As the survey conducted by Aibinu and Venkatesh, 2013, shows that only 37% that widely uses BIM.

Findings 4 also reflects first objective of this research, analysed based on average index analysis and categorised based on Table 9's ranking.

Table 9. Average Index Analysis on barriers of BIM implementation

	Average Index	Category	Rank
Lack of knowledge of BIM	4.1370	Agree	1
Initial cost (investment of software and hardware)	4.0411	Agree	2
Cultural resistance (the transition of traditional work base; e.g. CAD & Excel to BIM based)	3.9726	Agree	3
Cost of training	3.9178	Agree	4
Issue of whom will be responsible for the inaccuracies of data input	3.6849	Agree	5
Long learning curve	3.6438	Agree	6
Licensing issue (e.g. Client claims the ownership of design even though other stakeholders contributed information for the design)	3.5890	Agree	7
Lack of demand by client	3.5342	Agree	8

The data accumulated shows that most of the respondents agrees that the factors stated on BIM implementation are indeed a barrier in implementing BIM. Among all the barriers, lack of knowledge of BIM rank 1st, due to the complexity of BIM software with the incorporation of new methods, new technology and tools (Aibinu, 2012; Ismail et al., 2016; Lu et al., 2017; Nagalingam et al., 2013).

CONCLUSIONS AND RECOMMENDATIONS

Few to none research had been done on BIM for sustainable building development among QS thus research done does not involve other main players that will influence the performance of QS. Moreover, results heavily relied on questionnaires making the data inferior where certain point of views could not be expressed in detail.

In my point of view, this research should be done in conjunction with the interview in order to support the data found through questionnaires and providing in depth views, opinions or comments regarding this research. Further research on covering the perspective of other main players and stakeholders should be done to explore the relationship and influence of each main players towards quantity surveyor's performance especially directing their focus to Malaysia based. Moreover, more research could be done in the comparison of BIM approach and conventional approach in relation to sustainable building development as more and more projects are heading the direction of green building.

There is still huge space of improvement for BIM to cater for the needs for all main players and projects especially in the context of sustainable building development. Malaysia construction industry should speed up their pace in incorporating more technology and direct the path towards eco-friendly industry to encourage more sustainable building development. Through this research, it gave me the insight of BIM in relation to sustainable building development especially in the perspective of a quantity surveyors that will help pave my carrier path as a quantity surveyor. Nevertheless, there are still much to grasp on the topic of BIM and sustainable building development.

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MEASURING THE EFFECTS AND EFFICIENCY OF 3D MODELLING IN QUANTITY SURVEYING PROFESSION

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Abstract

3D modelling is promoted as a systematic innovation that improves the efficiency of quantities take-off in the construction industry. However, this advanced technology requires changes to almost every aspect of a firm's business. The effects and efficiency of 3D modelling are always a consideration for the quantity surveying in adopting this new technology. Therefore, this paper focuses on measuring the effects and effectiveness of 3D modelling in Quantity Surveying Profession based on the RIBA plan of work 2013. Semi-structured interviews have been adopted to collect the research data for this paper. Eleven respondents accepted the semi-structured interviews to share their 3D modelling experience. The analysis result indicates that quantity surveying job scopes are significantly affected at concept design, developed design and technical design stages when 3D modelling is implemented. Additionally, majorities of the respondents agreed that 3D modelling manages to improve the efficiency of the measurement work task in the quantity surveying profession. This research outcome serves as a guidance for quantity surveyors who are interested to adopt the 3D modelling in future.

Keywords: *3D Modelling; Quantity Surveyor; Efficiency; Effects; RIBA plan of work.*

INTRODUCTION

Building Information Modelling (BIM) is classified as a systematic innovation that requires changes to almost every aspect of a firm's business (Eastman et al., 2008). BIM platforms are depicted as the ability to develop virtual 3D models of the building using a machine-readable concept that manifests behaviour coequal with design needs and building design and testing (Sacks et al., 2004). Through implementing BIM, projects efficiency and accuracy in the Malaysia Architecture Engineering Construction (AEC) industry are expected to be improved since the BIM systems provide the function of performance analysis and rapid cost estimation which can improve the project's efficiency and accuracy.

The use of BIM requires collaboration and input from designers such as architects and engineers in the production of the 3D model for quantity surveyors (Qs) to prepare the cost estimate, quantity-take-off (QTO) and the Bills of Quantities (BQ). In BIM's implementation, Qs prepare the cost estimation based on the quantities generated from the designers' BIM model. The accuracy of the abstracted quantities depends on the methods that the designers use in developing the BIM model. Consequently, the estimation process in BIM implementation is not automatically generated (Monteiro and Martins, 2013).

Under the current practice of BIM, QS has to prepare quality verification and adjustment based on the standard method of measurement before the quantity takes off on the BIM 3D model designed by architects and engineers which fully depends on the construction designer's initiatives. This creates difficulties to Qs in managing the information within the BIM model in preparing the cost estimates (Wu et al., 2014). This phenomenon signifies a red light for the quantity surveying profession to keep pace with other professionals in the construction industry to maintain competitiveness.

In Malaysian quantity surveying profession, several quantity surveying firms are adopting 3D modelling in taking-off and cost estimation preparation based on the standard method of measurement (Derrick, 2018; Glodon, 2018). This indicates that several quantity surveying firms have accepted that the increased use of information technology in building a 3D model in BIM platform managed to increase the efficiency of the working flow in the Quantity Surveying firm. (Smith, 2000). However, this is still a new concept in the quantity surveying profession. To increase the usage of 3D modelling, which is far different compared to the traditional method, it is crucial to identify the effects of implementing 3D modelling in quantity surveying firms as well as the efficiency of 3D modelling compared to traditional measurement or CAD measurement.

THE EFFECTS OF ADOPTING 3D MODELLING IN QS PROFESSION

Generally, the innovation with the implementation of new technology tools poses difficulties which condensate the potential risks and challenges associated with the innovation, to displace the well-established traditional working processes. Such systematic innovation increased the difficulty of 3D modelling implementation partly due to AEC industry's reluctance to change existing work practice and hesitation to learn new concepts and technologies (Gu and London, 2010).

Initial stage

When there is a need for changes from the conservative practices, hard experiences and sense of distrust felt by individuals involved. The primary reason behind this is the personal resistance to changes due to fear of changes (Arayici et al., 2011). More importantly, the workers feel that the changes will threat their current work task and responsibilities. The anticipation of the loss of status, power or control and competencies are involved which causes the workers feel reluctant to change.

The implementation of 3D modelling required drastic changes in work practices and staff skills teams (Eastman et al., 2008). These individuals will feel overloaded and overwhelmed. With the changes, individual will have a misconception that they have to do more with fewer benefits or with the same pay without any increment. In short, people and process of QS firms are affected at the initial stage before the implementation of 3D modelling.

Strategic Definition and Preparation and Brief

At the Strategic Definition and Preparation and Brief stages, a QS is responsible for establishing the estimated cost of proposed building projects or relative building costs with a number of options. (Benge, 2014) Based on the client initial cost limit, QSs consultant prepares cost estimation for purposed building project manually by applying unit rates interpolated from historical cost data. With 3D modelling capability, floor area and volume information can be directly and accurately abstracted from 3D geometric model to help QSs to prepare the preliminary cost estimates.

Adopting 3D modelling process requires a significant adjustment to the current practices in the company. All QS historical cost data in the current system needs to be transferred to the new 3D modelling software for preparing a feasibility study or cost estimation which is

time-consuming especially for the new users. The entire industry faces unfavourable obstacles notably the lack of training and awareness of 3D modelling applications. (Gu and London, 2010). Most of the QSs have lack of experience to work on 3D modelling software in preparing a feasibility study or cost estimation.

High initial cost is always a significant concern in adopting new technology. The initial cost to purchase 3D modelling tools and proper training is required to use them. (Mohd and Latiffi, 2013) The cost of software is claimed to be more expensive compared to CAD software packages. The QS firm needs to incur extra expenses to send their workers to attend the training as well as to purchase the tools (Latiffi et al., 2013).

Concept Design and Developed Design Stages

In the 'concept design and developed design' stage, QS establish the cost targets for each group of elements and sub-elements based on the client cost limit for a building project. (Benge, 2014) Once design team members generate design drawings, QS consultants will prepare cost check for the developed design against the previous cost plan. Traditionally, QS consultant will measure the latest developed design drawings manually or use CAD measurement and revise cost target for each group element and sub-element in stages. With 3D modelling implementation, QS has to develop a 3D model and abstract the quantities from the 3D model to prepare the cost plan and cost check. The developed 3D model visualisation helps all consultant team members to understand the project design to reduce misunderstanding or communication problems between consultant team members (Prins & Owens, 2016).

Additionally, software issues are significantly affecting the 3D modelling implementation. Project participants such as QSs are used to working with the current measurement tools and not familiar with the new tools. (Migilinskas et al., 2013) QSs are not familiar with the 3D modelling software and may not be able to apply the tools correctly, then the software issues occurred.

Technical Design Stage

In the technical design stage, QS has to prepare the pre-tender estimate based on tender drawings. (Benge, 2014) QS Consultants have to understand and measure architecture and engineer drawings and specification schedules in preparing bill of quantities, tender documents and final cost check of the design against the cost plan. Traditionally, QS distinguish the drawings discrepancies and differences in this stage and quarries will be sent to design team members for professional feedback and answer purposes.

With the application of 3D modelling approach, the clash of design by different professionals can be detected visually (Latiffi et al., 2013). Detecting the drawing discrepancies in the earlier stage manage to reduce the variation orders in the construction project. Moreover, all the quantities in the 3D model can be auto quantified from 3D modelling software with measurement information and details. Cost estimation improves pre-tender estimate processes in this technical design stage if 3D modelling is implemented.

Construction, Handover and Close Out & In Use Stages

In the construction, handover and close out & in use stages, QS are responsible for preparing payment, check claims or variation orders for extra costs and savings as well as to confirm the adequacy of cost limit for the building project. (Benge, 2014) Traditionally, QS consultant has to verify and manage costs on architect and engineer’s instructions, check monthly construction projects by a site visit and prepare re-measurement works for provisional items in BQ.

The construction industries lack information about the strict 3D modelling implementation standards and rules which indirectly cause owners, designers and contractors to develop their own internal rules instead of knowledge sharing. (Monteiro and Martins, 2013) Construction players are using different standards, methods and software in this stage which minimise the effects of 3D modelling. However, with the benefits of 3D modelling in clash detection, clashes and problems of building construction can be detected earlier, and variations can be successfully reduced. Figure 1 summaries all the effects of adopting 3D modelling in QS Profession based on RIBA plan of work 2013.

RIBA PLAN OF WORK 2013	Effects of 3D Modelling
Initial Stage	People Cultural Changes Process Changes of work practices
Strategic Definition	Process Traffering Costing Resources
Preparation and Brief	Technology High Initial Cost
Concept Design	Process Communication among the consultant team members
Developed Design	Technology Software
Technical Design	Technology Measurement Auto-Quantifying the Quantities
Construction	Process Re-measurement Works
Handover and Close Out	Technology Interoperability issues between BIM platforms Data lost in file conversion process
In Use	

Figure 1. Effects of Adopting 3D Modelling in QS Profession based on RIBA plan of work 2013

RESEARCH METHODOLOGY

In this research, primary data was collected through personal interviews. Data collected from literature review is updated through collecting the QS consultants’ perception, experience and comments to understand the effects and efficiency of 3D modelling in the current Quantity Surveying Profession. Therefore, qualitative approach was being used to analyse the interviews owing to the nature of qualitative approach which emphasises more on understandings, experiences, opinion as well as views of people rather than enumerative evidence (Denzin and Lincoln, 1998).

There are many types of interviews notably unstructured, semi-structured and structured interview and each appropriate in different circumstances (Leech, 2002) In this primary data collection, this research mainly aims to collect professional feedbacks and experiences on the constraints of implementing 3D modelling and efficiency of 3D modelling compared to manual or CAD measurement. This research focus on semi-structure interview because semi-structured interview is useful for investigating opinions and collecting experiences. (Clifford et al., 2016).

DATA ANALYSIS

Eleven respondents accepted the semi-structure interviews to share their 3D modelling experience in this paper. The respondents were selected for the interviews are working as senior management staff in a quantity surveying firm and practising 3D modelling to obtain informative feedbacks for this research. All respondents are in management positions who hold a significant responsibility in the quantity surveying firms with the involvement in 3D modelling practice. Hence, all the respondents are accepted as experienced QS who have sufficient knowledge and insight to provide feedback and suggestions in the interviews.

The Effects of 3D Modelling Implementation in QS Profession

Table 1. The Effects of 3D Modelling Implementation at the Initial, Strategic Definition and Preparation and Brief Stages

Details	Significant comments/ feedbacks
Effects of 3D modelling	QS Resources in pre-tender stage is affected in implementing 3D modelling. It is not easy to transfer the resources from old system to a new 3D software. (P1)
Initial Stage	High Initial cost for software, computer and server. Reduction of business income in 3D modelling implementation (P1)
Strategic Definition	It improves the data keeping and data transfer. As long as the 3D model is well kept, new staff can easily take over the old staff job/work. (P2)
Preparation and Brief	High Initial cost for software and computer. Averagely RM6000 for one working laptop. Take several years to buy the software packages for all staff (P2)
	Yes, some staff leave in the initial stage of implementation. (P2)
	Company starts it with 1 to 2 projects initially. No reluctant from staff. (P3)
	Everything is the same. (P4, P7)
	Not Affected. (P5, P6, P8, P11)
	The same policy and procedure (P9, P10)

Adopting a 3D modelling process requires a significant adjustment of the current practices in the industry and the process or practice changes appear as major challenges. However, most of the interviewees commented that 3D modelling implementation did not change the people and process of QS firms. No reluctances from QS staff in QS 3D modelling implementation. Nevertheless, minor interviewees agreed that QS firm process and people were changed in implementing QS 3D modelling.

The process of quantity surveying firms notably on the database and resources were affected in 3D modelling implementation. It is not easy to transfer the database and resources from the old system to a new 3D system in the QS software. Therefore, director must be determined in implementing 3D modelling and fully enforce it in the office. On the other hand, these changes in company process manages to improve the data keeping and data

transfer processes. As long as the 3D model is well kept, new staff can easily take over the old staff work.

Based on interviewee's comments, some QS Firms have to invest a high initial cost for the 3D modelling software and computer hardware in implementing the 3D modelling which is often seen as the barrier for some small organisations. In order to overcome the high initial cost, QS firms are suggested to take several years to buy the software packages for all staff.

Table 2. The Effects of 3D Modelling Implementation at the Concept Design, Developed Design and Technical Design Stages

Details	Significant comments/ feedbacks
Effects of 3D modelling	Technical Design stage for measurement... (P1,P3,P6,P10, P11) Technical Design stage which reduces manpower by half...
Concept Design	Technical Design stage which everyone in the market is using SMM and BIM BQ may not be accepted by industry... contractors may not be able to price ... (P4) BQ preparation time is limited. Not all measurement/ BQ preparation is using 3D modelling software. (P4)
Developed Design	Concept & Developed Design stage and Technical Design stage, measurement and estimating purposes... (P5)
Technical Design	Concept & Developed Design and Technical Design stage for Cost Plan and Measurement purposes...(P7) Technical Design stage for measurement and tender preparation purposes...(P8) Technical Design stage which measurement is faster... (P9)

Table 2 summaries the effects of 3D modelling implementation at the concept design, developed design and technical design Stages. Based on the interviewees' comments, the effects of 3D modelling implementation in QS mainly focus on measurement tasks at the cost plan and pre-tender stage. Quantity take-off or Measurement remains as one of the major consultants QSs' tasks in Malaysia since most of the construction projects are still implementing traditional procurements and contracts with quantities. Therefore, measurement tasks are the main reasons of 3D modelling implementation.

Additionally, Standard Method of Measurement 1 & 2 have been extensively used in the current construction industry, and the contractors may not be able to price the tender document if the 3D modelling BQ is prepared. Additionally, some interviewees' states concept & developed design stages are affected by 3D modelling implementation. In this stage, QS is responsible for establishing cost targets for each group of the element in the building construction based on the master plan in planning approval. The efficiency of cost plan and cost estimating preparation can be improved since the quantities can be extracted faster in 3D modelling which eases the preparation of cost appraisal. This benefit leads to increase of the client satisfaction on QS performance as the client can receive economic feedback earlier on the alternatives purposed by the consultant team.

In the technical design stage, QS has to prepare a bill of quantities/tender document and final cost checks of the design against the cost plan. All these tasks required accurate measurements or quantities taking off by the QSs. In 3D modelling implementation, interviewees clearly stated that 3D modelling manage to reduce workforce by half and increase the efficiency of QS in preparing measurement. Interviewees' comments correspond to the literature review which stated the 3D modelling implementation manages to increase the efficiency of measurement as it avoids the time consuming and duplicate the process of

estimators in quantifying the designer's drawings. These positive comments from interviewees subtly indicate that there is an upward trend in the adoption of 3D modelling in the QS profession.

At the construction, handover and close out & in use stages, all the interviewees commented that the current 3D modelling implementation are fully initiated by QS firms only. There is no client requested QS to implement the 3D modelling in the current construction industry. In short, the 3D modelling process stopped at technical design stage and no further enhanced is implemented at the construction, handover and close out & in use stages.

The Efficiency of 3D Modelling Implementation in QS Profession

The efficiency of 3D modelling based on different type buildings have been included in the interview questions to analyse the increase of efficiency in quantities abstraction for 3D modelling compared to CAD measurement or manual measurement which can be an attractive point for 3D modelling transformation in quantity surveying profession.

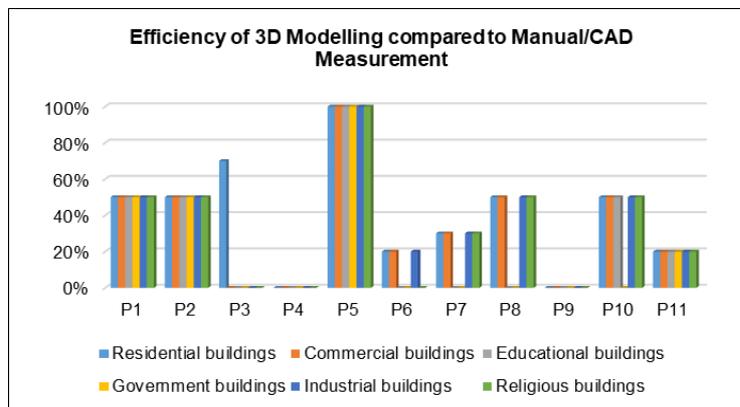


Figure 2. Efficiency of 3D Modelling compared to manual/excel or CAD measurement

Based on the interviewees' comments, the majority of the interviewees agree that 3D modelling manages to increase the efficiency of QSs in quantities take-off. Majority of the QSs manage to increase more than 20% of the efficiency in quantities take-off compared to manual measurement or CAD measurement. This result indirectly indicates that the efficiency of 3D modelling can be an attractive point for QSs to adopt the 3D modelling implementation.

CONCLUSION

Building Information Modelling (BIM) has been widely introduced in recent years, but the implementation of BIM in developing country such as Malaysia is still at its infant stage. Measurement remains as a significant consultant QSs' tasks in Malaysia as most of the construction projects are still implementing traditional procurement and contract with quantities. QSs in Malaysia have to prepare a bill of quantities with detail and accurate measurements, but most BIM tools were developed for designers and not for nontechnical end-users. Therefore, some QSs in Malaysia are having initiative to develop their own 3D model for cost estimation and measurement. Majority of the QSs manage to increase more than 20% of the efficiency in quantities take-off compared to manual measurement or CAD measurement which hints the reasons of QSs initiatives to adopt the 3D modelling in Malaysia.

However, there is no client requested QS to implement the 3D modelling in the current construction industry. In short, the 3D modelling process stopped at technical design stage and no further enhanced is implemented at the construction, handover and close out & in use stages. Therefore, a future study is recommended to further enhance the current 3D model prepared by QS firms to extend the benefits of 3D modelling to the construction, handover and close out & in use stages.

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THE IMPACT OF BUILDING INFORMATION MODELLING ON DESIGN PROCESS IN CONSTRUCTION INDUSTRY

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Abstract

The implementation of Building Information Modelling (BIM) in the construction industry is getting more and more frequent and it is starting to penetrate into the Malaysia construction industry. BIM software is a dynamically linked interface designed to take the place of redundant computer aided drafting (CAD) work. The implementation of BIM will bring significance changes into the design process in construction thus this research aims to identify the impact of BIM towards the design process in construction industry. The data collection was conducted through semi structured interview and literature review. The target respondents are architects and consultants who have applied BIM in their projects located at Klang Valley. Thematic analysis is applied in this study to allow elements in literature review to be developed as themes for analysing purpose. The data collected shows that BIM had advantages over traditional design with clash detection, 3D modelling stimulation and better collaboration of work which improves the efficiency, design and quality of a project. BIM has great impact towards the design process in the construction industry.

Keywords: *Building Information Modelling; Computer Aided Design; Design process.*

INTRODUCTION

Building Information Modelling (BIM) is a revolutionary technology and process that has quickly transformed the way buildings are conceived, designed, constructed and operated (H.K. Lan et al., 2015). It is becoming a better-known established collaboration process in the construction industry (Soon Ern et al., 2017; Goucher & Thurairajah, 2013). BIM is primarily a three-dimensional digital representation of a building and its intrinsic characteristics. It is made of intelligent building components which includes data attributes and parametric rules for each object. BIM provides consistent and coordinated views and representations of the digital model including reliable data for each view (Abdellah R.H. et al., 2017). According to the National BIM Standard, Building Information Model is “a digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition” (B. Succar, 2009). BIM is a combination of technologies that offers platform for collaboration between different parties in the construction industry. It is now increasingly used as an emerging technology to assist in conceiving, designing, construction and operating buildings in many countries (Rajendran P. et al., 2014). BIM software is a dynamically linked interface designed to take the place of redundant computer aided drafting (CAD) work. When BIM penetrates into Malaysia it will bring a lot of changes in the construction industry. One of the impacts would be the design process in construction. BIM software is a dynamically linked interface designed to take the place of redundant computer aided drafting (CAD) work. Idea being, architects are free to

design, and the software generates the plans, sections, and elevations. The implementation of BIM will bring a great impact to the use of traditional design process in construction process as the use of BIM might eliminate the use of CAD and brings a new design process in construction industry as mentioned above.

LITERATURE REVIEW

The Associated General Contractors of America (AGC) perceived BIM as: “Building Information Modelling is the development and use of a computer software model to simulate the construction and operation of a facility. BIM means not only using three-dimensional intelligent models but also making significant changes in the workflow and project delivery processes” (H.K. Lan et al., 2015). From technology perspective, a building information model is a project simulation consisting of the 3D models of the project components with links to all the required information connected with the project planning, design, construction or operation.

BIM greatly increases the user’s ability to control and manipulate data and information in an unprecedented way and in an interoperable format. Moving from paper-centric information to parametric, model-based information means that the digital design can be used for cost estimations, simulations, scheduling, energy analysis, structural design, GIS integration, fabrication, erection, and facilities management (K.C. Goh & J. Yang, 2014; Manap N. et al., 2016). All of which are relative to each other, and changes in one category will have impacts on the others that are automatically accounted for. As so, productivity from recalculation of simple and minor changes will be greatly increased because the computer program will be able to handle the changes and calculations internally. BIM can be viewed as a virtual process that encompasses all aspects, disciplines, and systems of a facility within a single, virtual model, allowing all team members (owners, architects, engineers, contractors, subcontractors and suppliers) to collaborate more accurately and efficiently than traditional processes.

BIM incorporates the use of 3D visualization techniques with real-time, data driven, object-based imaging as a tool by all facets of the industries (Rajendran P. et al., 2014). Documents a BIM can generate include, but are not limited to, drawings, lists, tables, and 3D renderings related to the project. Resulting 4D models allow project stakeholders to view the planned construction of a facility over time on a computer screen and to review the planned or actual status of a project in the context of a 3D CAD model for any day, week, or month of the project (Soon Ern et al., 2017). Goal of using BIM is to provide a common structure for information sharing that can be used by all agents in the design process and construction, as well as for the facility management after a building is constructed and occupied.

There are five big differences between BIM and Traditional CAD design. BIM adopts a task-oriented more quickly than an object-oriented methodology - In 2D drafting the wall we draw with 2 lines while BIM has a tool to present the wall itself. The wall has height, width, bearing or non-bearing, interior or exterior, materials, fire rating and demolished. With this BIM is much more effective than 2D drafting (Abdellah R.H. et al., 2017; Goh K.C. et al., 2017). BIM shows the real data- While utilizing BIM, the elements have properties based on real-life properties while in CAD system it can be easy to overlook. BIM is not just a 3D modeler - Usual Modelling does not have the ability to document a design for construction

but it is possible to bring a model into BIM application and progressed through design, analysis and documentation. BIM is a data-driven design tool - BIM can allow the user to create custom content and libraries thus it is not just 3D but a 3D with intelligent information. BIM is based on an architectural classification system and not layered - In CAD, every line belongs to a layer and it is the reason that placement of windows or doors into a wrong layer can be done in 2D drafting. In BIM, there will be less risk of placing a window into wrong 'wall' layer.

BIM brings impacts towards the design process in construction industry. Fully integrated BIM design process links the CM to the architect at the beginning of the design phase. Each of them will have input to the design of the building, and the end result will be a more cost-effective building due to the increased productivity from this type of relationship (Kuehmeier J.C., 2008).

RESEARCH METHODOLOGY

Research methodology is very important in a research as it is the pathway to collect and analyse the data which are important for the research to succeed. In this research, qualitative approach was used to collect the data. Semi structured interview was used to collect the data. It is because semi structured provides valuable information from the context of the respondents and the varied professional, educational and personal histories of the sample group precluded the use of a standardized interview schedule (Abdellah R.H. et al., 2017). By using semi structured interview, more information was gained from the respondents through their experience and opinion sharing.

The target population of this research was the architects and consultants in Malaysia as the design mainly depends on these two groups of people. Kuala Lumpur is selected as the location to collect data. There are ten respondents were targeted to be interviewed. The respondents were selected through convenience sampling which respondents who meets the criteria of answering the questions and have the time to respond were selected. Interviewees that had been selected for the interview in this study are those who had experience in using BIM from different companies, this is to ensure the data collected are variable with different company BIM users. However, this study managed to get eight respondents to participate the interview.

The qualitative data collected was transcript and analysed by using thematic analysis method. Thematic data analysis is one that looks across all the data to identify the main themes that summarise all the views of the data collected. This is the most common method for analysing case study because it is well suited to large and complicated data sets (B. Succar, 2009; Abdellah R.H. et al., 2017). Then, all collected data from interview can be coded and classifying manually using identified themes (Goh K.C. et al., 2017).

RESULTS AND DISCUSSIONS

The position of each interviewee is different, and they had different experience in using BIM. Interviewee 1,3,5,8 are involved in medical equipment's and have more than 5 years of BIM experience and the company had implemented BIM in only one of their projects. Interviewee 2,7 are the BIM team leaders with 10 years and more of BIM experience and they

had implemented 11 projects with BIM technology. For interviewee 4,6, they are the BIM team leader with 7 years of BIM experience with 6 projects implemented with BIM.

Differences between BIM Design and Traditional Design

Advantage of BIM design - They are communications, parametric solutions, automated tables, zoom control and database in file. These are the advantages that are stated with using BIM compare to CAD.

Some direct feedbacks retrieved from the interview sessions:

“The advantage of using BIM is that it has functions such as clash detection analysis, structural models, coordinated drawings, stimulation, scheduling analysis, animation, As-built drawing, facility management” (Interviewee 1,3)

“It’s very fast, make a lot of alternative (few models) for one project, clash detection visualization, analysis and it can store all data in one model. It has no limits” (Interviewee 2,4,5)

“BIM allows us to do analysis on the drawings on where it has clashes. We can immediately do correction on the drawings” (Interviewee 6,7,8)

Based on the comments by the interviewees, we can know that BIM allows better communication, solve clashing in drawings and storing data of a model in one file.

There are also differences in terms of cost based on the comments by the interviewee; the cost of using BIM is higher as compare to traditional design due to its training and software license. The BIM software is complicated, and training is needed for the person who uses it and the training itself cost a lot. Furthermore, the cost of purchasing the license to use BIM is very costly.

Some direct feedbacks retrieved from the interview sessions:

“Cost is higher, you need high cost in BIM modelling” (All interviewers)

“Cost is slightly higher as you need cost for training and software for BIM” (Interviewee 2,4,5,6,8)

“Well, the cost is higher compare to CAD design as you need training for the people who uses BIM and the software cost quite a lot which I think only large companies are afford to use BIM but overall cost for a project using BIM would be lower due to its advantage cause there is less mistakes in design and the project can be run smoother and no delay” (Interviewee 1 and 3)

Based on the answers from the interviewees we can see that BIM design is better than traditional design. This is due to the fact that BIM contains 3D design which can be model, and clients can visualise the model through BIM and gain satisfaction. As for traditional design, the 2D layer drawings are not so effective in giving the clients a visual on how the building would look like. Thus, it is shown that the design of BIM is better since it is less likely to make mistake using BIM in designing.

Modelling of a project requires a lot of time as BIM user needs to be specific on the data and scaling of the model but with the function of allowing BIM user to notice the mistakes and clashes more easily and correct the mistakes allows BIM user to shorten the time needed to analyse clashes in a drawing. Therefore, it is concluding the BIM design is faster than AutoCAD design.

With comments from the interviewees, all of them agreed that the quality of BIM design is better compare to traditional design. This is due to the fact that BIM contains 3D model which give a lot of advantage for the design improving the quality of the design.

However, some of the respondents mentioned that there are problems occurs with BIM implementation that does not occur in traditional design process since it is a new technology and not all people are familiar with the new process. Time is needed for people to get comfortable with the new design process provided by BIM.

Some direct feedbacks retrieved from the interview sessions:

“There are many problems since it’s the first time we used BIM in our projects. Such as training is not sufficient, and we have to wait the person who are expertise in BIM to start our meeting since not all of us knows how to operate the software” (Interviewee 1)

“There are problems occur when using BIM such as the new style of collaboration. For example, who is in charge of changing the specs in the model and how to inform others that the model has change” (Interviewee 2)

“There will be problems when you first start using BIM, problems such as expertise is not enough to handle BIM software. If the most expertise person in BIM does not know what’s wrong in the model, then there will a delay of time where we need time to solve the problem encountered” (Interviewee 3)

The Impact of BIM towards the Design Process in the Construction Industry

BIM will enable better communication and collaboration of work in a project group. This proves that BIM will change the communication process in the designing stage between the architects and engineers. Some respondents believe that BIM involves modelling process which traditional design does not have thus it changes the style in designing phases. It also brings a new style of communication between architects and engineers making it more convenient to communicate with each other about the design. Besides, it reduces the loss of information and BIM changes how they work especially related to collaboration of a project group and the style of communicating between each other in designing the project’.

However, interviewee 2, 3, 4 and 7 commented that BIM design is an extra process in the design phase which indirectly increasing the overall cost of a project in order to improve the quality of work done by the project group. More expertise and software cost are included in the design stage thus increasing the cost of the project.

Some direct feedbacks retrieved from the interview sessions:

“The cost is becoming higher as compare to traditional design process as you need license to use BIM software” (Interviewee 2)

“The cost is higher in the design stage but overall it will be lower compare to traditional design as it will lower the mistakes done in construction phase” (Interviewee 3,4)

“In terms of cost, using BIM will cost more as it involves more expertise in one project, you’ll need to hire someone who knows how to handle the software and it will cost quite a lot for that” (Interviewee 7)

From the finding, it can conclude that BIM changes the design into 3D model compare to only 2D drawings in traditional design process. It has lightened the works of BIM user.

Some direct feedbacks retrieved from the interview sessions:

“The design would be in 3D and easier to be visualise thus giving a good way for designer to analyse the clashes” (Interviewee 2,3,4)

“The design process would be more enjoyable as 3D modelling is rather more interesting than drawing 2d lines” (Interviewee 1,5,6)

“We will have 3D model in BIM design compare to traditional with only 2D drawings and the design would probably more effective since we can detect clashes and analyse the 3D model more accurate as compare to 2D drawings” (Interviewee 7,8)

The design process will be prolonged as BIM is implemented in design stage as modelling is a long process since it needs more concentration in editing models and accurate data to minimize the amount of mistakes make in designing phase. Most interviewee agreed that the design phase BIM will need a lot more time compare to traditional 2D design as they need accurate data and size to model the structure. Architectural models sometimes are quite difficult to edit and since they need more accurate data thus it will take a lot of time editing the whole structure. Besides, BIM will affect the design process to be longer in terms of time. As 3D modelling is not an easy job, they need more accurate models to proceed on the design in order to minimise mistakes in the designing phase.

The aforementioned parts show that there are some differences between BIM design process and CAD design process which is BIM requires training and software license making the cost of BIM design process cost a lot higher than design process using CAD only. With the newer technology the quality and design of BIM is better than the design on CAD as 3D model exist in BIM with database included in the building making it easier to estimate the cost of the project. As mentioned, with 3D model and database information included in BIM accurate information and modelling requires a lot more time in the designing phase but will lower the time in construction phase as clash detection can be done in BIM.

Besides, according to the findings, there are three main changes in the design process when BIM is implemented in a project. Modelling process is added into the predesign phase whereby architects no more sketches a drawing to show the clients but designing a 3D pre-model for the client to give out his thoughts and expectations on the building. In terms of cost, the design process will be higher as it includes the process of modelling which requires training and software license in using BIM. In terms of design, rather than focusing on the

plane views layered drawings of a project the schematic design phase focus more into database and 3D modelling. The data on the materials and design of the building must be specific and accurate so that scheduling and cost estimation can be done easily after the model is finished.

CONCLUSIONS

In conclusion, the differences between BIM design and traditional CAD design as well as the impact of BIM towards the design process in the construction industry had been identified and clearly stated. The data collected shows that BIM had advantages over traditional design with clash detection, 3D modelling stimulation and better collaboration of work which improves the efficiency, design and quality of a project. BIM has great impact towards the design process in the construction industry. A last question was asking about the replacement of CAD for BIM in the future and 3 out of 3 respondents answered that BIM will definitely be used in the future for better profit and efficiency in a project. As so, construction players should aware of this advanced technology to gain benefits from it.

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CAPABILITY OF BUILDING INFORMATION MODELLING (BIM) IN IMPROVING THE EFFICIENCY OF GREEN BUILDING PROJECT IN KLANG VALLEY – A LITERATURE REVIEW

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Abstract

There are countless issues regarding unsustainability activities from irresponsible bodies, where, sustainable development is needed in the event of global climate changes, air pollution, water pollution and others. Due to that, construction industry has taken this issue seriously and has come out with an idea of “green building”. Along with the existence of modern technologies, it is true that technological innovation does play an important role in both short and long term in societal, economic and also environment. In order to enhance the performance of Green Building construction, the construction industry can apply Building Information Modelling (BIM) in their project. The aim of this paper is to enhance the existing knowledge towards green building. For this paper there are about 15 research papers published within the past 7 years which are used in abstracting all the relevant literature, analysing and coming out with the findings on what are the indicators in identifying the benefits and factors of BIM application towards green building project.

Keywords: *Building Information Modelling (BIM); Green Building; Benefits.*

INTRODUCTION

In recent years, environmental issues have been rising, especially in consumption of energy and resources in the building sector. Green buildings or sustainable developments are the examples of environmental concerns. What is green building? Green Buildings should be designed and operated to reduce the overall impact of the built environment on its surroundings (“Green Building Index”, 2017). While sustainable development is ‘development which meets the needs of the present without compromising the ability of future generations to meet their needs’ according to Suhaida et al. (2011). By having an understanding of what it is all about, construction industry could have the knowledge on how to implement it on the building itself. Thus, these buildings are qualified for certification by one of the foreign rating systems tools or nothing else than Malaysia’s which is Green Building Index (GBI). But what are the relations between Green Building and Green Building Index (GBI) as it is mentioned previously? As a result, the government had introduced a specific green building assessment tool in 2009, known as the GBI, which follows similar methodological approach tools such as Building Research Establishment Environmental Assessment Leadership in Energy and Environmental Design.

In order to enhance the performance of Green Building construction, the construction industry can implement Building Information Modelling (BIM) application in their project to produce data-rich models of buildings and structures since it started in the 1970s and its development in the 1980s and 1990s (Wong & Fan, 2013). In Malaysia, BIM’s role is well-defined as a modelling technology and associated set of processes to analyse, communicate, produce and use digital information models throughout the construction project life cycle

("BIM", 2017). According to Succar & Kassem (2015), BIM has been considered as one of the most effective technological and organizational innovation in architecture, engineering and construction (AEC) industry.

Therefore, by having a little knowledge about what Green Building is and how it is related with BIM the developer, consultant, contractor and others connected could not have the idea on BIM technology can facilitate on producing green building. As in Malaysia, green building concept slightly new even though it is already exposed to the other countries for a long time ago. By hiring more expertise on green building in term of the materials, technology, designing and also financial stability is also needed.

LITERATURE REVIEW

Malaysia has started implementing on green building practices even though it is slightly slow moving due to the level of awareness towards sustainability in construction industry still at the minimum stage. According to Suhaida et al. (2011), there are several countries that had implemented green building sustainable development. It is started with BREEM in (UK, 1990) and following LEED in (US, 1996). In 2009, Malaysia had launched National Green Technology Policy (NGTP) where the government's manifesto is emphasized in applying 'green' for the country. Apart from that, Sim & Putuhena (2015), stated that NGTP are promoting the practicality of green management in many projects such as Kuala Lumpur International Airport Terminal II (KLIA2) and Sunway Resort City Development. In order, for green building to be well-executed, the construction industry can apply BIM throughout the project instead of using traditional method as BIM is capable to enhance the communication and coordination between different parties. In Malaysia, most of the construction players do not familiar with BIM as a technology due to not widely used in the construction project. But there are only few companies in Malaysia implemented BIM in the construction project by providing BIM tools, consultancy services and training for example, Sunway Berhad, Petaling Jaya, Selangor, and Precision Design Solution Sdn. Bhd. (PDSSB), Petaling Jaya, Selangor (Aryani, 2013). Hence, it indicates that by implementing of BIM in green building construction project, the efficiency of the project not only can be enhanced but also support in advanced of the construction activities.

Building Information Modelling (BIM)

BIM application has capture attention among construction players in Malaysia and most of them already started implementing BIM throughout their project. According to Fathoni et al. (2015), the projects that has been implementing BIM application are Proposed Hotel Ancasa (involving consultation on applying BIM modeler, 4D Project Planning Consultant by using BIM and Microsoft Project Planning Tools), Multi-purpose Hall, Universiti Tun Hussein Onn Malaysia (utilizing Integrated Project Delivery and BIM) and Proposed Educity Sports Complex (by using BIM 4D Project Planning Consultant by adopting BIM and Microsoft Project Planning Tools).

The benefits of implementing BIM can be divided by three aspects which is environmental, social and economic aspects. Firstly, environmental aspects are designers are able to enhance the designs in terms of shading design, determine mechanical heating and cooling and adjust the location for vegetation and garden layouts. For example, by using

software Autodesk ECOTECH, it is capable to estimate the percentage of reflection and shading along with amount of the solar radiation dropping on the object where it is tremendous in determining the setting and orientation for solar panels. Hence, the features of ECOTECH like 'solar analysis' will help towards the optimization of total energy consumption of the building and it easy to calculate the energy production thru the year (Wong & Fan, 2013). While, based on the case studies at Savannah State University in Georgia, the owner and the architect coordinate with contractor in preparing BIM at the predesign stage in order to produce three different design options. Therefore, the owner was capable to choose the best option that fit the needs (Azhar, 2011).

Secondly is a social aspect. Wong & Fan (2013) found that the teamwork and communication between team members developed by implement Integrated Project Delivery (IPD) where it could reduce the risk in a construction project. Not only that, IPD also helps in improving the safety by expecting the problems in the early stage of the project. For example, by combining the architectural and MEP models in Naviswork, function of a clash detection identified. Apart from that, the number of job opportunities in professional BIM consultancy increased as the popularity of BIM rising. While, Azhar (2011) stated that the implementation of BIM in the project could improve the communication and belief between the parties and fasten in making the decision.

The last benefit for BIM is economic aspects. The reduction of un-desirable of wastage in order to reduce the cost of the project and to improve the construction management. It is can be done by implement IPD like stated above. By having better quality of material and energy efficiency in the construction industry, it could help in reducing the capital and costs as well (Wong & Fan, 2013). According to Azhar (2011) the usage of BIM application resulted in cost and time savings in AEC industry. Hence, case studies were conducted by using BIM application in planning, design, pre-construction and construction phase for the project of Aquarium Hilton Garden based in Atlanta, Georgia. Even though at the beginning of the project, it does not initially design using BIM application but during completion, it had exceeded the expectations of the owner and also the team members. Where this can be shown by the unknown costs avoided and the cost benefits to the owner were really sufficiently great. Azhar (2011) stated that, BIM application capable to prepare cost estimate for all virtual models that prepared by the architect. While, Soltani (2016) concluded that the implementation of BIM application influent economic efficiency for instance reducing wastage, decreasing the costs and also saving time of the project.

Green Building

In 2009, Suhaida et al. (2011), found that the Association of Consulting Engineers Malaysia (ACEM) together with Malaysia Institute of Architects (PAM) had launched GBI to allow green grading and certification of Malaysia buildings. GBI was formulated based on six criteria namely; indoor environment quality, energy efficiency, sustainable site and management, materials and resources, innovation and water efficiency. For example, green building project that entitled platinum in GBI rating for Non-Residential New Construction (NRNC) are Bangunan Suruhanjaya Tenaga, S P Setia Berhad HQ and Menara Kerja Raya.

The benefits of Green Building divided by three aspects which is environmental, social and economic aspects. Firstly, environmental aspects are the construction industry is

knowingly tied to the environmental issues. Through reducing waste, improvement of air-water quality, secure the ecosystem and preserve natural resources could bring benefits to green building in environmental aspects (Turcotte et al., 2011). While, Gonchar et al. (2011) also found that green building could bring the advantage to the environment in reducing the waste.

Next is social aspects. By referring to the benefits in social aspects of green building, it is not only enriching occupants' comfort and healthy but, it is also able to improve the aesthetic and quality of life (Turcotte et al., 2011). Besides that, green design is may possibly increase the worker productivity and health benefits via green materials in the construction project. Moreover, green building competent in increasing the efficiency, prolong the life of buildings and enhance the occupant well-being (Gonchar et al., 2011). Due to that, most of the people nowadays are concerning in buying property that adequate the criteria in green building. Birkenfeld et al. (2011) found that green building helps consequential health welfares to occupants that associated with LEED credits by enhance the indoor air quality.

Then, the third benefits of green building are economic aspects. According to Turcotte et al. (2011), as green building becomes widely known among developers and owners, thus the financial benefits are becoming clearer. For example, maintenance and utility costs are the majority savings in green building. Apart from that, green building could increase for green products and services in the marketplace. Gonchar et al. (2011) stated that green building construction can reduce operating and maintenance costs. The existing green buildings are able to minimize negative effects to the environment in terms of the usage of natural resources, energy and water. Birkenfeld et al. (2011) concluded that any organizations that have implemented green building would found improvement that measure economic, environmental, and social aspects performance for example like saves the cost in the construction project.

Last but not least, in order for Malaysia to become a country that widely implementing BIM application in green building project especially buildings in Klang Valley area, the construction industry should be more educate and exposed about the what the benefits is. According to Mohd Adnan et al. (2017), since information and awareness can be learned and improved, so it will be one of the strong factors in implementing green building in Klang Valley. Even though, Malaysia is not being well exposed about the implementing green building compared to the other Asian countries. But this is not a reason why Malaysia could not become a well-known country who are the most contribute to the world in producing sustainable building. The awareness can be taught consistently, and it moves reasonably with learning. The more information individuals have on green building; the more awareness can be produced.

METHODOLOGY

15 selected papers publications had been chosen to justify and analyse the obtained information in regards with the benefits of implementing BIM in green building project. The publications were selected within the timeline from 2011 until 2017 with 15 relevant research papers selected. From the 15 papers, only six authors have been considered to be analyses based on the benefits of BIM and green building where it is explained and discussed as well as cited accordingly.

ANALYSIS AND FINDINGS

This section represents the findings from analysis and reviewing process of relevant literatures to identify the benefits of BIM application towards green building construction project. The publications were selected within the timeline from 2011 until 2017 with 15 relevant research papers has been selected. The contribution shows from years to numbers of publication as shown in Figure 1.

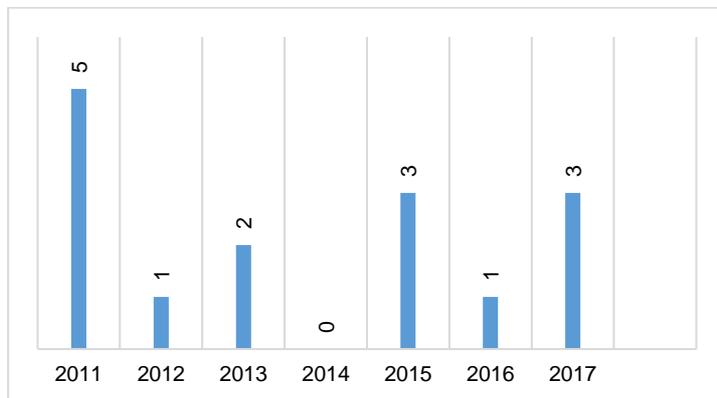


Figure 1. Numbers of referred paper publication from 2011-2017

Table 1 shows the benefits of BIM. There are six numbers of factors has been listed and cited as well as analysed in term of environmental, social and economic aspects based on three authors by considering the paper published within the year interval of 2011 to 2017. By referring to Table 1 below, the highest times referred for factors benefits of BIM goes to economic aspects which is cost savings. Where this factor can be considered as the highest main factors whom contributing to the benefits of BIM in the construction project. The numbers of times referred for these factors are 3.

Table 1. Factors benefits of BIM

No	Benefits of BIM	Wong & Fan, (2013)	Azhar, (2011)	(Soltani, 2016)	Times referred
1.	Environmental aspects: - Enhance the designs	✓	✓		2
2.	Social aspects: - Teamwork and communication improved - Job opportunities increased	✓ ✓	✓		2 1
3.	Economic aspects: - Reduction of wastage - Costs savings - Time Savings	✓ ✓	✓ ✓	✓ ✓ ✓	2 3 2

While, Table 2 shows the benefits of green building project. There are 12 numbers of factors has been listed and cited as well as analysed in term of environmental, social and economic aspects based on three authors by considering the paper published within the year interval of 2011 to 2017. By referring to Table 2 below, the highest times referred for benefits of green building goes to social aspects which is enhance occupant comfort and health. Where

this factor can be considered as the highest main factors whom contributing to the benefits of green building in the construction project. The numbers of times referred for these factors are 3. Then, it is followed by environmental aspects which is reduce the wastage.

Table 2. Factors benefits of Green Building

No	Benefits of Green Building	Turcotte, Villareal & Bermingham, (2011)	A.G. Gonchar & H. Akhtar, (2011)	Birkenfeld, Brown, Kresse, Sullivan & Thiam, (2011)	Times referred
1.	Environmental aspects:				
	- Protect biodiversity and ecosystems	✓			1
	- Reduce waste	✓	✓		2
2.	- Conserve and restore natural resources	✓			1
	Social aspects:				
	- Enhance occupant comfort and health	✓	✓	✓	3
	- Improve aesthetic	✓			1
	- Improve quality of life	✓			1
3.	- Increase efficiency		✓		1
	- Prolong the life of building		✓		1
	Economic aspects:				
	- Increase markets for green products and services	✓			1
	- Enhance life-cycle economic performance				1
	- Lower operational costs	✓	✓		1
	- Lower maintenance costs		✓	✓	1

Hence, for these two concepts can be well implemented, the construction industry should knowledgeable in BIM application towards green building project in order to create the efficiency in construction activities.

CONCLUSION

This research was all about to identify the implementation of BIM application in enhancing the efficiency of green building construction project in Klang Valley. According to Mohd Adnan et al. (2017), these recent years the issue of sustainability across many restraints has been raising. Particularly, these implementing BIM application in green buildings will bring benefits to the environment that respond to the building users' needs, lifestyles and also could preserve natural. However, the BIM application in green building initiative need strong support from all the stakeholders to meet the aim and objectives. It can be done by improving the level of awareness among team members in construction industry. It is hoped that in the future, Malaysia moving towards a broader in implementing BIM application in green building project.

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INFLUENCE OF SOIL TYPE ON STEEL REINFORCEMENT OF FOUR STOREY REINFORCED CONCRETE BUILDING WITH SEISMIC DESIGN

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Abstract

For a few decades before December 2004, Malaysia is known as a country which free from earthquake hazard, unlike Japan and Indonesia. However, the fact has changed after the great Mw9.1 Aceh earthquake in December 2004. The tremor was felt in several places in Peninsular Malaysia. Since that moment, Malaysia was affected by ground tremors from Indonesia and Philippines earthquakes. The local earthquake with small magnitude occurred in Bukit Tinggi, Pahang in 2007 before Mw6.1 Ranau earthquake in June 2015. The latter had caused minor to severe damage on reinforced concrete building around Ranau town. Recently, the government has decided to implement seismic design on new buildings. Soil Type is one of parameters that influencing the seismic design and structural performance. This study presents the influence of different Soil Type on the total weight of steel reinforcement of four storey reinforced concrete building. The building has been simplified and modelled as building in important class IV. The reference peak ground acceleration, α_{GR} was assumed as equal to 0.07g. The building had been repeatedly designed on five different type of soil namely as Soil Type A, B, C, D, and E by referring to Eurocode 8. Based on result, the Soil Type is strongly influencing the total weight of steel reinforcement. The latter is higher for softer type of soil. In this study, the buildings with seismic design require around 1.16 to 2.11 times higher amount of steel reinforcement compared to the non-seismic building. Therefore, the Soil Type will be influencing the cost of steel reinforcement.

Keywords: *Cost Comparison; Seismic Design; Soil Type; Steel Reinforcement; Reinforced Concrete*

INTRODUCTION

Unlike Japan and Indonesia, Malaysia is geologically situated far away from active seismic fault zones. The nation is considered to be located in low seismicity region (MOSTI, 2009). Therefore, no seismic consideration has been taken into account in construction industry in Malaysia, except for a few special buildings. Existing reinforced concrete buildings in Malaysia had been designed by referring to BS8110 without any seismic provision (Tukiar et al., 2016). However, Malaysia still has a certain risk of earthquake hazard due to high seismicity region in neighbouring countries. West coast of Peninsular Malaysia is exposed to Sumatra Andaman and Java earthquakes from Indonesia while Sabah is exposed to Philippines earthquake. In fact, Sabah has its own local earthquakes. According to Harith et al. (2017) large increment of earthquake events has been recorded in Sabah for the last 140 years ago. This trend depicts that earthquake hazard cannot be ignored anymore.

One of the memorable earthquakes occurred in Sabah is the Mw6.1 Ranau earthquake which occurred on 5th June 2015. The epicentre was located around 16 km to the northwest of Ranau city. Based on preliminary in-situ observation by Majid et al. (2017) the earthquake had caused damages to reinforced concrete buildings especially on beam, column, and beam-

column joint. The damages on column were severe than the beam due to Weak Column – Strong Beam design concept of non-seismic building. Besides, the damages also occurred on the non-structural elements such as ceiling and brickwall (Adiyanto, 2017).

Seismic design on new buildings is one of the initiatives taken by the government for the sake of public safety. According to MOSTI (2009) it is worth to consider seismic design for new buildings in medium to high risk earthquake zone in Malaysia. The implementation of seismic design also has pro and con. The consideration of earthquake load tends to change the detailing of structural element which will be differ compared to non-seismic design. From economical view, it is interesting to know the effect of seismic design on cost of material for construction. According to Ramli et al. (2017) seismic design tends to cause increment in total steel reinforcement which will directly increase the cost. However, the cost for repair and maintenance in the future will be reduced by implementation of seismic design. A few studies had been conducted to study the effect of reference peak ground acceleration, α_{gR} on seismic design. According to Adiyanto and Majid (2014) and Adiyanto et al. (2019) the increment of total steel used as reinforcement for reinforced concrete building is strongly influenced by the level of reference peak ground acceleration, α_{gR} . The authors only considered Soil Type D and hospital building in their study.

Soil Type also influencing the seismic performance of buildings when subjected to earthquake load. Buildings built on soft soil tends to have greater damage compared to harder soil. Therefore, it is expected that different design and detailing are required for buildings to be built on different Soil Type. This paper presents the study on the influence of Soil Type on the design and detailing of four storey reinforced concrete building with earthquake load consideration. The comparison is presented in form of total weight of steel used as reinforcement for beams and columns.

MATERIAL AND METHODOLOGY

This study utilised a four-storey reinforced concrete buildings as model. The building was regular in both plan and elevation as shown in Figure 1. The model had been simplified and assumed to be used as safety centre building like fire station. Due to its importance during and after disaster, it was categorized as importance class IV (Fardis et al., 2015) and the value of importance factor, γ_I is equal to 1.4 as proposed by Eurocode 8 (2004). The floor to floor height was set to be equal to 3.6 m. The longer and shorter beam span are equal to 6.0 m and 3.0 m, respectively. All beams have similar size of section which is equal to 350 mm width and 600 mm depth regardless the position. The size of section for all columns is typical which is 500 mm width and 500 mm depth. The modelling process had been conducted by using Tekla Structural Designer computer software. The model had been assigned to appropriate dead load, G_k like floor finishing, brickwall, suspended ceiling, as well as mechanical and electrical equipment as proposed by Mc Kenzie (2004). The imposed load, Q_k was assigned on the model based on Category B as proposed by Eurocode 1 (2002).

Consideration of earthquake load had been conducted by assigning appropriate seismic design parameter such as reference peak ground acceleration, α_{gR} behaviour factor, q and Soil Type. Since this study focused on the influence of Soil Type on seismic design, a total of five Soil Type namely as Soil Type A, Soil Type B, Soil Type C, Soil Type D, and Soil Type E had been taken into account. The value of reference peak ground acceleration, α_{gR} was fixed

as equal to 0.07g. In Malaysia, the latter represents the seismicity of some area in Kuala Lumpur, Beluran, and Sandakan (National Annex, 2017). Since the building has more than one storey and multiple bay, the value of behaviour factor, q was fixed as 3.9 for ductility class medium as proposed in Eurocode 8 (2004).

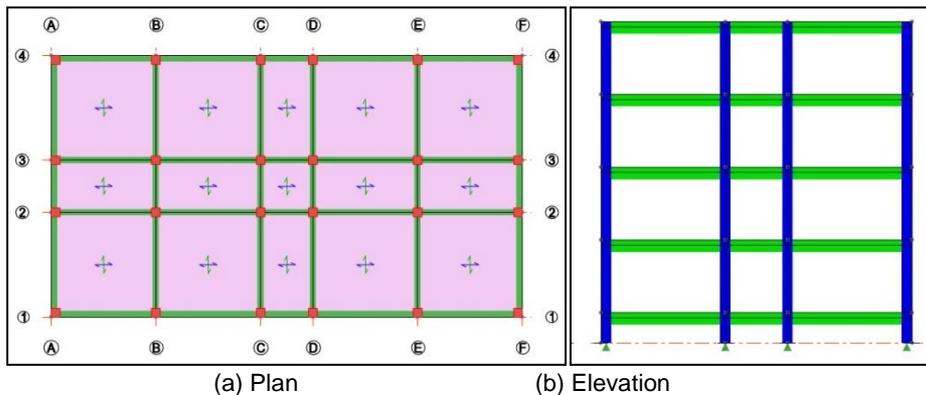


Figure 1. Model of the four-storey reinforced concrete building

The fundamental period of vibration of the building, T_1 was estimated to be around 0.6 sec. The typical model had been analysed and designed repeatedly for every Soil Type. One model had been designed without any seismic consideration for control and comparison purpose. Concrete grade C30 was considered for all models as summarized in Table 1. The analysis and designed had been conducted based on lateral force method as proposed by Eurocode 8 (2004) and also implemented in previous study by Adiyanto et al. (2019).

Table 1. Design consideration

Model Number	Design Consideration	Reference Code	Soil Type
1	Gravity load only	Eurocode 2	Non applicable
2	Gravity + Seismic load	Eurocode 8	A
3	Gravity + Seismic load	Eurocode 8	B
4	Gravity + Seismic load	Eurocode 8	C
5	Gravity + Seismic load	Eurocode 8	D
6	Gravity + Seismic load	Eurocode 8	E

RESULT AND DISCUSSION

Design Response Spectrum and Base Shear Force

Based on lateral force method, the magnitude of horizontal seismic force acting on every story, F_i are directly proportional to the magnitude of its base shear force, F_b . According to Eurocode 8 (2004), the magnitude of base shear force, F_b is strongly influenced by the total mass of the building, m and the spectral acceleration at the fundamental period of vibration, $S_d(T_1)$. In this study, the latter was determined based on the design response spectrum developed for reference peak ground acceleration, $\alpha_{gR} = 0.07g$ and importance factor, $\gamma_1 = 1.4$ as shown in Figure 2.

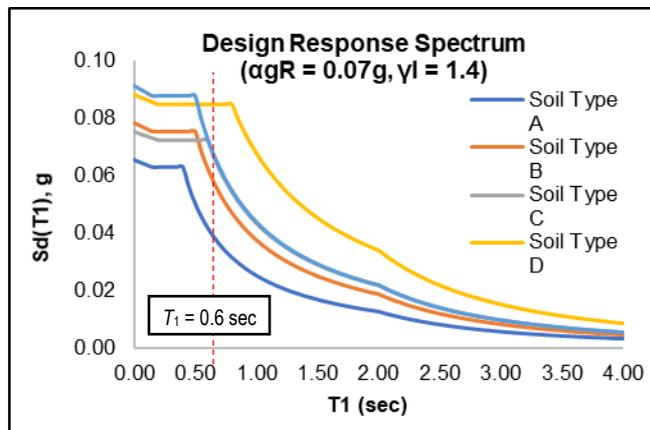


Figure 2. Design response spectrum for different Soil Type

As mentioned in previous section, the fundamental period of vibration of the building, T_1 was estimated to be around 0.6 sec. Therefore, based on design response spectrum shown in Figure 2, the magnitude of spectral acceleration at the fundamental period of vibration, $S_d(T_1)$ for Soil Type A is equal to 0.042g which is the lowest compared to other Soil Type. Table 2 presents the magnitude of spectral acceleration at the fundamental period of vibration, $S_d(T_1)$ and the base shear force, F_b of all models.

Table 2. Seismic load acting on every model

Model Number	Soil Type	Spectral acceleration at the fundamental period of vibration, $S_d(T_1)$, g	Base shear force, F_b (kN)
1	Non applicable	Non applicable	Non applicable
2	A	0.042	1050
3	B	0.063	1696
4	C	0.072	1869
5	D	0.085	2279
6	E	0.073	1979

In Table 2, it is clear that the magnitude of base shear force, F_b increases as the magnitude of spectral acceleration at the fundamental period of vibration, $S_d(T_1)$ increases. The latter is strongly influenced by the value of soil factor, S . In this study, Model 5 which considering Soil Type D has the highest magnitude of base shear force, F_b which is equal to 2279 kN. This means Model 5 is exposed to the highest horizontal seismic force, F_1 on every storey compared to other model. Due to different magnitude of seismic force, the design and detailing shall be differing for every model.

Comparison on Total Weight of Steel Reinforcement

According to Booth and Key (2006) it is hard to determine the cost increment due to seismic design. This is because every project has its own uniqueness such as function, layout, and requirement. However, it is worth to study the effect of seismic design on costing to give clear picture to every stakeholder in construction industry for better planning and management. Figure 3 presents the influence of Soil Type on the total weight of steel reinforcement for all beams. The total weight of steel reinforcement for models with seismic design are normalised to the total weight of steel reinforcement of beam for model 1 which is not considering seismic design.

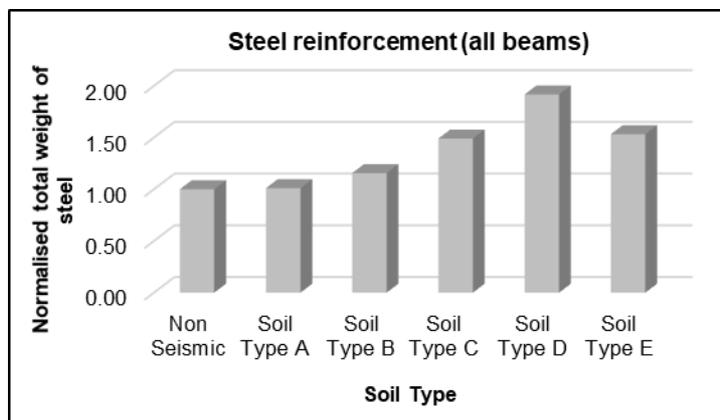


Figure 3. Normalised total weight of steel reinforcement for beam

From Figure 3, the total weight of steel used as reinforcement for beam varies for every model. It is clear that models with seismic design require higher amount of steel reinforcement. Beams with seismic design require around 1% to 92% higher amount of steel reinforcement compared to the beams without seismic design. The model considering Soil Type D has the highest amount of steel reinforcement for beams followed by models with Soil Type E, Soil Type C, Soil Type B, and Soil Type A. This result is strongly associated with the magnitude of base shear force, F_b acting on every model. As discussed in previous subsection, model 5 with Soil Type D has the highest magnitude of base shear force, F_b compared to other models. Therefore, based on structural analysis, Model 5 has the highest magnitude of bending moment, M as well as shear force, V which result in highest amount of steel to be provided as reinforcement. This result is in good agreement with previous finding by Ramli et al. (2017).

The influence of Soil Type on the total amount of steel used as reinforcement for column is presented by Figure 4. The result show similar pattern to the beam where columns with seismic design require higher amount of steel as reinforcement compared to the nonseismic column design. Model 2 which considering Soil Type A has similar amount of steel reinforcement for column with Model 1 which designed without any seismic consideration. This means the increasing of steel reinforcement due to seismic design is not significant for Soil Type A. However, the column for models on Soil Type B, Soil Type C, Soil Type D, and Soil Type E require around 1.29, 1.58, 2.11, and 1.72 times higher amount of steel reinforcement, respectively compared to the nonseismic column design. The pattern is similar to result for beam. This is because in seismic provision, the column design has to be stronger than its beam in order to achieve the Strong Column – Weak Beam design philosophy (Eurocode 8, 2004; Elghazouli, 2009; Elnashai and Sarno, 2008). Therefore, the design moment for column, M_c is directly derived from the moment resistance capacity of it beam, M_{RB} . In this study, the beams for Model 5 has the highest amount of steel reinforcement which result in the highest moment resistance capacity of beam, M_{RB} . Therefore, all columns for Model 5 were designed stronger which result in higher amount of steel as reinforcement.

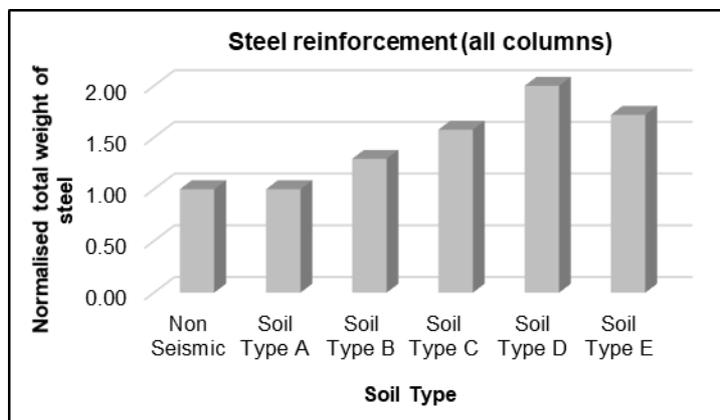


Figure 4. Normalised total weight of steel reinforcement for column

CONCLUSION

This paper presents the influence of Soil Type on the total amount of steel used as reinforcement by considering seismic design. A four-storey reinforced concrete building in importance class IV has been utilised as typical model. The latter had been designed separately by considering five different Soil Type namely as Soil Type A, Soil Type B, Soil Type C, Soil Type D, and Soil Type E as defined by Eurocode 8 (2004). The reference peak ground acceleration, a_{gR} was fixed as equal to 0.07g while the behaviour factor, q was fixed as equal to 3.9 for ductility class medium. Based on the result, it can be concluded that the site condition, represented by Soil Type strongly influencing the design and detailing of beams and columns. Except for Soil Type A, models considering seismic design with Soil Type B to Soil Type E generally require higher amount of steel reinforcement compared to the nonseismic model. The increment of steel reinforcement is in range of 1.16 to 2.11 times higher compared to the nonseismic design. Therefore, the Soil Type will result in different cost of steel reinforcement even for similar building layout and configuration.

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THE CHALLENGERS FACTORS IN IMPLEMENTING FOREST CITY CONCEPT: AN INSIGHT FROM JOHOR BAHRU'S CONSTRUCTION PLAYERS

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Abstract

The urban centres growing population and the urbanization contributions to global environmental change have been make it increased the attention to the sustainability of cities and led to the emergence of the "Forest City" concept. Forest City also known as Green City is using the same meaning with "Sustainable city" or "Eco-city" which also count in sustainable development category. Forest City represented as a role model for future cities because it has a lot of benefit which have been extensively studied in recent years especially in environmental sustainability and its application of green technology. From the extensive study of literature review from the past 10 years until updating year of publication. This study it's to identify the challenge factors in implementing forest city concept. The structured questionnaire been sent out to all the construction players in Johor Bahru as this to complement the project of forest city itself located in that particular location. About 100 construction players from different background responded to the questionnaire. The expecting finding its to contribute in enhancing the existing knowledge especially for Malaysia's construction players.

Keywords: *Forest City, Sustainable Development, Green City, Urbanization, Challengers' Factors*

INTRODUCTION

In the world population, more than a half are currently lives in cities and it will increase the share to 75 % by 2050. Today, the most urbanized regions are Northern America (82 %), Latin America and the Caribbean (80 %), and Europe (73 %) (FAO, 2015). The urban centres growing population and the urbanization contributions to global environmental change have been make it increased the attention to the sustainability of cities and led to the emergence of the "Forest City" concept. In this research, Forest City also known as Green City is using the same meaning with "Sustainable city" or "Resilience city" (Pace, 2016; Chaturvedi. A, 2013).

Forest City, Johor in Malaysia is a smart-city project which a benchmark project for Country Garden and the first city in the world where the horticulture covers the facade of the buildings that creates a forest-like environment and it is known also as a sustainable development (Garden, 2016). According to Hosam. K, 2015, the phrase of sustainable development has been defined and merged by the World Commission on Environment and Development in 1987 which is they did set forth that "sustainable development is improving people's life-enabling habits meeting the needs of the present without compromising the ability of future generations to meet their own needs".

Forest City represented as a role model for future cities because it has a lot of benefit which have been extensively studied in recent years especially in environmental sustainability and its application of green technology. It plays an important role in solving a lot of environmental problems, such as water pollution, loss of biodiversity, rising temperatures associated with city heat-island and soil erosion (Lee and Maheswaran, 2011; Lovell and Taylor, 2013; Adinolfi et al., 2014; Rahman S., 2017). Other than that, it also can create social,

economic and ecological benefits for the city and its residents will strongly be contributing to the development and maintenance of quality of life in the city. (Kingsley & Townsend, 2006; Lang, 2014; Lossau & Winter, 2011; Pothukuchi & Kaufman, 1999; Turner, 2011).

Forest City, Johor is a city which is being built on reclaimed land of 1,386 hectares on four islands at the tip of the Malay Peninsula that opposite Singapore as shown in figure1. Forest City is constructed and designed by one of the largest property development companies in China, Country Garden Holdings and this company is ranked 273rd on the Forbes list of 500 of the world's biggest public companies (Sarah Moser, 2017).

Figure 1. Shows location of Forest city in Johor Bahru.



RESEARCH BACKGROUND

Most cities in the world started from small communities and it is slowly growing by attracting people to live there. These inhabitants demand for cities to be sustainable and the ways to get it is so called 'triple-bottom line' which the precepts of sustainability (environment, society and economy). The United Nations in 2015 established the Sustainable Development Goals (SDGs) with an aim to protect the planet, to end the poverty and to make sure that people in this world enjoy peace and prosperity (Invest KL, 2013).

There has a lot of stakeholders contributed to environmental activities in cities but most of them are having different angles, for example by adopting a broader approach of green, smart, sustainability city where social, economic and financial sustainability are parameter's primary on equal footing as environmental indicators or by working on specific urban sectors. As a result, there is a lack of consensus and clarity on what could be defined as a forest city.

Environment related issues are by far is the most often that presented in forest city definitions, methods and concepts so therefore, this research proposes a definition of forest city which is emphasising the environmental performance in Table 1. However, economic and social performance are not the primary target, they also contributing the important characteristic of green city and will be useful to consider in priority monitoring, setting and evaluation of green city services and activities (EBRD, 2016; Ogenis Brilhante, 2018).

Table 1. Criteria of Forest City

Criteria		EBRD (2016)	Rocco Pace (2016)	Green cities (n.d.)	Dr Rosli Nekat (2010)	Mehdi Rakhshai ndehroo (2015)	C40 Cities (2015)	Ogenis Brihante (2018)	Total Referred
Environment	Air Quality	√	√	√	√	√	√	√	7
	Water Quality	√	√	√	√			√	5
	Land/Soil Quality	√			√				2
	Biodiversity and ecosystem	√			√			√	3
	Water resources availability	√			√				2
	Green space availability	√			√	√			3
	Climate change mitigation	√		√	√		√	√	5
	Climate change adaptation	√			√			√	3
	Economic	Economic growth and employment	√		√			√	√
	Economic resilience	√							1
	Revenue and expenditure	√							1
Social	Public health	√		√	√	√	√	√	6
	Access to urban services	√	√	√	√	√	√	√	7
	Behaviour and awareness	√				√	√	√	4
	Citizen engagement	√				√	√		3
	Social resilience	√							1
	Gender equality	√						√	2

Table 1 shows the criteria of green city from different author. There are 17 criteria that cover environment, social and economic has been listed and cited as well as analysed based on 7 authors by considering the paper published within the year 2010 to 2018. By referring Table 1 above, the highest time referred for criteria is air quality and access to urban services with 7 times referred then it followed by public health with 6 times referred. Then, water quality and climate change mitigation referred by 5 times and economic growth and employment and behaviour and awareness are referred by 4 times. Next factor that has shared the same reading of times referred which are 3 are follows by biodiversity and ecosystem green space availability, climate change adaptation and citizen engagement. Water resources availability, land or soil quality and gender equality are referred by 2 times. Last but not least, economic resilience, revenue and expenditure and social resilience are referred only 1 time.

By referring to Table 2 below, targeted environmental has been listed based on three general environmental.

Table 2. Green city environmental

General environmental	Targeted environmental
Quality of environmental assets	Air quality
	Water quality
	Land/Soil quality
Efficient use of resources	Water resources availability
	Green space availability
	Biodiversity and ecosystems
Climate change risks	Mitigation (greenhouse gas emissions)
	Adaptation (resilience to climate change risks)

Forest City have clean water and air and pleasant streets and parks. Forest city constitute an inherent element of human existence and the land space and provides many ecosystem functions. Ecosystem function in general are a subset of the interactions between its structure and the processes that underpin the capacity of an ecosystem which is provide goods and services (Joint Research Centre, 2005; M. Ciesielski, 2018).

Green environment has a positive impact on children's physical movement skills and outdoor activities. It also increases knowledge and awareness of environmental issues on green space availability. Moreover, spending time in open green spaces is not only recreation but also a learning experience, and that enhances the quality of development and self-growth (Olsson, 2012; Greencities, 2015).

Cities consume 67% of global energy and it is over 70% of Green House Gas (GHG) which has become the main contributor to climate change. The lighting and heating of residential & commercial buildings alone contribute to 25% of GHG while transport emits to 13.5% causing irreversible climate change. Forest city is a multi-layered transportation which is covered with lush green surrounding with no vehicles traveling on the surface because vehicles will be parked in a transportation hub or in lower levels of the island so GHG will reduce because transportation will be at underground (Dr. Rosli Nekmat, 2010).

Forest city has adopted best practices to minimizing the negative impacts of construction activities on the environment. Dust control, noise reduction, clean and neat site, supply on demand, solid waste reduction, sewage reduction and make full use of resources. Forest city definition also includes social and economic that linked to the environmental which should be taken into account to fully grasp the ins and outs of a forest city. The main economic and social and objectives relevant to a forest city have been listed. To enhance a city's environmental performance, they should find to maximise social and economic co-benefits. These links between environmental, economic, social objectives will add some motives for city leaders to undertake the green city actions (EBRD, 2016).

There are some examples of green city actions contribute in economic and social to improving. For economic growth and employment, economic development of green city sectors will contribute to GDP output and employment. There will be lots of job in each sector that have issues or problem. Next example is innovation in green city sectors contributes to GDP output. Then for economic resilience, resilience to the impacts of climate change will improves the economic resilience. For revenue and expenditure, financial incentives, green infrastructure and services provision, taxes and charges to promote green cities that can generate revenue and expenditures for a municipality (EBRD,2016).

For social which is public health, improvements in water and air quality will reduce public health issues. Next, there has a lot of example in access to urban, firstly, enhancement of the efficiency and water supply coverage of infrastructure or network, enhancement of the efficiency and coverage of low-emission in terms of air pollutants and GHG electricity and heat supply network, enhancement of the efficiency and coverage of sustainable modes of transport which is low-emission private and public transport, walking and cycling, enhancement of the efficiency and coverage solid waste collection system, enhancement of the efficiency and coverage of safe and energy-efficient housing, affordable basic services for all the urban population and last example is and all of this are services for the urban population and may participate in poverty and inequality reduction efforts. Last example for urban services is enhancement of the quantity of green spaces increases access of such services for all the urban population and generate well-being. What is the example of behaviour and awareness? Green behaviours increase the use of existing sustainable urban utility systems which is transport, solid waste recycling systems, high public awareness on natural disaster risk enhances the civil society's preparedness to such events, citizen with

green behaviours are more likely to preserve habitats and ecosystems, green behaviours result in lower consumption of water and energy resources. For citizen engagement, the example is involving citizens in green city planning processes helps to achieve public participation objectives and buy-in of the population and community involvement in green city actions, for instance, nature conservation and solid waste can be an effective implementation means and provide social benefits. Social resilience is tackling the vulnerability of poor communities to natural disaster risk can have high benefits on a city's resilience and avoid further urban inequalities. Lastly for gender equality is enhancement of the safety and accessibility of public transport participates in promoting gender equality (EBRD, 2016). These all the fact may conclude that forest city also in line with the sustainable development based on three main principles discussed which are environmental, social and economic.

RESEARCH METHODOLOGY

Table 3 shows that the journals referred for the research and total journal referred on the year of published journal between 1996 to 2018. Based on table 3, eight (8) references are used from the journal were published on 2016 as there were many information which related to Forest City.

Table 3. Journal referred for research

Year of Published Journal	Total Referred
2018	2
2017	7
2016	8
2015	3
2014	2
2013	6
2012	3
2011	5
2010	4
2006	2
2005	1
2004	1
2002	2
2000	1
1999	2
1996	1
Total Journal Referred	50

100 sets of structured questionnaires been sent to varies background of respondent of construction players. The questionnaire based on 5-points Likert scale.

RESULTS AND FINDINGS

Table 4 and Figure 2 shows the result from 100 questionnaires has been responded by the respondents. The challenger's factors been list in Table 4.

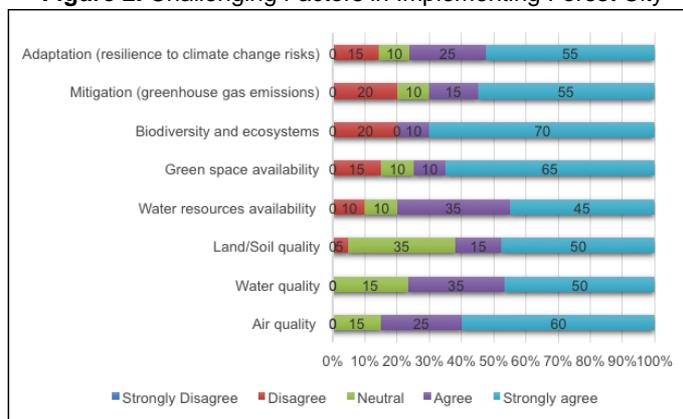
From the reading, Air quality – 60 are strongly agree, 25 are agree and 13 neutral. Water quality having 50 are strongly agree, 35 are agree and 15 neutral. Land/Soil quality having 50 are strongly agree, 15 are agree, 35 neutral and 5 disagree. Water resources availability having 45 are strongly agree, 35 are agree, 10 neutral and 10 disagree. Green space availability

having 65 are strongly agree, 10 are agree, 10 neutral and 15 disagree. Biodiversity and ecosystems having 70 are strongly agree, 10 are agree, and 20 disagree. Mitigation (greenhouse gas emissions) having 55 are strongly agree, 15 are agree, 10 neutral and 20 disagree. Adaptation (resilience to climate change risks) having 55 are strongly agree, 25 are agree, 10 neutral and 15 disagree.

Table 4. Challenging Factors in Implementing Forest City

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Air quality	0	0	15	25	60
Water quality	0	0	15	35	50
Land/Soil quality	0	5	35	15	50
Water resources availability	0	10	10	35	45
Green space availability	0	15	10	10	65
Biodiversity and ecosystems	0	20	0	10	70
Mitigation (greenhouse gas emissions)	0	20	10	15	55
Adaptation (resilience to climate change risks)	0	15	10	25	55

Figure 2. Challenging Factors in Implementing Forest City



CONCLUSION

Several recommendations that can be speed up to overcome the stated issues; providing knowledge and training like organizing seminar, talk or workshop and conferences to educating the and offering to the public and potential buyer for green principles on the concept and the benefits can be generated from implementing this concept in their project. Actions must be initiated to enable this concept to be applied efficiently in future construction projects in order to meeting up with the current industry needs. Finally, stakeholders' actions are influenced by the market situation and demand from the buyer. a wave of pushing factors must be acting upon to the project owners and also contractors to improve the efficiency by adopting the concept. The modern and modest design and practices must be play with the current platform for the construction project.

In summary, more efforts are necessary to enhance the level of awareness and consciousness among the Johor Bahru's construction practitioners to implementing this concept in the future project. These are the point that should put into an account to make them ready to be implementing this concept. It's should start from the most important people in

that particular state so that this concept can be successfully implementing in their area. Forest city is a model of future cities that positioned itself as a smart, sustainable, resilient and green city with industry integration. Many studies have attempted to define forest city concept and studies shows that there are actually having a same meaning. Unfortunately, there is not universally that accepted the definition or observed the practical approach to Forest City. Therefore explaining more that, "Cities are the future's growth engine which is offering their populations in greater opportunities for employment, education, and prosperity but there still have the negative effects of their growth can also result in environmental pollution, traffic congestion, exploitation of resources, urban sprawl, informal settlements and a significant contribution to climate change in future research truly appreciated as all these may contribute to sustainable development in other hand also to sustain whatever has been develop in the pieces of land so called *Forest City*.

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AN IDENTIFICATION OF BUILDING MAINTENANCE CRITERIA TOWARD GREEN BUILDING RESIDENTIAL PROJECT

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Abstract

Building maintenance can be used for services, facilities, facades, elements and structures and each maintenance activity is different in their classification. All buildings require maintenance to allow buildings to continue to operate, keeping their value as high as possible and extending their lives. Building maintenance is also important to provide a safe and better working environment and to maintain the aesthetic value of the building. However, its less concern on building maintenance towards green building residential project. Therefore, this paper its to study and identify the building maintenance criteria towards green building residential project. The extensive literature review from the latest 10 years of publication has been used to run this study. Perhaps, the expecting finding may contribute and enhance the existing knowledge towards this issue.

Keywords: *Building Maintenance; Green Criteria; Residential Project*

INTRODUCTION

Every building element requires care to restrict the deterioration and exposure of the elements which eventually thursts. According to Shirley Jin Lin Chua et al. (2018) it is important for buildings to have the activity of building maintenance to keep them in good condition of working. The same authors also in lined with Ali et al. (2010) agree that, generally building maintenance is defined conclusively from the different definitions as a combination of technical and related administrations actions to ensure that all building items and elements is working and work in satisfactory and acceptable standards.

As a fact that Building Maintenance can be used for facilities, services, elements, facades and structures and each maintenance activity is different in their classification while; All buildings require maintenance to allow buildings to continue to operate, keeping their value as high as possible and extending their lives (Shirley Jin Lin Chua et al., 2018). According to the same author, to get good maintenance practices in the building, it is important to take into account the whole maintenance management aspect which is standard maintenance, maintenance planning, statutory control, maintenance information, cost management, maintenance organization, service delivery, maintenance document, and sustainability. Everything must be well designed to provide a good application for building maintenance. Strategy of maintenance is one of the important elements to be carefully selected based on these factors such as building size, user standard, budget and functionality, as well as any relevant factors reflected to the Building Maintenance.

In order to achieve Malaysia's Advanced Economy by 2020, gazetted as an important milestone in the Eleventh Malaysia Plan 2016-2020 (R. Saian et al., 2017). Where in The Eleventh Malaysia Plan has developed six core strategies which one of them focuses on continuing green growth for sustainability and endurance. This is where the place in country will begin green growth particularly in development of the new project. Besides, it will also

be a lifeway for Malaysians. They are not only either the public or government sectors put their effort to take the initiative in developing green environment and culture, but also NGOs and private companies.

Therefore, this study is to seek for the main criteria of building maintenance of conventional building to emerge with the green building particularly for residential types of project. Even though the application of green building in Malaysia is still at the initial stage, but in a few buildings in Malaysia, there are some successful applications of green building (R. Saian et al., 2017; Ismail et al., 2012). Nevertheless, the green building application in this country is still low especially for residential types of project. Due to the merits of green building offered, the trend of applying such green building is spread in building industry slowly to certain residential building project in urban cities is.

In building industry, maintenance is a must. It should be practically handled. Maintenance is a work undertaken to keep, improve or restore every part of the building; to extend the life and maintain value of the building (Tan Yong Tao et al., 2014; Seeley, 1976). Building maintenance is so important to provide a better and safer working environment and to retain the value of aesthetic for the building (Shirley Jin Lin Chua et al., 2018; Wood, 2009). Different type of building also functioned different. Hence, it adopts different maintenance management method (Azlan Shah Ali et al., 2016). With a numerous of benefits available, it pointed out that maintenance for green building should be promoted and used widely over the country.

RESEARCH BACKGROUND

The building maintenance strategy that is generally applied in Malaysian buildings is reactive or unplanned based and sometimes the strategy even the criteria not really suit based on the application of the building itself. The strategy claimed as ineffective if it causes frequent breakdown or downtime and require high maintenance cost for repairing also replacement work (Shirley Jin Lin Chua et al., 2018; Au-Yong et al., 2014b). Shirley Jin Lin Chua et al. (2018) and Au-Yong et al. (2014b) stress the causes of no specific building maintenance measures leads to poor performance performing a building maintenance to existing building even to the green building.

Moreover, the Urban Wellbeing, Housing and Local Government Ministry carried out a survey and reported that more than 50% of the Malaysia high-rise residential buildings were ranked below average in the assess of property management standards. The survey also found the residents who live in these building was feeling dissatisfied with the service quality of current building maintenance management (Abd-Wahab et al., 2015; Feng, 2016). It is necessary to manage a physical asset in an effective and systematic way as it will affect the value of the site and the facilities.

Therefore, a clear identification on the criteria of building maintenance practicing in green residential building truly appreciated to overcome the stated issues. Gazetted by Ministry of Energy, Green Technology and Water (KeTTHA) is to improve green technology and environment (KeTTHA). Meanwhile, the Malaysian Institute of Architects / Association of Malaysian Architects (PAM) and Association of Consultants Malaysia (ACEM) have developed the Green Building Index (GBI) (R. Saian et al., 2017) as an assessment tool for

assessing and evaluating the building green status. Malaysia Green Technology Corporation (GreenTechMalaysia) has also been formed to enact legal mechanisms for regulating and enforcing green technology, and to determine the role of each government agency involved in the implementation of green technology in the country (Rahman et al., 2013).

There are also many green technology exhibitions and conferences that have been held and established in Malaysia itself, for example in the region the largest green technology exhibition and conference, KeTTHA, Ministry of Energy, Greentech International and Eco and Conference Malaysia Product (IGEM) Exhibition every year since 2010. This suggests that Malaysia has looked and moved towards the sustainability with the essential requirements of water efficiency, energy efficiency, materials and resources management, sustainability and planning, quality closed environment as well as new innovations.

Although the GBI rating tool is introduced, it can play the role as a benchmark for buildings to accomplish the green status. One of the criteria for assessing GBI's assessment is to ensure existing buildings are proper upgraded and refurbished to remain relevant and new buildings keep relevant in the future (R. Saian et al., 2017). The relevance speaks out loud on the building maintenance towards green building. However, in Malaysia particularly, there is a problem where the non-existence of framework or guidelines which specify on building maintenance, Malaysia is not being fully observed and explored where it is always been rejected. That are very advance in green technologies such as Germany, Canada, Japan and America, they already have their own guidelines for green building system which may leads to proper building maintenance strategy and procedure (R. Saian et al., 2017; Hui, 2010). Therefore, it can lead to determine the existing tools to measure building maintenance performance towards green building to extend the existing knowledge not only on GBI but also to any relevant tools defining in building maintenance particularly for green building residential types of project.

Therefore, to determine the existing tools to measure building maintenance performance towards green building particularly for Malaysia really much appreciated as Malaysia as for now moving forward to develop and deliver more green residential building. Even so, as compared to Singapore where have the same climate and weather, Malaysia is said to be far behind in terms of policies, practice, technology and research done in this area; Malaysia is lacking of government guidance, incentives and the support of green building standard organization (R. Saian et al., 2017). According to R. Saian et al. (2017) this shows that the short of research and knowledge on maintenance system which mainly for tropical climate has led to a zero interest in using the system among the developers and owners of the building. Maintenance can be said as a main part of the process in managing green building system after the completion of construction and installation stage. Therefore, this research to investigate the barriers factors in practicing building maintenance to green residential building particularly for Malaysia scope.

The emerging of 2 conceptual ideas of building maintenance and green building may lead to developing to new conceptual framework on for to managing the green building and to do the routine maintenance process towards those building. The new developing framework may also lead to clear and better understanding and to enhance the existing knowledge towards the said concept.

Table 1. Criteria for building maintenance

Criteria	Authors				
	Nik- Mat et al. (2011)	Olanrewaju (2009)	Roslan Taib et al. (2014)	L. Jawahar Nesan et al. (2015)	Mahmoud Sodangi et al. (2013)
Assurance	√				
Reliability	√	√			
Responsiveness	√				
Relevance	√				
Timeliness	√				
Validity	√				
Cleaning & Landscaping	√			√	
General Maintenance	√				
Lighting	√				
Air Conditioning	√				
Lifts/ Escalators	√				
Mechanical & Electrical	√		√		
Sanitary & Washing Facilities	√		√		
Access, Signage & Parking	√				
Safety & Security	√	√	√	√	
External Finishes	√		√		
Internal Finishes	√		√		
Durability				√	
Material Sustainability			√	√	
Compatibility				√	
Health and Safety				√	
Material Economy				√	
Material Availability				√	
Functional Performance				√	
Thermal Performance				√	
Acoustical				√	
Structural Components			√		
roof component			√		
life cycle cost		√			
maintenance planning		√			
user's satisfaction		√			
retaining cultural significance					√
clear maintenance policies					√
management plan					√
management processes and procedures					√
change in attitude					√
maintenance prioritization					√
regular inspection					√
information management					√
maintenance staff training and expertise					√
conservation consciousness					√
financial planning and budgets					√
monitoring and review system					√
planned maintenance approaches					√
organizational culture and structure					√
integration with corporate strategy					√

There are many difference criteria for building maintenance so that we are going to identify the criteria of building maintenance which practicing in different type of building. Table 1 show the criteria of building maintenance from different references and the maintenance for different type of building too. For author 1 to 3 is doing the research for building maintenance on normal building; L. Jawahar Nesan et al. define the criteria for building maintenance particularly for material and Mahmoud Sodangi et al. (2017) is giving the criteria for building maintenance on heritage building. Among the 46 criteria, the most popular criteria that discuss by the authors are safety & security.

By refer to Table 2 which about the criteria of building maintenance on green building. Among the 12 factors which pointed out by 5 different authors, it shows that the green building maintenance is more referred or concern on the criteria of thermal performance, life cycle approach and energy.

Table 2. Criteria for green building

Authors	Ashok Kumar et al. (2013)	Nurul Nadjiah Zainol et al. (2014)	Abdul Lateef Olanrewaju et al. (2015)	Alan M. Forste et al. (2015)	Shafikah Saharuddin et al. (2017)
Drainage system					√
Waterproofing membrane					√
Structural deck					√
Thermal Performance	√				√
Wall and roof	√				
Lighting	√				
Solar energy	√				
Life cycle approach			√	√	
Material and component			√		
Energy		√		√	
Resources emission		√			
Building facilities		√			

RESEARCH METHODOLOGY

Table 3 shows that the journals referred for the research and total journal referred on the year of published journal between 1996 to 2018. Based on Table 3, eight (8) references are used from the journal were published on 2016 as there were many information which related to topic discuss.

Table 3. Journal referred for research

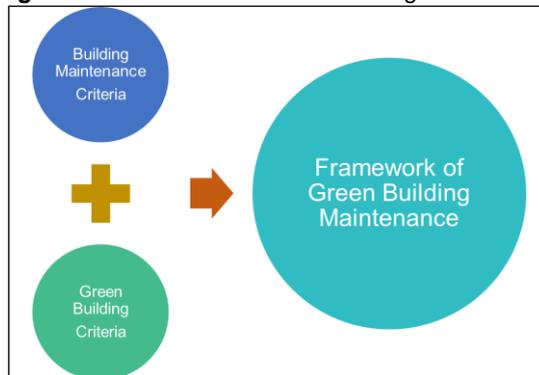
Year of Published Journal	Total Referred
2018	5
2017	11
2016	4
2015	2
2014	9
2013	4
2012	2
2011	3
2010	7

Year of Published Journal	Total Referred
2009	1
2006	1
2005	0
2004	0
2002	0
2000	0
1999	0
1997	1
1996	0
Total Journal Referred	50

RESULTS AND FINDINGS

From the extensive study in literature review towards seeking criteria for building maintenance and criteria for green building, the summary of the idea can be concluding as Figure 1 below. Where the framework can be used to clearly define the maintenance procedure can be made to green building by combining the two criteria has been discussing previously in Table 1 and Table 2.

Figure 1. Framework of Green Building Maintenance



CONCLUSION

From this research, we hopefully can enhance an existing knowledge which to provide addition criteria for the green building maintenance assessment. The most referred criteria from each of the table which the table of criteria for building maintenance on conventional and green building and assessment tools of green building. All these criteria will put in the questionnaire and distribute to our target respondent and see whether the answer we collect back is agreed to all those criteria or not.

In summary, building maintenance is a very important work or can be say as a work which must have to carry on after the after the completion of construction and installation stage. There is the problem of lack of standard guideline for building maintenance in Malaysia; at the same time we can also see the growing numbers the of green building in construction industry Malaysia, therefore we have to find look for the existing tools and get our own suitable criteria of assessment tools to assess the maintenance work on green building. This will ensure the people in Malaysia who satisfied to the place they live or stay and live safety in the building.

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SUSTAINABLE CONSTRUCTION WASTE MANAGEMENT PRACTICES IN MALAYSIAN CONSTRUCTION INDUSTRY; THE KUALA LUMPUR FEDERAL TERRITORY CONTEXT

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Abstract

The vast property development in Malaysia has causing the construction industry to generate tons of construction waste. All of the construction parties such as developers, architects, engineers, quantity surveyors and contractors are likely to be responsible for the construction waste generated during the construction process since they are the professional's players in the construction industry. However, it seems like Malaysia players are still weak in managing construction waste and sustainable construction waste management initiatives are often ignored by Malaysia construction players throughout most of the construction stages. There are unclear initiatives and policies that shall be complied by the construction players which resulting an uncertainty among the construction players and causing the matter of sustainable construction waste management to remain unresolved. This study is to further understand the sustainable construction waste management practice trends and obstacle faced by the construction players in Malaysia. The data collection was carried out through the distribution of questionnaires. The results will then be analysed using IBM SPSS statistics 24. The result of the survey questionnaires shown in SPSS has been identified using scatterplot and multiple linear regression. It shows a trend between the Independent variables and the dependent variables which could conclude an interesting and statistically significant finding on this sustainable construction waste management subject matter in Malaysian construction industry.

Keywords: *Construction Waste; Sustainable Construction Waste Management; Construction Industry; Multiple Linear Regression.*

INTRODUCTION

In recent years, the numbers of construction projects have increased dramatically since 1991 due to 'Malaysian Plan 2020' (Nagapan et al., 2013). This is because the plan considers moving Malaysia into a fully developed country by the year 2020 by Prime Minister of Malaysia Tun Dr. Mahathir Mohamad during the tabling of the Sixth Malaysia Plan in 1991. Unfortunately, the rapid growth in the construction industry is the major contribution to the generation of Construction Waste. Today, the construction industry itself has generated tons of waste during construction and renovation of buildings or structures.

The increase of construction activities due to the development in developing countries increases the generation of waste (Nurzalikha et al., 2016). Despite being a major generator of waste, the construction industry has had little motivation to adopt efficient sustainable waste management practices. The growth of waste has become critical and more severe because of the increased consumption of natural resources and raw material to achieve the satisfaction of users. It creates negative impacts to the environment such as pollution that leads to economic lose and resources or material depletion that leads to affecting the social wellbeing of the society. For instance, a recent chemical waste dumping issue at Sungai Kim

Kim, Johor Bahru causing 13 schools around Pasir Gudang are called to be closed immediately, where this incident caused many victims hospitalized due to the inhalation of the toxic fumes emanating from the chemical waste (Bernama, 2019).

Furthermore, Construction Waste has become a pressing issue in Malaysia due to massive development, the weak waste management hierarchy and lack of the enactment of construction waste management policies in Malaysia. For example, illegal dumping has not been well managed all over Malaysia due to the financial, timeframe and location of a project. Furthermore, little action has been taken by the responsible authorities due to a small amount of research has been carried out. Therefore, this study is focusing on Construction Waste Management that contribute to the small amount of research carried out by the Government to achieve sustainability.

In additional to achieve sustainability, it requires the cooperation of the local authorities and all the construction parties to reduce Construction Waste. This lack of cooperation between the local authorities and all the construction parties shows weak communication in managing Construction Waste. Moreover, a suitable Construction Waste Management method must be adopted, and all construction parties must have the right attitudes in managing Construction Waste. The society felt that there was a need to address the negative impacts of Construction Waste due to illegal dumping done by irresponsible construction parties (Effie et al., 2011).

Along with the Construction Waste matter in Malaysia, it has become a major problem in the construction industry because of the construction projects in Malaysia has increased rapidly. The Construction Waste produced by high level of activities in construction projects will be disposed in public landfill area. Thus, there will be shortages of public landfills areas in the future to dispose all Construction Waste due to the increasing activities in Malaysia construction projects. Minimising construction waste is often not considered by Malaysia construction projects during the early stage of construction project (Dainty and Brooke, 2004). Minimising construction waste can lead to higher productivity, save time and improve safety at the construction site. However, there are only a few Contractors who are willing to and consider a sustainable environment by minimising and recycling construction waste due to time constraint and working pressure. This shows that the Malaysia construction projects are very weak in handling and managing struggling with Construction Waste Management problems. Most contractors will try to complete a construction work in shortest time possible without considering sustainability and recycling. As reported by The Star Online Metro Community dated 24 January 2017, there are some unscrupulous contractors who disposed their construction waste on a slip road at Jalan Lagong, Kuang.

Due to the increasing of Construction Waste in high level of construction activities, the purpose of this study is to improve the Construction Waste Management in Malaysia construction projects. Thus, this research will investigate the current Construction Waste Management practices adopted in Malaysia and its challenges obstructing the workers to practice them, the impacts towards the environment, social and economic without Construction Waste Management, the factors likely obstructing the workers to practice Construction Waste Management and identifying the worker's behaviour when practicing Construction Waste Management using Ajzen's Theory of Planned Behaviour.

CURRENT CONSTRUCTION WASTE MINIMISATION PRACTICES IN MALAYSIA

The increase of construction activities due to the development in the developing countries increases the generation of waste (Nurzalikhah et al., 2016). Despite being a major generator of waste, the construction industry has had little motivation to adopt efficient waste management practices. This is because of the poor implementation of Construction Waste Management Practices in Malaysia. Landfill has been used widely in Malaysia to dispose all waste including inert and non-inert Construction Waste (Agamuthu and Victor, n.d.). This reflects that the practice we apply is kind of substandard in waste management practices. As per referring to Figure 1, the waste management hierarchy, the disposal of waste is the least preferred in the waste management practice from the illustration.



Figure 1. The Construction Waste Management Hierarchy (Pinterest, n.d.)

The 3Rs method (Recycle, Reduce & Reuse) is well recognized in Malaysia. This is because of the well-publicized government campaign aimed at creating awareness of the public. However, the campaign is merely successful because the authorities are only focusing on having campaign. They have forgotten to look into the content of Construction Waste Management system and Practices that are more important, such as lack of stringent regulations, lack of enforcement, inadequate facilities, lack of collection network and weak attitudes and behaviours of construction workers (Ya'cob et al., 2013). Changes in the contents of Construction Waste Management system are more important than having campaign to create awareness to the public. These contents are clearly shown as Datuk Abdul Rahman Dahlan (Urban Wellbeing, Housing and Local Government Minister) said that only 15 percent of waste are recycled as of 4 February 2016. Referring to Figure 2 on the comparison of composition of recycling waste each country implemented, the 15 percent that Malaysia achieved is much lower than many other countries such as Austria (68 percent), Germany (62 percent), Taiwan (60 percent), Singapore (59 percent) and South Korea (50 percent) (Yiswaree Palansamy, 2016).

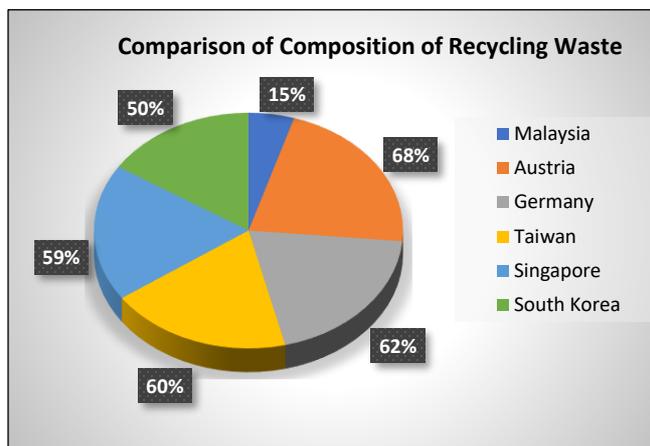


Figure 2. Comparison of Composition of Recycling Waste

The Current Construction Waste Management Policies in Malaysia

The Construction Waste in the central and southern region of Malaysia occupied 28.34% of the municipal solid waste in Malaysia (Samsudin and Don, 2013). There is no requirement for the Malaysian construction company to exercise a sustainable Construction Waste Management Practice where this causing improper waste management for most of the construction players in Malaysia. Thus, the illegal dumping activity continuously becoming a problem in Malaysia (Begum et al., 2009). There are various policies have evolved through the years. The National Strategic Plan for Solid Waste Management 2005 in Malaysia is the framework for the following:

- a) Master Plan on National Waste Minimization (MWM 2006)
The objective of this plan is to provide Vision, Strategies and Roles of Stakeholders to minimise local solid waste. The Vision is to embed waste minimization activities into the behaviour of Malaysians.
- b) National Solid Waste Management Policy (2006)
It aimed to establish a systematic Solid Waste Management (SWM) that comprises all sorts of waste such as construction waste, household waste and others. This policy uses the 3R activities to emphasize on reduction, treatment and disposal of waste. (Agamuthu et al., 2011)
- c) Solid Waste and Public Cleansing Management Act (SWMA 2007)
This Act controls the Solid Waste Management (SWM) by ensuring proper sanitation in Peninsular Malaysia and the Federal Territories of Putrajaya and Labuan. It identifies the sources of waste, defines waste and provides some ways to reduce waste. (Agamuthu et al., 2011)
- d) SWM Corporation Strategic Plan (2009-2013)
It implements policies, plans and scheme for Solid Waste Management (SWM). It focuses public awareness program, monitoring of SWM services, and environmentally sustainable SWM.

The National Strategic Plan for Solid Waste Management is used as the basis for the policies and measures of minimizing solid waste in Peninsular Malaysia until 2020 (Agamuthu et al., 2011). However, all the National Strategic Plan for Solid Waste Management frameworks as mentioned above do not focus on Construction Waste. Therefore, the Construction Waste Management is not put an eye by anybody, and it is not treated seriously in Malaysia.

CHALLENGES OBSTRUCTING THE CONSTRUCTION PLAYERS TO PRACTICE CONSTRUCTION WASTE MANAGEMENT

Along with the not very rigid policies that emphasis on the construction industry waste. This phenomenon is causing a customary practice to the construction players not to practice construction waste management practice in a proper manner. There are the five challenges major challenges the construction players encounter as in the following:

Challenges 1: Insufficient Technologies and Facilities

The fast-increasing rate of Construction Waste generation has caused the current technologies such as land filling unable to cope with. Prediction shows that landfill will be running out by 2020 if the Construction Waste is not managed properly (Mahayuddin et al., 2008).

Challenges 2: Lack of a well recycling market

All resources used during construction have high wastage because lack of recycling effort in the construction market. It requires the efforts of the market to introduce recycling. Lack of it will restrict the effectiveness in implementing waste recycling (Mahayuddin et al., 2008).

Challenges 3: Insufficient fund

As minimising Construction Waste requires higher cost, therefore, many industry practitioners are unwilling to minimise Construction Waste. An incentives or appropriate fund may be their motivation to apply waste minimization as one of the waste management method (Mahayuddin et al., 2008).

Challenges 4: Insufficient regulations

Regulations are required for the construction site to obey during minimising Construction Waste. However, it is difficult to implement regulations into the Construction Waste Management system because it needs to be cost effective, sustainable, and acceptable by the community (Teo et al., n.d.).

Challenges 5: Lacking awareness

Although there are several policies established, most of the construction workers do not realize the issues of Construction Waste which damage the environment and the importance of waste reduction through 3R (Recycle, Reduce & Reuse) before final disposal (Nurzalikha et al., 2016).

IMPACTS TOWARDS THE ENVIRONMENT, SOCIAL AND ECONOMIC WITHOUT A PROPER CONSTRUCTION WASTE MANAGEMENT PRACTICES

By not adopting construction waste management practices by Malaysian construction players, it has causing impacts towards the environment, social community and economy. These impacts are elaborated further as followed:

Environment Impact

Global Warming and Climate Change

Global warming occurs when carbon dioxide (CO₂) and other air pollutants and greenhouse gases collected in the atmosphere which may last for years to centuries will trap the sunlight heat. These gases will block the solar radiation from bouncing off the earth's surface (European Commission, 2016).

Resources Depletion

Wood has been used widely in construction. Its consumption is faster than it can be replenished. It experiences the slowest rate of growth compared to other materials although wood is a renewable resource (OECD, 2017).

Social Impact

Harmful Pathogenic Waste

Most pathogenic wastes are generated during the construction of medical institutions and microbiological laboratories. Pathogens are caused by infectious microorganisms such as bacteria and virus. These wastes are harmful to the environment and people, it may cause infectious diseases. For example, sanitary sewer systems, which consist of pipes and pumps to convey microbiological waste to treatment plant (OECD, 2017).

Air, Water and Land Pollution

The air, water and land quality will be significant impact of construction waste. For example, some certain components of construction waste such as plasterboard are hazardous once landfilled. Plasterboard is broken down and releasing hydrogen sulphide, a toxic gas. Inhalation of high concentrations of hydrogen sulphide can produce extremely rapid unconsciousness and death (OECD, 2017).

Economics Impact

Increase Landfill Development Cost

Landfills are becoming scarce each day. This is because the increasing Construction Waste caused by the increasing demand. Thus, more landfills will be needed and soon landfills will run out. Vacant land will be purchased, and hills and slopes will be cut. A much higher cost will be incurred to develop the vacant land into landfills (Anon, 2017).

Increase Cost of Collection and Processing

A very far distance to the landfill sites will cause the direct costs of transporting to increase. In addition, fossil-fuels are becoming scarce and expensive. Therefore, the cost of collection and processing will be increased (Anon, 2017).

Attitudes Towards Practicing Sustainable Construction Waste Management

There are three factors used in Ajzen's theory of planned behaviour which are: (1) attitude, which is the individual's positive or negative thought of performing a behaviour; (2) social norms, which is social pressure of performing a behaviour; and (3) perceived behavioural control, which is individual's ability to perform a behaviour. They are beyond the control of waste management. (Ajzen, 1991, 1993, 2001) This plan of behaviour is discussing about the motivation of individual's behaviour of him to behave in such a way. Most of all the previous study have conducted little amount of research on managerial and operatives' level of minimising waste. Changes in behavioural attitudes are more important than changes in technology of construction.

Attitudes may affect one's behaviour without him/her realising it. (Kulatunga et al., 2006) A work environment which has positive attitudes such as friendly and helpful will definitely influence a person behaviour. This is because positive attitudes person is active, productive and willing to accept anything to improve themselves. In contrast, people with negative attitudes such as boredom and irresponsible will reduce the efficiency and effectiveness during working. To reduce waste in the construction industry, the top management has to understand there are 4 categories of attitude which are:

Utilitarian

It is caused by community interests. The word utilitarian comes from the word utility which means value. For example, if a person is getting a raise, it creates positive attitudes in that person and will affect his/her behaviour (Boundless, 2017).

Knowledge

The person under this category is logical and rationalizing. If the organisation explains the reason of assigning the task to workers, then workers may have more positive mentality to complete the task rather than forcing them without giving them a reason (Boundless, 2017).

Ego-defensive

This is when people will protect their ego. For example, if a person has done wrong, the manager should provide suggestions for improvement instead of criticising the workers. The workers may feel insulted and adopt a negative attitude and dismiss the manager to defend their works (Boundless, 2017).

Value-expressive

Everyone has their own values. Values are things that a person believes are important in the way they live and work. The manager should always be aware what the employees are good at to prove their worth in the organisation. By doing so, it will achieve the organisation vision easily and will generate passion among the workers. For example, if a person is cooperating, he is suitable to work as the project manager because he is required to work together to ensure the project completion is on time (Boundless, 2017).

FACTORS CAUSING FAILURE OF SUSTAINABLE CONSTRUCTION WASTE MANAGEMENT PRACTICES

Subsequently, in Malaysia, dumping construction waste at illegal dumpsites is very common due to the factors such as lack of stringent legislation, lack of enforcement, inadequate facilities, lack of collection network and weak attitudes and behaviours of construction workers (Eusuf et al., 2012). The statistics of construction waste generated and the disposal of construction waste shows that Malaysian construction industry still practice waste disposal at landfill sites, which the landfill will cause various pollutions.

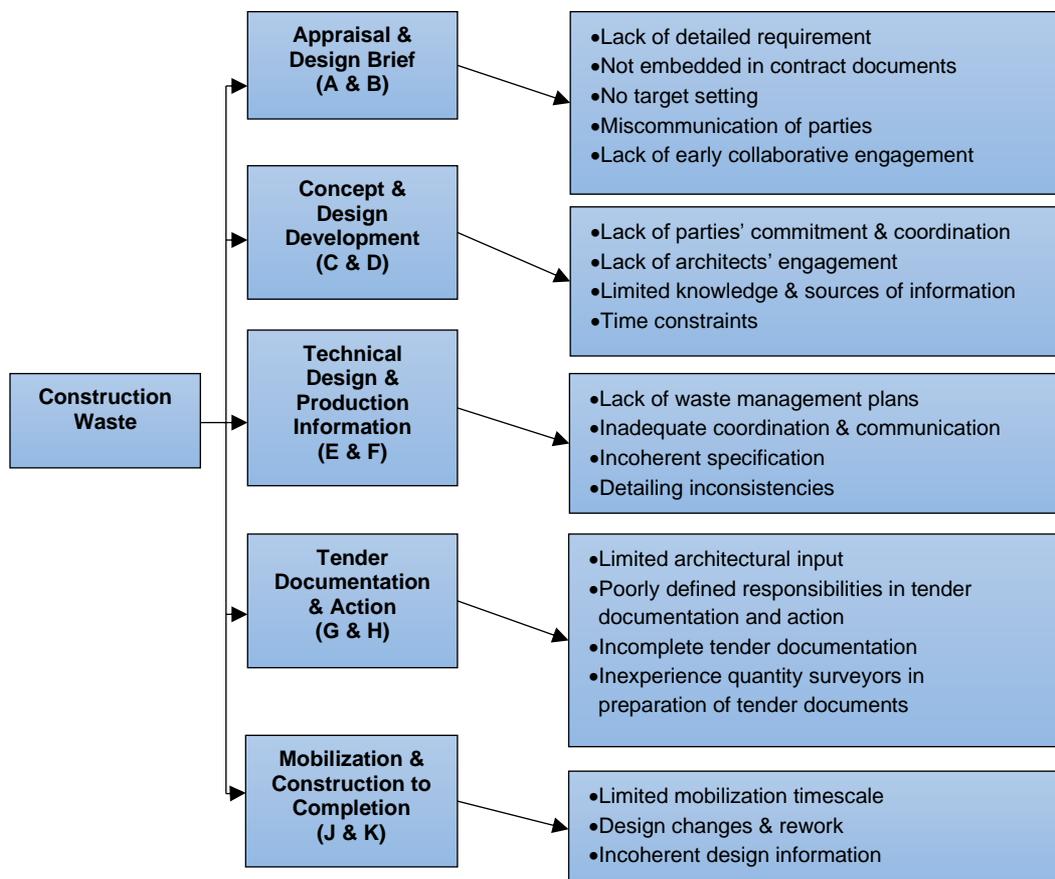


Figure 3. Factors Causing Failure of Construction Waste Management according to RIBA plan of works (Osmani, 2013)

According to Osmani (2013), following are the summarized factors contributing to the failure of proper construction waste management practices using the Royal Institute of British Architects (RIBA) plan of works. Referring to Figure 3, there are 5 stages of construction causing generation of Construction Waste. Each stage has its own factors causing the generation of Construction Waste.

METHODOLOGY

Quantitative Approach

A quantitative approach, a questionnaire survey was prepared for data collection. A questionnaire survey was used for this study as the research is descriptive in nature. A descriptive survey study is appropriate for portraying a reliable profile or describing the characteristics such as opinions, behaviour, knowledge, and abilities of a particular groups, situation or individual (Shilubane, 2010). This research is going to use quantitative method. This is because the result of this research study requires statistical, numerical and computational techniques to analyse and manipulate the data.

Scope and Sampling

In this research study, the sampling group who will be involved in this questionnaire survey study will be the contractors who are typically involve in building construction works in Kuala Lumpur, Malaysia. They are chosen as the research sample respondents because they are the ones who exposed themselves frequently on site. The questionnaires survey will be distributed using emails and via hardcopies.

The required sample size of the respondents in the questionnaires will be calculated using the formula as shown below.

$$S = \frac{X^2NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$

Equation 1. Formula for the required sample size calculation

Where

S = Required sample size

X² = The table value of chi square for 1 degree of freedom at the desired confidence level

N = Population size of registered Contractors (619) in Kuala Lumpur building construction works

P = The population proportion, always fixed at 0.50 as this would provide the maximum sample size

d = Degree of accuracy expressed as a proportion at 0.05.

The calculation of required sample size for this study is shown below:

Equation 3.2: The respondents required sample size for this research study

$$S = \frac{3.841 \times 619 \times 0.5 (1 - 0.5)}{0.05^2 (619 - 1) + 3.841^2 \times 0.5 (1 - 0.5)}$$

$$= \underline{\underline{114 \text{ questionnaires}}}$$

The minimum sampling size of survey questionnaires need to be collected for this research study is 114 Contractor companies. Each company will only allow 1 questionnaire because Contractor is a company and not an individual person. The population proportion (P) is fixed at 0.50 equivalent to 50% to provide value associated with a population in the maximum sample size. The degree of accuracy (d) given for this study is 5%. This shows that the data obtained will be 95% accurate and only 5% of significant error.

Research Framework

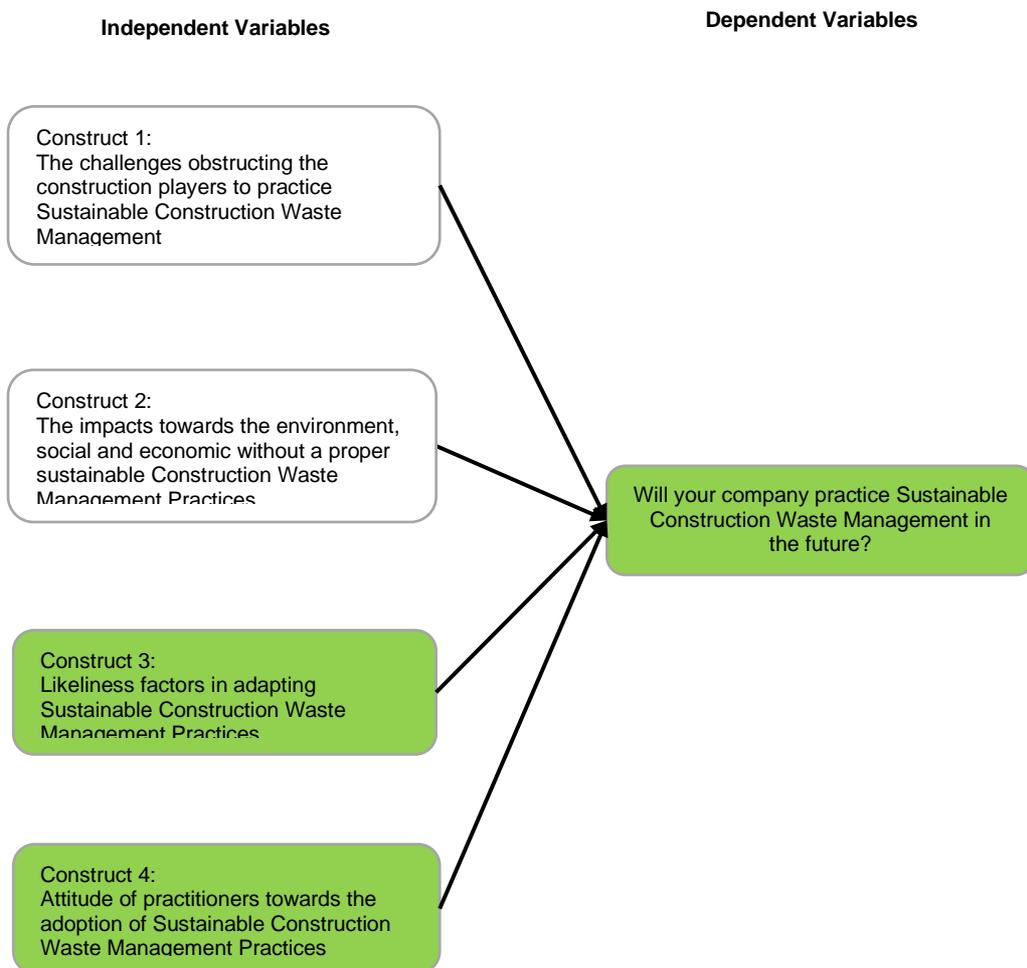


Figure 4. Research Framework

The research framework of this study is shown in Figure 4 above. This research is studying on 4 major independent factors namely “The challenges obstructing the construction players to practice sustainable construction waste management”, “The impacts towards the environmental, social and economic without a property sustainable construction waste management practices”, “The likeliness factors in adapting sustainable construction waste management practices” and “Attitude of practitioners towards the adoption of sustainable construction waste management practices”. Moreover, after the independent factors are being understood in the study, these factors are put into a group research framework which looking into the impact of these factors; named independent variables, towards the dependent variable which is asked in a nominal type of scale.

Questionnaire Survey Scales

The study deployed both nominal scale and interval scale in the survey questionnaire design. The nominal scale is used for to label the variables asked in the survey questionnaires, without any quantitative value. The nominal scale is only used to label the respondent’s profile such as gender and age of the respondents. Next, interval scale is used to scale and rate the responses using multiple levels of ratings. It is a method used to ascribe qualitative value into statistical data. Most of the questions from independent variables are designed by using interval scale. 5 points Likert scale with description were used for the questions. Besides, interval scale is used in the dependent variable, the scale of the dependent variable in the study are designed in a way that “yes” or “no” scales are asked in the question, with 5 range of “yes” and 5 range of “no” are set for the dependent variable to further understand the perception of the respondents.

Techniques for Data Analysis

A series of analysis methods which are descriptive statistics analysis and multiple regression analysis have been adopted to explore and study on the factors of sustainable waste management practices and the relationship between the independent variables and dependent variable of this study. The below techniques are used to analyse the data:

Descriptive Statistic – Mean and Standard Deviation

Mean analysis with ranking used in this research to identify which type of items from the four factors will highly affect the preferences of the respondents in sustainable construction waste management practices.

Multiple Linear Regression

Linear regression is commonly used for predictive analysis. The overall idea of regression is to examine two things:

- 1) Does a set of independent variables do a good job in predicting the dependent variables?
- 2) Which independent variables, are the significant predictors of the dependent variable, and in what way do they—indicated by the magnitude (P) and sign of the beta estimates (Coef) impact the dependent variable?

These regression estimates from Figure 5, are used to explain the relationship between one dependent variable and one or more independent variables. The simplest form of the regression equation with one dependent and one independent variable is defined by the formula $y = c + b \cdot x$, where y = estimated dependent variable score, c = constant, b = regression coefficient, and x = score on the independent variable.

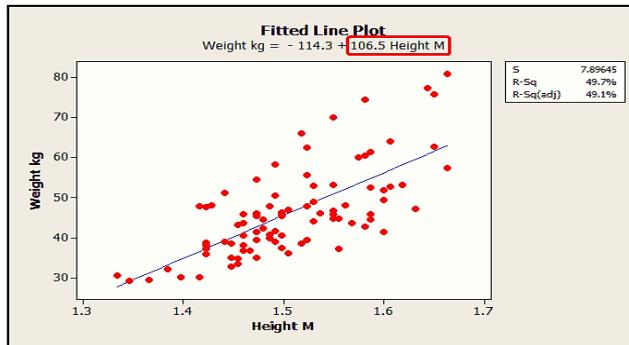


Figure 5. Fitted Line Plot (Frost, 2017; Statistics Solutions, 2017)

Next, the result of P-values or significant value is shown in Figure 6. A low p-value (P -value < 0.05) indicates that you can reject the null hypothesis. In other words, a predictor that has a low P-value is significant to your model because changes in the predictor's value (Y-b axis) are related to changes in the response variable (X-axis). If the P-values is high (> 0.05), it is insignificant and therefore null hypothesis. In Figure 6 below shows the significance of the predictor variables, we can see that the predictor variables of South and North are significant because both of their p-values are 0.000. However, the p-value for East (0.092) is greater than the common alpha level of 0.05, which indicates that it is not statistically significant (Frost, 2017).

Coefficients					
Term	Coef	SE Coef	T	P	
Constant	389.166	66.0937	5.8881	0.000	
East	2.125	1.2145	1.7495	0.092	
South	5.318	0.9629	5.5232	0.000	
North	-24.132	1.8685	-12.9153	0.000	

Figure 6. P-values (Frost, 2017)

Regression coefficients (b) represent the mean change in the dependent variable for one unit of change in the independent variable while holding other variables in the model constant. This statistical control that regression provides is important because it isolates the role of one variable from all of the others in the model. Figure 7 shows that the coefficient for height in meters is 106.5 kilograms. The coefficient indicates that for every additional meter in height you can expect weight to increase by an average of 106.5 kilograms.

Coefficients					
Term	Coef	SE Coef	T	P	
Constant	-114.326	17.4425	-6.55444	0.000	
Height M	106.505	11.5500	9.22117	0.000	

Figure 7. Regression Coefficients (Frost, 2017)

DATA ANALYSIS AND DISCUSSION

Demographic Characteristic of The Respondents

The analysis results for demographic characteristics of the respondents are given in the following Figure 8 and Figure 9.

As shown in the Figure 8, out of one hundred twenty-one (121) respondents, sixty-four (64) respondents (52.89%) obtained less than 3 years of experience. Thirty-five (35) respondents (28.93%) obtained 3 to 6 years of experience. Furthermore, two (2) respondents (1.65%) obtained 6 to 9 years of experience. Lastly, twenty (20) respondents (16.53%) obtained more than 9 years of experience.

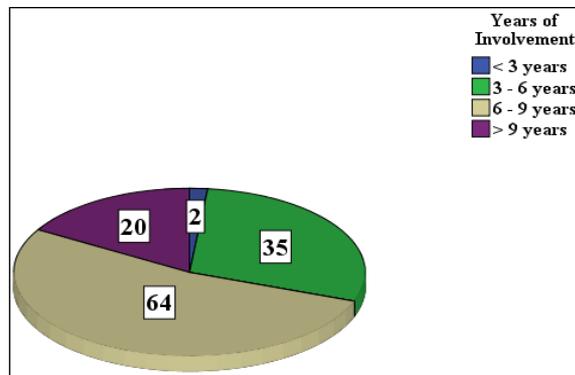


Figure 8. Frequency table for respondents' years of experience involvement in the industry

As shown in the Figure 9, out of one hundred twenty-one (121) respondents, fifty (50) respondents (41.32%) obtained G7 license which he has no financial limit during construction. Forty-three (43) respondents (35.54%) obtained G6 license which he is only allowed to construct building which is not more than RM 10 million. Furthermore, twenty-seven (27) respondents (22.31%) obtained G5 license which he is only allowed to construct building which is not more than RM 5 million. Lastly, only one (1) respondent (0.83%) obtained G3 license which he is only allowed to construct building which is not more than RM 1 million.

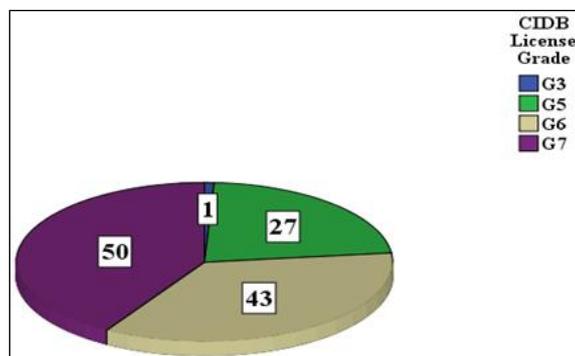


Figure 9. Frequency table for respondents Construction Industry Development Board License Grade

Descriptive Statistic on the Factors Influencing the Construction Waste Management Practices

There are four (4) factors which were carried out in this study. The descriptive analysis results are calculated in accordance with the scales which were chosen by the respondents. The scales are design in 5 points Likert scales with description on each scale.

Table 1 shows the opinion from the contractors on the challenges on practicing sustainable construction waste management in Malaysia. From the ranking result in Table 1, it shows that the most significant challenges faced by the contractors is insufficient technologies and facilities followed by lack of well recycling method and insufficient regulations to carry out the sustainable construction waste management practices. This finding supported (Mahayuddin et al., 2008) statement that the fast-increasing rate of construction waste generated has caused the current conventional land filling method is unable to cope with it which causing the need of developing a new technology to overcome the issue.

Table 1. The Challenges on Practicing Sustainable Construction Waste Management

	Mean	Ranking	Standard Deviation
Insufficient Technologies & Facilities	3.49	1	0.607
Lack of Well Recycling Method	3.47	2	0.549
Insufficient Funds	2.63	4	0.685
Insufficient Regulations	2.78	3	0.639
Lacking Awareness	2.63	4	0.818

Next, Table 2 shows the impacts from non-practicing the sustainable waste management. From the ranking result in Table 2, the top three (3) results from not practicing sustainable waste management are global warming and climate change, followed by air, water and land pollution, resources depletion. The result reflects that the respondents are cleared about the impact from non-practicing a proper sustainable waste management where the factors are supporting European Commission (2016) that global warming, climate change, air, water & land pollutions and resources depletion are the top impact from not practice sustainable waste management.

Table 2. Impacts from Non-Practicing Sustainable Waste Management

	Mean	Ranking	Standard Deviation
Global Warming and Climate Change	3.72	1	0.520
Resources Depletion	3.40	3	0.524
Harmful Pathogenic Waste	2.73	4	0.645
Air, Water and Land Pollution	3.59	2	0.558
Increase Landfill Development Cost	2.31	5	0.707
Increase Cost of Collection and Processing	2.31	5	0.563

Following from Table 3 shows that the factors likely obstructing the practice of sustainable construction waste management by the Malaysian contractors. The results show that technical design and production information ranked first from the finding. This is because the information is insufficient from the technical design and product on the methods to properly dispose the waste. Appraisal and design brief are ranked second where the contractors felt that there is lack of detailed requirement, no embedded requirement in contract documents and lack of early collaborative engagement in construction waste disposal methodology. Next, concept and design development are ranked third where the contractors

felt that lack of architects' engagement, limited resources of information and time constraints are the factors likely to obstruct the contractors to practice sustainable construction waste management practices.

Table 3. Factors Likely Obstructing the Practice of Sustainable Construction Waste Management

	Mean	Ranking	Standard Deviation
Appraisal & Design Brief	2.8793	2	0.27139
Concept & Design Development	2.8554	3	0.39889
Technical Design & Production Information	2.8926	1	0.37753
Tender Documentation & Action	2.6302	4	0.34626
Mobilization & Construction to Completion	2.6006	5	0.32948

Subsequently, Table 4 shows the contractors attitudes towards practicing sustainable construction waste management. Utilitarian is ranked first followed by knowledge, value-expressive and lastly ego-defensive. Utilitarian is the highest in rank in which this result supports Boundless (2017) statement that if a contractor is getting rewards by practicing sustainable construction waste management, it will create a positive attitude in the contractor that will greatly affect his/her behaviour to continue this action.

Table 4. Contractors Attitudes towards Practicing Sustainable Construction Waste Management

	Mean	Ranking	Standard Deviation
Utilitarian	3.39	1	0.597
Knowledge	3.28	2	0.609
Ego-Defensive	2.39	4	0.820
Value-Expressive	2.45	3	0.658

Multiple Linear Regression Analysis

A multiple linear regression analysis is conducted on the four (4) factors which were discussed in the previous heading. These four (4) factors are the independent variables that will be analysed together with the dependent variable. This multiple linear regression analysis is conducted to identify what are the variables that are significantly affect the contractor's decision to practice sustainable construction waste management in Malaysian context.

Table 5. The Regression Result Between the Challenges of Sustainable Construction Waster Management towards the Dependent Variable

Model		Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	2.099	.408	5.140	.000
	Insufficient Technologies & Facilities	.174	.085	2.049	.043
	Lack of Well Recycling Method	.303	.088	3.444	.001
	Insufficient Funds	-.133	.090	-1.474	.143
	Insufficient Regulations	.106	.097	1.099	.274
	Lacking Awareness	-.032	.068	-.475	.636

According to the Table 5, there are two challenges significant to the dependent variable with the value of 0.043 and 0.001 which are lesser than 0.05. They are Insufficient Technologies & Facilities and Lack of Well Recycling Method. These two challenges are variables which caused the contractors to have difficulties to practice sustainable construction waste management in the future. This is because Insufficient Technologies & Facilities and Lack of Well Recycling Method is difficult for the contractor to practice sustainable

construction waste management and they do not have a direction to practice it. The regression coefficient of B for Insufficient Technologies & Facilities is 0.174 and Lack of Well Recycling Method is 0.303. These show that Insufficient Technologies & Facilities and Lack of Well Recycling Method are significantly affecting the contractors to practice sustainable construction waste management by 17.4% and 30.3% respectively in the future. In short, lack of well recycling method is a stronger challenge compared to Insufficient Technologies & Facilities.

According to Table 6, there are two impacts if the Contractors will not practice Construction Waste Management in the future. They are Global Warming and Climate Change and Resources Depletion. Their significant values are 0.035 and 0.000. The regression coefficients of B are 0.283 and -0.349. In other words, Global Warming and Climate Change will be impacted by 28.3% and Resources Depletion will be impacted by 34.9% if the contractors are not willing to practice sustainable construction waste management in the future. The result shows that from both significant impacts, the resources depletion is a stronger impact (-34.9%) compared to Global Warming and Climate Change (28.3%) if the sustainable construction waste management is not being practiced in the construction industry.

Table 6. The Regression Result Between the Impacts of Sustainable Construction Waster Management towards the Dependent Variable

Model		Coefficients		t	Sig.
		B	Std. Error		
2	(Constant)	3.629	.527	6.891	.000
	Global Warming and Climate Change	.283	.132	2.136	.035
	Resources Depletion	-.349	.089	-3.909	.000
	Harmful Pathogenic Waste	-.001	.093	-.008	.994
	Air, Water and Land Pollution	.012	.106	.112	.911
	Increase Landfill Development Cost	.058	.081	.714	.477
	Increase Cost of Collection and Processing	-.030	.103	-.296	.768

According to Table 7, there are two variables that likely to obstruct the contractor's in practicing the sustainable construction waste management in the future, namely appraisal & design brief and technical design & production information, which have significant values of 0.001 and 0.016 respectively. The regression coefficient, B values are 0.572 and -0.295 respectively, which mean that the lack of detailed requirement, no embedded requirement in contract documents and lack of early collaborative engagement, from the appraisal and design brief variable, is significantly affecting the contractor decision to practice sustainable construction waste management by more than 50%. Followed by the insufficient information from the technical design and product which will affect the contractor's decision by 29.5%.

Table 7. The Regression Result Between the Factors Likely Obstructing the Practice of Sustainable Construction Waste Management

Model		Coefficients		t	Sig.
		B	Std. Error		
3	(Constant)	3.219	.683	4.712	.000
	Appraisal & Design Brief	.572	.176	3.258	.001
	Concept & Design Development	-.048	.111	-.430	.668
	Technical Design & Production Information	-.295	.121	-2.436	.016
	Tender Documentation & Action	.069	.134	.518	.606
	Mobilization & Construction to Completion	-.172	.138	-1.246	.215

According to Table 8, the Utilitarian is the only significant variable to the dependent variable with the value of 0.002. This attitude is the one which will determine whether the contractors will practice sustainable construction waste management in the future. Utilitarian means people will do it for interest which is money. The Contractor will practice sustainable construction waste management in the future if they have been given monetary rewards. The regression coefficient of B for Utilitarian is 0.271. In other words, Utilitarian; monetary rewards, will affect a contractor to practice sustainable construction waste management by 27.1%.

Table 8. The Regression Result Between the Workers' Attitudes in Construction Waste Management towards the Dependent Variable

Model		Coefficients		t	Sig.
		B	Std. Error		
4	(Constant)	2.417	.412	5.862	.000
	Utilitarian	.271	.084	3.234	.002
	Knowledge	-.010	.089	-.117	.907
	Ego-Defensive	.104	.062	1.684	.095
	Value-Expressive	.023	.076	.297	.767

CONCLUSION

The aim of this study is to understand the sustainable construction waste management problems in the Malaysian construction industry. Sustainable construction waste management is a practice that seeks to reduce construction waste in the Malaysia construction industry. This research study has identified the challenges, impacts, factors and the contractors' attitudes, meanwhile, addressing those variables that are significant to the adoption of sustainable construction waste management by the contractors. These findings will enable the contractors' companies and Malaysian authorities to pay more attention to the significant challenges, impacts, factors and attitudes and to make improvement in the future. The key finding of this study is to play a role and contribute in encouraging the implementation of sustainable construction waste management practices among the construction players. Although the sustainable construction waste management is not familiar in the Malaysia construction industry currently, the construction waste will keep increasing if there is not severely action to deal with it immediately. There is a need to caution the younger generation to be more proactive in managing construction waste.

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BARRIERS OF UTILISING SUSTAINABLE ALTERNATIVE MATERIAL FOR CEMENT PRODUCTION INDUSTRY IN MALAYSIA

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Abstract

The environmental and climate impact vary significantly due to large amount of carbon dioxide, CO₂ emitted from cement industry into the atmospheres. Lots of alternative materials were used in global cement industries to obtain positive environmental achievements as it avoids the release of CO₂, but much more has yet to be done in Malaysia. Hence, this study intends to identify the barriers of alternative material utilisation in cement production. Consequently, a case study with structured observation and semi-structured interview were conducted. The case study plays a central role in Malaysia's cement industries such as promoting development for sustainable construction techniques and technology. Based on the reflection of the case study legislative condition in Malaysia is considered as the most influential barrier in cement production. The results indicate the difficulty of practicing alternative material approach in cement production is by obeying all the regulatory permitting and legislative condition. Therefore, this barrier must take into account of other cement manufacturers for further development towards alternative material utilisation in cement production and hence maximising the alternative materials utilisation in cement sector.

Keywords: *Cement Industry; Alternative Materials; Environmental; Malaysia; Sustainable Construction.*

INTRODUCTION

Cement is a global marketed construction material because it satisfies global housing and modern infrastructure needs. However, the global cement industry is facing a critical environmental challenge in reducing carbon dioxide (CO₂) emission during the cement production (Schneider et al., 2011). According to Cement Industry Environment Report (2003), cement industry is under close inspection as cement production industry is the major source for CO₂ emission, creating up to 5% of worldwide man-made emission of CO₂ accounting for about 4% of global warming, of which 52% is from the chemical process, 36% from the burning fuel and remaining 12% from indirect emissions (Rodrigues and Joekes, 2011).

According to the International Energy Agency's (IEA) Greenhouse Gas (GHG) Research and Development Program (2013), an average world CO₂ emission of 0.81kg will be generated during the cement production. Almost 900kg CO₂ is emitted to the atmosphere in producing one ton of cement from calcinations of raw materials (calcium carbonate is thermally decomposed) and also through the combustion proses of fossil fuels in the kiln (Mushtaq, 2008).

CO₂ anthropogenic emission produced from main sources that associated with cement production is the chemical process of making clinker. Clinker production is an intensive process as it emits energy and carbon. During the de-carbonation process of calcium carbonate (CaCO₃) to produce the calcium silicates and aluminates under intense heat (around 1450°C), and release CO₂ from CaCO₃ to form calcium oxide (CaO) (Huntzinger and Eatmon, 2009).

The second source of CO₂ emission is linked to the combustion of fossil fuels in heating the kiln. The fuels are combusted to achieve the required temperatures for running the preheaters, thus the de-carbonation occurs in burning the clinker. This operation in cement production emitted 36% of CO₂ (Mahasenan et al., 2002). Low amounts of CO₂ emission are produced due to the quarrying of raw materials and the transportations, grinding, and packing processes, as well as indirect emission from electrical power for generating electricity during the cement production process (Hendricks et al., 2002).

As for the promising solution towards environmental threats and prospect of well management in terms of environmental aspect, alternative materials utilisation in cement production is expected to increase at a rapid rate in the future. Since composition and fineness of raw materials are the critical properties which directly influence the ability of burning in pyro-processing units and caused environmental issues during the cement manufacturing process, therefore, by altering the conventional raw materials with proper alternative materials, such as other industrial by-products (fly ash), biomass wastes, slag or sludge can considerably reduce the CO₂ emission (Benhelal et al., 2013).

LITERATURE REVIEW

Due to the huge amount of cement is needed in the construction industry; the understanding for environmental approach in mitigate sources of anthropogenic carbon emission in the cement manufacturing process is crucial. The life cycle assessment (LCA) had determined the fuels, raw materials and clinker substitutions have a higher contribution level for mitigating CO₂ emission from cement manufacturing process (Huntzinger and Eatmon, 2009).

A lot of alternative materials were being used in the global cement industries to obtain positive environmental achievements. There is large potential for the use of fly ash in cement production in terms of protecting the environment by reducing Green House Gas, GHG emission. For instance, a successful process, which considered as the most promising and practical approach to reduce CO₂ accumulation during the cement production in Company X is by replacing a portion of the raw material with fly ash. By utilising fly ash as a substitute, it can improve the level of materials combustion and decomposition of the limestone in cement production, while CO₂ emission can be reduced (Collins and Ciesielski, 1994).

Therefore, one of the prominent approaches toward CO₂ emission reduction in cement production is by substituting a portion of raw materials which resulted in high amount of CO₂ emission with a suitable amount of alternative materials. For the time being, utilising alternative materials is considered as the most promising approach to mitigate CO₂ emission in cement production. However, there are barriers and limitations for utilising alternative materials in the cement manufacturing process. The barriers and limitations are the issues that may restrict the widespread and continual of utilising alternative materials in cement production (GNR, 2009).

First, due to the global or regional availability for appropriate materials limitation, the availability of alternative materials is considered as the first barrier in utilising alternative materials in cement production. For example, granulated blast furnace slag and fly ash as alternative materials in cement production was about one billion tons per year in 2007 and 2008, this amount of alternative materials is not sufficient for high rate of cement industries' usages (Schneider et al., 2011).

Second, the properties of most alternative materials are significantly distinctive from the conventional materials properties in cement production due to different sizes, densities and characteristics of alternative materials. Therefore, the burning behaviour (burning grade) and reactivity of alternative materials which have considerable influences for the produced cement properties has to be considered. For instance, alternative fuels produce different quantity and composition of ashes compared to the conventional fossil fuel ashes (Phutke and Schneider, 2008). Moreover, alternative materials as the substitute for raw materials in cement production may affect the development strength of cement (Schneider et al., 2011). For example, phosphorous may has longer setting times during the cement production compare to others (Puntke and Schneider, 2008).

Third, technical challenges have to be monitor accurately during cement manufacturing process while utilising large amount of alternative materials (Hewlett, 2004). The adaptation of the combustion process and comprehensive cement production control are required during the cement production process. For example, the burning grade of the fuels and the burning conditions for the clinker are essential to optimise during the utilisations of alternative materials in cement production (Wirthwein and Emberger, 2010).

Fourth, the economic concerns in utilising alternative materials, such as the expenses that are needed for purchasing, treating, and transporting the alternative materials from the sources must be taken in account (Goh et al., 2017). Besides, the technical adjustments issue is compulsory in cement production for utilising alternative materials will also impose additional expenses. Thus, cost is an overarching issue in selection for alternative materials in cement production (Benhelal et al., 2013; Zahedi et al., 2008).

Fifth, local markets acceptance and permitting issues may be the highest degree of limitations for alternative materials utilisation in cement industries. In some countries and regional markets, there are still incompatibilities between the national standards and the properties of cement produced using alternative materials. Thus, this barrier hinders higher rate of cement production in utilising alternative materials (Benhelal et al., 2013).

According to the background research of this study, there is no doubt that the approach of using alternative materials in cement production reduces anthropogenic CO₂ emission. The development of alternative materials utilisation allows a more sustainable and environmentally friendly method in cement production. Nevertheless, the barriers of utilising alternative materials as mentioned above still have to be considered. Therefore, the barriers of alternative materials utilisation in cement production must investigate in this study.

BARRIERS OF UTILISING ALTERNATIVE MATERIALS IN CEMENT PRODUCTION

Although many researches had addressed the alternative materials in cement production are beneficial to the environment, these researches did not provide a clear description on the barriers of utilising alternative materials. Hence, there still considerable debate about the contribution of alternative materials in cement production, particularly in the view for the adoption of cost-effective, technically and environmentally beneficial cement production (Benhelal and Haslenda, 2011). The barriers of alternative materials utilisation are necessary to be identified and evaluated in this study, so the beneficial uses of alternative materials are possible to increase in cement production after the barriers of utilising alternative materials were determined.

In reality, some alternative materials sources of the same constituent with cements may be available, but that particular source may not be very widespread. For example, bauxite is only readily available in some locations but less widespread in other places. The same goes to magnesite, and also phosphate ores. Thus, alternative materials that are rich in aluminium (Al), magnesium (Mg) or phosphorus (P) seem less likely to be available in a global basis, although they might be useful for local or specialised applications (Gartner, 2003). Obtaining a sufficient long-term supply of material of consistent quality is an important issue concerning the usage of alternative materials in cement production. The reason for this is the cement plant may need to spend several million ringgits to purchase or upgrade the kiln or materials handling equipment in order to establish the use of alternative materials. Materials handling systems that are designed for a specific alternative material may not be easily converted in handling another different alternative material if supply of the original alternative material is interrupted, and even if so, the cement plant would incur costs in converting the materials handling system for the new alternative material (Ha et al., 2005).

The range of alternative materials that can be used as substitutes for raw cement materials is very wide, thus, the nature of the alternative materials is very important in implementing alternative materials during cement production. Alternative materials may create many problems to the properties of produced cements such as being low durability and affect the characteristic strength of cements, delay the reaction of cement in production or weaken the compressive strength of cements (Aranda et al., 2013). Thus, the composition of the alternative material must be considered before it was used as a substitute. It is not only the mineralogical and chemical composition of the alternative materials have to be considered, but also their particle sizes distribution, particle shapes, material densities and their characteristics, which will govern their potential for inclusion as a cement substitutes (Davies et al., 2003).

During utilising alternative materials, various aspects related to the cement production process have to be considered by preparing the detailed statistics and other data toward all relevant aspects of existing technical limitations (Loo, 2003). If there is complete or very high substitution of alternative fuel or materials, the modifications of manufacturing equipment or the intermediary processes are needed (Kookos et al., 2011). For instance, high replacement ratios of alternative materials resulted in high alterations to the burning process. This is due to alternative materials normally have higher material densities and transport characteristics, which means these characteristics had a large influence on the burning process, related to the

temperature profile of the kiln including the sintering temperature, the length of the burning zone, and the cooling conditions (Schneider et al., 2011). Besides, the aspect of air supply needed for combustion is another important parameter to take into account for technical challenges. If the air requirements are high, the kiln fans must run at a higher speed, consequently increasing the exhaust gas flow, which can influence the whole function of the pre-heating system. On the other hand, if there is a decrease in the air requirements, extra capacity on the fan side is acquired and this provides the opportunity to increase production levels. Subsequently, the technical limitations linked to the usage of alternative materials have to be considered for maintaining the quality of the product (Aranda et al., 2013).

Generally, economic factor of the cement industry will be affected by the cost of alternative material transportation to a processing site (Gartner, 2003). This applies as well in the investment costs on cement industry. The effect of materials transportation costs depends on part of the material that was being transported, and also the part for local landfill disposal costs. Meanwhile, the management cost for the use of alternative materials approaches is needed in order to modify during cement manufacturing process. Company-wide initiatives to invest in upgrades of kilns or materials handling equipment to initiate and accept use of alternative materials would have spent several million ringgits (ICF International, 2008). In some cases, there are companies that less inclined to invest in kiln or equipment upgrades and are more inclined to only test different alternative materials that can be handled using existing materials handling equipment and existing kiln configurations.

The successful use of alternative materials in cement production must depend on the current environmental legislation. All of the alternative materials are expected to fulfil certain legislative requirements to ensure the regulation of environmental protection (Goh et al., 2016). Cement plants that use alternative materials may need to obtain state permits, including solid waste facility permits, however depend upon the specific state regulations and the type of alternative material being used (Aranda et al., 2013). Moreover, cement plants in generally are required to obtain Construction Permit for establishing the use of any new alternative material, in part of modifications to the materials handling system involving expenses, or in part of testing the amount of alternative material that could be used within a limit on the duration of the tests (ICF International, 2008).

Besides, to establish the performance and durability of alternative cements to the required level of the appropriate new Standard and Construction Codes, a huge number of tests are involved and very expensive to undertake. The company needed to promote pilot projects in different company cement plants with conducting studies of different alternative materials (e.g., bio solids would be tested at one company plant, plastics would be tested at another company plant, and the test results would inform on-going corporate initiatives). It requires the full participation and co-operation from industry, government, scientific community and the members of the general public (Gartner, 2003). In short, the level of social acceptance of alternative materials utilisation in cement plants can strongly affect local uptake for alternative materials in cement production (Rovira et al., 2010).

In conclusion, utilising alternative materials in cement production can reduce CO₂ emission as it avoids the release of GHG. Benefits such as by replacing a portion of the conventional material with alternative material can makes a huge different to our environment. However, the literature review also highlighted the barriers of the utilisation of alternative

materials. It mentioned the risk of using alternative materials in cement production although the environmental impacts can be reduced significantly (Manap et al., 2016).

The alternative materials approach in cement industry is considered as a standard practice but much more has yet to be done in Malaysia. Therefore, the current study attempts to determine the barriers of alternative materials in cement production and find out the solution to the barriers associated with the alternative materials utilisation. Improvement for alternative materials approach during cement production can contribute a positive environmental impact and leads to future improvement for more eco-efficiency cement.

RESEARCH METHODOLOGY

In order to achieve the objectives and acquire more information, a case study with two qualitative methods for primary data were conducted in Company X. The first qualitative method conducted in this study was a structured observation in cement plant at the site of Company X. Cement plant site visit in Company X had assisted this study by providing direct access to the barriers of utilising alternative material in cement production. Almost all of the barriers faced in cement plant when utilising alternative material can be determined and identified throughout the whole process during site visit.

Meanwhile, the second qualitative method conducted in this study was three semi-structured interviews with selected interviewees from technical, production and operation department of Company X. The semi-structured interview not only emphasis in identifying the barriers of utilising alternative material in cement production, but also investigate the methods to continuously improve the practice of utilising alternative material in cement industry.

Company X is one of the leading building materials providers in Johor and the Southern Peninsular Malaysia. It one of the main players in Malaysia's cement industries that promotes and develop sustainable construction techniques and technology in cement production. To provide sustainable solutions, Company X demonstrates the innovation through utilising fly ash as alternative material in cement production to mitigate CO₂ emission. At the same time, the research sample is drawn from Company X which is three interviewees from technical, production and operation departments to ensure the generalization of this study.

RESULTS AND DISCUSSIONS

In this case study, company X does not consider long term supply of fly ash to cement plant as one of the barriers of alternative material utilisation in its cement production, since company X is contracted with third party more than seven years. The third-party supplier acts as an active medium in supplying fly ash to company X due to large availability of fly ash can be provided by the third-party supplier for continuous cement production in company X. The third party supplier can supply at least 30 to 40 tons of fly ash to company X every day as long as it is contributing the nation by its power sector in Port Dickson to cater the increasing of demand toward Malaysian electricity, and hence, the industrial waste of fly ash is continued produced. If long-term supply of alternative material is engaged to the third party, it may cause an ineffective in materials sourcing of alternative materials for cement plants.

Before the cement production company X had conducted several tests on fly ash itself and also on the produced cement to identify the fly ash's properties. It is necessary to know the mineralogical and chemical composition of the fly ash, but also its particle sizes distribution, density, sulphur and chloride contents as well as moisture content for controlling the consistence of cement quality. Figure 1 shows the lists of tests on fly ash and produced cement that were carried out in Company X based on the observation checklist.

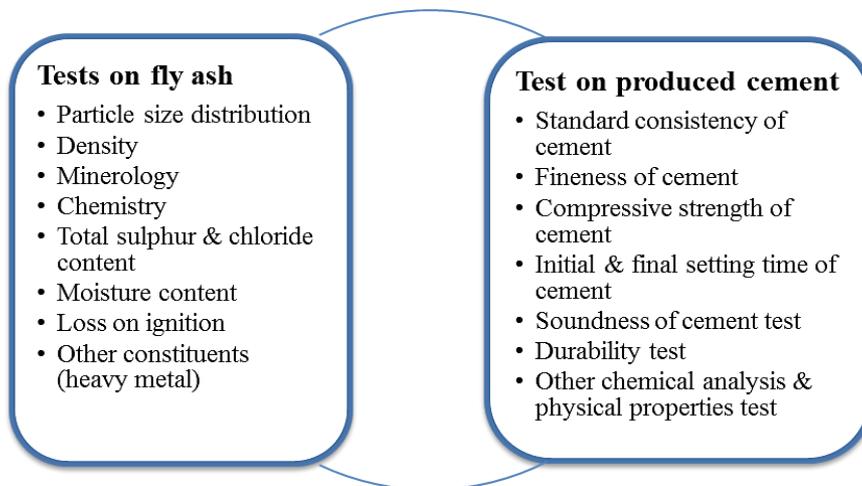


Figure 1. Lists of tests on fly ash and produced cement that involved in Company X

All kinds of varieties ranging from physical to mineralogical properties must be encountered when dealing with fly ash. This is due to the composition of fly ash will directly influence the produced cement quality if the characteristic of fly ash did not conform to EN 197-1 as shown in (European Committee for Standardization, 2000). In order to confirm the adequate of upper limit standard in EN 197-1 Company X developed some technologies for performance tests.

Company X develops quality assurance systems are to control the composition of all inputs, which included fly ash as well as all the manufacturing processing conditions while using microscopy or X-ray diffraction (XRD). The physical testing of produced cement on statistical process control (SPC) is conducted later on to ensure the manufacturing quality control on centring of quality targets toward the requirements of the customer or application, followed by reducing the variation.

All the tests are conducted by randomly choose the batch of fly ash when it delivered to cement plant site, same to the produced cement before packaging. Tested fly ash or cement were compared with the samples in laboratory to maintain the consistency of cement quality.

Material properties issue in utilising cement production regarding the parameters on fly ash and cement quality must be controlled constantly.

Company X installed cement production system that specified for fly ash, which is fly ash storage silo and feeding system. The fly ash storage silo and feeding system are being installed within the technology specification benchmark to achieve the desired manufacturing capacity.

Preparation of detailed statistic and data with respect to all relevant aspects of existing technical limitations are considered when there is higher substitution of fly ash in clinker composition. The workforce skills development is critical towards technical limitations in utilising alternative materials (ILO, 2014), thus, it might be a new barrier in terms of the technical aspect. The technical challenge for installing the system is all the civil engineers or advisory team must be familiar with the on-going advances in cement technology from the developments in standards, specifications and building practice in Malaysia.

The Preventative Maintenance Master Programme are practiced as well for cement production. The Preventative Maintenance Master Programme not only served as maintenance system for fly ash, but also acts as the preventative routine for other equipment and machines in cement plant. However, the maintenance has to be schedule carefully due to the cement plant operates non-stop every day. It must cater for testing the system during the cleaning of machine and equipment.

Moreover, the air supply technical for combustion must take into account in technical limitation which revealed on Kookes et al. (2011); Schneider et al. (2011) and Aranda et al. (2013), thus the related measures in terms of drive speed as well as compresses air and fan system are listed in the observation checklist as general measures. General measures for technical available in Company X:

- Preventative maintenance
- High & efficiency motors & drivers
- Variable speed drives (VSD)
- Compressed air & fan system optimisation

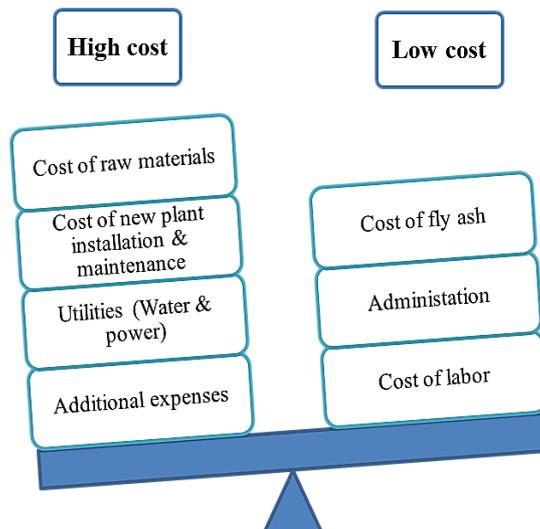


Figure 2. Economic concerns of Company X

As shown in Figure 2, the investment costs in cement industry towards alternative material utilization are high. Company X End Year Audit Report 2013 reported that the cost-benefit analyses for fly ash expenses are not favourable after the material acquisition costs, transportation costs, screening and grinding costs. However, Company X is prioritized in

long-term sustainable advancement, thus it cannot phase out the use of alternative material due to the cost-quality issues.

Based on the observation checklist, the total cost for raw materials consumed were high due to the expenses for major raw materials which contained the costs for limestone, clay, laterite, bauxite, gypsum and so on. On the other hand, cost for fly ash is much lower once compare to it and can helps to reduce the industry clinker's cost. Besides, cost issues that associated with the alternative material system is directly related to the upgrades of kiln and fly ash handling equipment where it increases the expenses by several million ringgits. In addition, electric power and water utilities cost are relatively high when compared to other management cost consumption. Besides that, the actual human resource management or administration cost is relatively small, and it does not consider in the cost issue for fly ash utilisation in cement production, based on the interviewees where the human resource management cost may only contribute 5%.

In addition, geographic location of fly ash supplier and Company X Cement Plant is not 'cost-effective' because of the transportation cost since the fly ash source is around 300km away from Company X Cement Plant. However, Company X does not consider additional expenses in terms of transport cost because the cost of fly ash obtained from the supplier is relatively cheap as compared to the transportation cost.

Another additional expense is the safety precaution, where safety precaution prepares a safer environment to enhance the productivity of cement. In this case study, the most emphasis part of the addition expenses is engaged with the service department expenses. Company X continues to invest towards Research and Development (R&D) approach. For example, Company X is setting up some laboratories for developing high value of fly ash cement associated with the world leading technology.

Therefore, the economic barrier in Company X is seen from the electric power and water utilities costs as well as the additional expenses from R&D Department and laboratory. Nevertheless, those high management costs are necessary to spend toward cement production.

The utilization of alternative material towards cement production is limited in Malaysia. The public of Malaysia is not strong in terms of the 'Go Green' concept as compared to European Countries. The level of social acceptance of alternative materials in cement production is not strong enough to affect the local uptake of fly ash to well-managed cement plants (Rovira et al., 2010).

Besides that, the Construction Permit to modify the feeding system is the main challenge in permitting condition. The EN Standard associated with environmental legislation hinders the high rate of alternative material. It also involves a lot of capital expenditure to get the permit for all the regulatory and legislation. The alternative system must fulfil all the legislative requirements to protect the environment. Besides, the environmental regulatory requires the companies to submit the alternative material testing report on fly ash before the feeding system installation begins. Legislative barrier is seen from Operating License and Permit, Regional/District Approval and Activity Designation Approval where those regulatory approvals and permits require annual payment.

The interviewees stated that the local permit condition is the most influential barrier compares to other barriers. All of these regulatory took a lot of money and time to fulfil it. Some specific testing and report for environmental protection must be prepared to ensure the continuous approval of permits.

From the reflections above, the legislative and regulatory permitting conditions restrict the increases of alternative material utilisation in cement production. This is the highest risk that was faced by cement manufacturers who practicing alternative material utilisation approach in their cement production. The summary of barriers in utilising alternative material in cement production was shown in the Table 1 below.

Table 1. Summary of barriers in utilising alternative material in cement production

Barriers to entry toward utilising alternative material	Highlighted results from the study
Availability of alternative material	<ul style="list-style-type: none"> It must continuous to engage with third party for the long-term supply of alternative material.
Properties of alternative material	<ul style="list-style-type: none"> All kinds of varieties ranging from physical to mineralogical properties must be encountered when dealing with alternative material. Additional technologies and performance tests are needed to control cement quality.
Technical Challenges	<ul style="list-style-type: none"> Reactivity and fineness of fly ash brought out difficulty for the alternative material feeding system installation. Preparation of detailed statistic and data with respect to all relevant aspects of existing technical limitations are needed when installing the alternative material system. Quality and skill level of maintenance work force group is good but need some improvement.
Economic Concerns	<ul style="list-style-type: none"> Mismatch between the location of power plant and cement plant, thereby increasing the cost of transportation. Upgrades of kiln and alternative material handling equipment spent several million ringgits. Electric power and water utilities are relatively high in cement production. Additional expenses from R&D and laboratory are necessity for alternative material utilisation.
Local Market Acceptance	<ul style="list-style-type: none"> Government departments are still reluctant to use fly ash-based cement. Public of Malaysia is not strong in up taking alternative material for well-managed cement plant.
Policy and Regulatory	<ul style="list-style-type: none"> No freight equalisation policy for fly ash transportation. Do not permit fly ash addition beyond from the requirements of EN 197-1. Construction Permit is required to modify the feeding system It involved a lot of capital expenditure to get the permit for all manufacturing processing with adopted alternative material. Inactive and inconsistent waste legislation within State and Federal jurisdiction results in regulatory uncertainty and disincentives to promote the alternative material utilisation.

Although it is seen that alternative material utilisation approach included several barriers, while this approach is useful to develop sustainable construction materials. Hence, there are some recommendations provided to enhance alternative material utilisation in cement production (refer to Table 2).

Table 2. Recommendation table

Recommended action plan	Further action
<p>Committed to the “Triple Bottom Line” Concept</p> <ul style="list-style-type: none"> ▪ It asserts the long-term and sustainable advancement which requires balanced achievement of economic development, environmental performance, and social responsibility associated with the criteria for Malaysian Standard. ▪ It encouraged cement manufacturer continue to invest towards alternative materials utilisation approach in cement production. 	<ul style="list-style-type: none"> ▪ Hold strong on standard and quality in cement production when utilising alternative material with every couple hours or days to conduct a test in order to fulfil the standard and quality towards cement production.
<p>Offering an array of services</p> <ul style="list-style-type: none"> ▪ It enhances the value of the partnership with clients, while the process improves vastly in terms of supplying and quality management capabilities, refining construction practices, and cultivating the establishment of new standards throughout the industry. 	<ul style="list-style-type: none"> ▪ Maximise the benefit of the company’s products (cement) by having consultation and advisory services based on the government and customers’ needs, objectives, and specific limitations or construction challenges.
<p>Enhancing operational efficiency</p> <ul style="list-style-type: none"> ▪ It is the key priorities of cement industry. 	<ul style="list-style-type: none"> ▪ Continue to invest in new technologies, systems and infrastructure while developing and cultivating talent.

CONCLUSIONS

In conclusion, the barriers of utilising alternative material in cement production were identified. In addition, according to the reflection of case study in Company X, legislative condition in Malaysia is considered as the most influential barrier in cement production. Company X brought out the difficulty of practicing alternative material approach in cement production which is obeyed all the regulatory permitting and legislative condition. Moreover, suggestions of Company X towards the method to utilising alternative material in cement production are provided. Cement manufacturers were recommended to continue invest in new technologies and systems to hold strong on maximising the benefits from the alternative materials utilisation to cement production sector. This recommendation from Company X hoped to give some insight to other cement manufacturers who interested in implementing alternative material approach for their cement production. Lastly, the limitation of the study also addressed in this chapter, hence the recommendations for improving the future study to suit the local and global changes can be done.

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SUSTAINABLE TRANSPORTATION: A PERCEPTION AMONG CONSTRUCTION PLAYER IN KLANG VALLEY

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Abstract

The quality of transportation service it's a main factor to increase the level of economic and social in Klang Valley. By increasing the system may buzz-up all sector and may contribute the benefit to the community. This research will be conducting in Klang Valley. The reason to choose this location it's because of the role that the location plays in contributing to the economic sector in Selangor state itself. Methodology to be used to conduct these researches its quantitative method. Where, 200 set of questionnaires to be distributing to get a perception on the concept of sustainable transportation among respondents. Questionnaire distributing to those who has knowledge towards sustainable transportation, and it's limited to those who have experience in construction sector only. The objectives of this research it's to investigate the construction player's perception towards sustainability transportation in Klang Valley; and to identify the barriers factor to implementing this concept. Expecting distribution from this research it's to create awareness by implementing this concept it's beneficial to the routine activities as well as can generate and increase awareness to the public.

Keywords: *Sustainable Transportation; Construction Player's; Perception; Constraint Factor; Progress; Potential.*

INTRODUCTION

Transportation assumes a key part in advancing the live ability of groups (Luis et al., 2015 and Miller et al., 2013) because of its cooperation with each of the three regions of maintainable advancement (Luis et al., 2015 and Souza and Kahn, 2013). Under this condition, partner inclusion is fundamental with a specific end goal to consolidate differing points of view and inclinations (Luis et al., 2015 and Rangarajan et al., 2013). Remembering this, the goals of this examination it's to explore the development player's discernment towards supportability transportation in Klang Valley; and to recognize the limitation component to actualizing this idea. The transportation segment incorporates the development of individuals and merchandise via autos, trucks, trains, boats, planes, and different vehicles (Luis et al., 2015). The high development rates of transportation movement has created negative consequences for nature and on populaces (Luis et al., 2015 and Eppel, 1999) who are encountering various activity issues, for example, extreme movement blockage and street mischances combined with air and clamour contamination groups (Luis et al., 2015 and Sarkar and Tagore, 2011).

Any idea that incorporates the descriptive word reasonable stems from the root idea of feasible improvement. Understanding it has been one of the significant difficulties for maintainability scientists and specialists from the time when supportable improvement was initially instituted as an advancement that addresses the issues of the present without trading off the capacity of future era to address their own issues (The World Commission on Environment and Advancement, 1987). This definition has unmistakable implications to individuals in various settings that imagine supportability and act towards it relying upon their insight, foundation, encounter, recognition, qualities, and setting (Leal, 2000). Despite the fact that this entanglement has been discussed widely (Ayres, 1993), the base specialized

prerequisites are frequently obscure (Prugh et al., 2000). In spite of errors about the significance, individuals concur that the idea includes, at any rate, natural, social, and monetary contemplations (Dragun and Jakobsson, 1997) what is known as the triple primary concern (Hacking and Guthie, 2008).

The idea of maintainable transportation includes a similar open deliberation about significance and vulnerability, as indicated by Dark (2010), there is still no political or logical concurrence on a supportable transportation definition. It can mean the least expensive indicate point transport accessible, or dependable and unsurprising trips, or the fastest intends to move perishable cargo, or excursions that utilization minimal measure of vitality or assets to satisfy the errand (Sweeting and Winfield, 2012). Toward the end, there is likewise a rising accord that transportation framework manageability ought to catch properties of framework viability and framework impacts on monetary improvement, natural honesty, and social personal satisfaction (Jeon et al., 2013). A definition fitting in the general meaning of supportable improvement is given by the Association for Financial Participation and Advancement (OECD) (2002), characterizing a feasible transportation framework as "one that does not jeopardize general wellbeing or environments and addresses versatility issues reliable with utilization of renewable assets at underneath their rates".

LITERATURE REVIEW

Transit service quality is one of the main drivers of sustainable transport policies as it increasingly steers user choices toward energy and space-efficient transport modes (e.g., European Commission 1995b, 2001, 2007). Public transport quality depends on several factors (attributes) of the service; some are quantitative (e.g., average travel time and its reliability, transit waiting time, monetary costs) while others are qualitative, whose effects on user behaviour are more difficult to assess (e.g., riding comfort, information, personal security). Assessment of service quality in Public Passenger Transport (PPT) requires methods for defining standard quality indicators and related measurement techniques. Such an assessment should be used both by service providers in presenting and monitoring their services and by local decision makers and procurement agencies in preparing tendering requirements and monitoring PPT services. In this way, customer expectations and perceptions of quality can be translated into measurable and manageable quality parameters.

There is an ongoing debate in the scientific community about what is the best quality definition and how it should be measured, while it is widely recognized that service quality is intrinsically related to the user (Berry et al., 1990; Gatta and Marcucci, 2007). There is also a continued debate as to whether quality indicators should be objective and or subjective. It seems appropriate to define both objective and subjective measures of transit quality as suggested by EU regulations, since they are relevant to achieving different purposes. The former are direct measures of indicators perceived as significant by the customers (Transportation Research Board 1999, 2003). As an example, traditional level-of-service indicators (e.g., in-vehicle time or percentage of passengers departing-arriving) can be considered as objective performance measures from the service provider's point of view. Some critiques made to objective indicators suggest that not all quality attributes are measurable (e.g., seat comfort or aesthetic quality). By contrast, subjective measures are based on direct (statements) and indirect (choices) customer perception of service quality. In the literature many techniques for measuring subjective indicators have been proposed.

Service quality and customer satisfaction can be evaluated according to different methods, for example, by asking users their perception and satisfaction or expectation also the importance on service quality. Alternatively, it is possible to estimate a utility function, given a set of assumptions on an underlying set of preferences, that is able to measure the attribute's reciprocal substitution such as the willingness to pay for an attribute (e.g., punctuality, station aesthetics, info mobility).

Research on the different areas of mobility management has been extensive: recently published studies have focused on travel plans (Rye 2002; Dickinson et al., 2003; Fujii and Taniguchi, 2006; Bonsall, 2009; Roby, 2010), transportation of employees (Potter et al., 2006; Vanoutrive et al., 2010), land use planning in MM (Rye et al., 2010), carpooling (Enoch and Taylor, 2006; Correia and Viegas, 2011), assessment of MM measures in facilities (Miralles-Guasch and Domene, 2010), travel behaviour change (Cairns et al., 2008; Brog et al., 2009; Stofer et al., 2009; Bamberg et al., 2010), the impact of information on the quality of travel choice (Chorus et al., 2006; Chorus et al., 2007), congestion charging (Eliasson, 2008) and so on. Furthermore, many European cities have been implementing sustainability transportation indicators in their country. The question comes when measuring into Sarawak state on the sustainability transportation implementation especially on the most targeting places like Klang Valley.

The quality of transportation service it's a main factor to increase the level of economic and social in Sarawak. By increasing the system may buzz-up all sector that may contribute the benefit to the community. Therefore, this research will be conducting in Klang Valley. The reason to choose these four locations it's because of the role that each location plays in contributing to the economic sector in Selangor state itself.

One of the reactions raised at subjective measures is that these markers are frequently constructing just in light of travel clients' assessments, overlooking non-clients' discernments. This is the situation for direct articulations and models evaluated just for travel benefit clients. By complexity, reviews could be completed on all mode's clients. This is not generally the situation for direct fulfilment review, while backhanded decision display-based measures regularly manage all modes explorers.

The fundamental investigate to the subjective pointers is their constrained part in outlining (arranging) administrations since they can't be dependably watched for non-existing administrations. Few reviews have examined both subjective (voyager fulfilment) and goal (transit execution) measures (Ennio Cascetta & Armando Carteni, 2014; European Committee for Standardization, 2002; Nathanail, 2008; Tyrinopoulos and Aifadopoulou, 2008; Eboli and Mazulla, 2010). Techniques to gauge benefit quality markers (both subjective and goal) can be ordered in two distinct classifications: non-behavioural and behavioural measures (for a refreshed survey see for instance: Eboli and Mazulla, 2008). The principal class incorporates pointers assessed through factual investigation methods, for example, quadrant and hole examination, scramble charts, and bunch examination (Ennio Cascetta & Armando Carteni, 2014; Cronin and Taylor, 1992; Swanson et al., 1997; Bollen, 1989; Teas, 1993; Hill, 2000; Hill et al., 2003; Grønholdt and Martensen, 2005).

The second classification of techniques comprises of behavioural models (Ennio Cascetta & Armando Carteni, 2014; Ben-Akiva and Lerman, 1985; Cascetta, 2009; Train, 2009). A

few cases are mode decision models considering diverse client-based administration quality traits (Ennio Cascetta & Armando Carteni, 2014; Hensher and Prioni, 2002; Cascetta and Papola, 2003; Gatta and Marcucci, 2007). In Hensher et al. (2003), a Nested-Logit model was proposed for contrasting administration quality levels inside and between transport administrators. A Mixed Logit model was likewise proposed by Hensher (2001) to investigate watched and surreptitiously heterogeneity among clients.

Parameters of behavioural models could be evaluated utilizing both reviews of real travel conduct in a genuine setting (uncovered inclination or RP studies) and studies of theoretical travel conduct in invented situations (Ennio Cascetta & Armando Carteni, 2014; Pearmain et al., 1991; Eboli and Mazzulla, 2008; 2010). The significant preferred standpoint of SP information over RP information is given by the likelihood of a broader properties space, considering speculative situations (e.g., new astounding administration lines) and characteristics (e.g., stylish nature of stations or data frameworks). By difference, the principle limitations of SP strategies concern the dependability of client reactions to speculative and, now and again, unreasonably complex situations (e.g., Bradley and Daly 1991). Along these lines, SP studies quality relies on upon how data is exhibited to respondents (Ennio Cascetta & Armando Carteni, 2014; Hensher, 2006).

METHODOLOGY

Methodology to be used to conduct this research its quantitative method. Where, 200 set of questionnaires to be distributing to target respondents in Klang Valley to get a perception on the concept of sustainable transportation among respondents. Questionnaire distributes to those who have a basic knowledge towards sustainable transportation, and it's limited to those who have experience in construction sector only. Which this it's to cater for two objectives for these researches; first it's; to investigate the user perception towards sustainability transportation in Klang Valley; and second it's to identify the constraint factor to implementing this concept in the stated four areas. Expecting distribution from this research it's to create awareness by implementing this concept it's beneficial to the routine activities as well as can generate and increase the Sarawak's economic sector.

ANALYSIS AND FINDINGS

Both primary and secondary source has been used as research methodology in order to achieve clear picture and understanding of the results. The primary source consists a set of questionnaire survey while the secondary source obtains from the desk stop study. Literature review resources obtain from the form of journal, research paper and articles; relevant references books, newspaper and electronic data – also known as desktop study. Almost of the time in order to conducting this research it's to do the desktop study in order to obtain the sources in order to support the literature review for this research.

However, this research having its limitation where the research area coverage only at Klang Valley. The rationale by choosing this area is because of the functioning of the area contributing to the movement of Selangor's economies. The data collections for the study it's through structured questionnaire which send to 350 respondents which are consists of those who having a good profession because the result from this group will affect the level of accuracy of the data collection.

The structured questionnaire scale on answer limited to five-point Likert scale; strongly agree, agree, neutral, disagree and strongly disagree it's a choice of answer expecting from the respondents. Also, the frequency analysis has been used too to analyses the data for structured questionnaire which focusing to get respondents simple answer either 'yes' or 'no'. Furthermore, the analysing of the data it's based on the frequency or by percentage analysis. The highest percentage indicates the higher indicator or momentum to the point of description tested to the respective respondents.

Figure 1. Respondent's perception on the momentum of sustainable transportation in Klang Valley

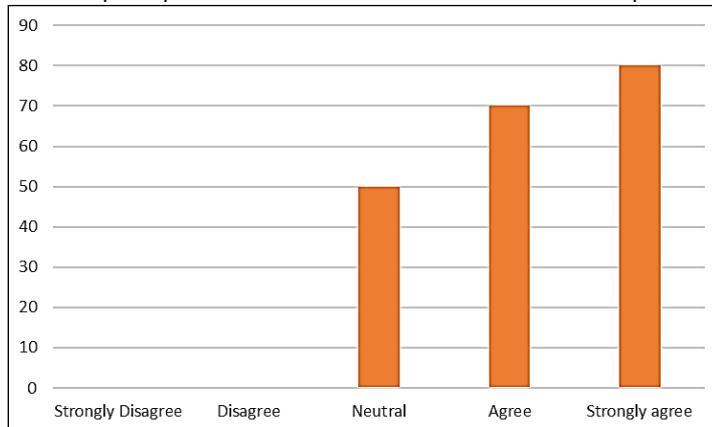


Figure 1 stating about the respondent's perception on the momentum of sustainable transportation. Where 50 numbers of respondents stick with the neutral and 70 numbers of respondents saying agree that Klang Valley actually having a momentum towards sustainable transportation implementation and only 80 numbers of respondents strongly agree on the stated statement.

Figure 2. Perceived barriers in perspective of time

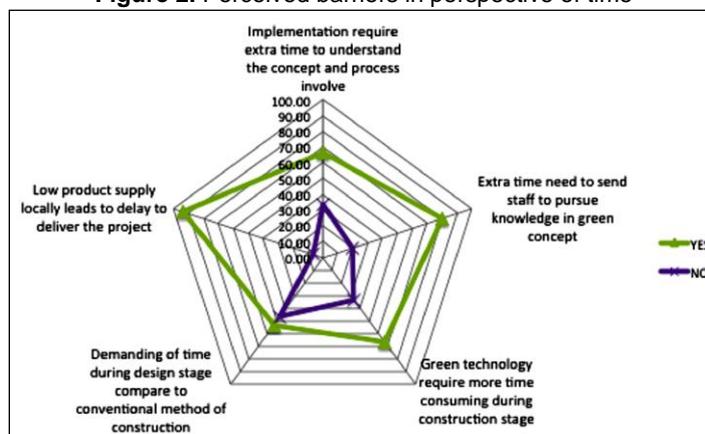


Figure 2 stating on the results of perceived barriers of time. There are five elements or description has been tested to the respective respondents. The description include low product supply locally leads to delay to deliver the Project, implementation require extra time to understand the concept and process involve, extra time need to send staff to pursue knowledge in green concept, green technology require more time consuming during construction stage

and demanding time during design stage compare to conventional method of construction. Out of five questions, the most score it's on the description of low product supply locally leads to delay the deliver the project with 93% said 'yes'. Follow by 80% said 'yes' on the extra time needed to send staff to get a knowledge on green concept itself. 67% of respondents agree on implementation require extra time to understand the concept and process involve as well as the respondents also agree with the same percentage on green technology require more time-consuming during construction stage. Furthermore, 53% said that demanding of time during design stage compare to conventional method of construction.

By referring to the Figure 3 stating the perceive barriers in perspective of cost. There are five question has been tested to the respondents and the question as follow: expensive cost on services and product's relating to green, low demand in green design from local buyer, no exempted on the taxes, no incentives provided by relevant organization and implementation require extra time and cost. Out of five questions has been tested among respondents, most of them agree with 87% said that low demand in green design from local buyer it perceives barriers in perspective of cost to implementing the green building concept in their project. Others four description having almost the same percentage 60% to 67%. With 67% agree that expensive cost on services and product's relating to green and implementation require extra time and cost. With 60% agree that no exempted on the taxes and no incentives provided by relevant organization.

Figure 3. Perceive barrier in perspective of cost

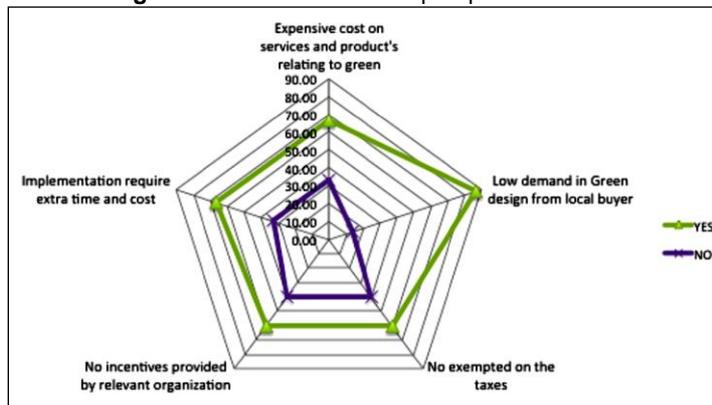


Figure 4. Perceive barrier in perspective of knowledge

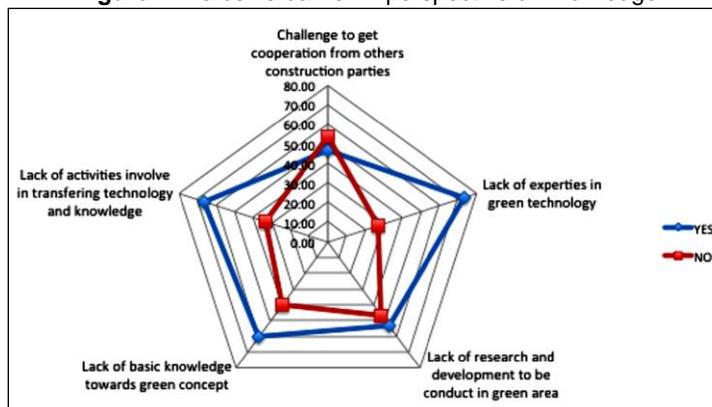


Figure 4 stating about perceive barriers in perspective of knowledge. There are five questions under these factors leads to the barriers in implementing green concept among Klang Valley's construction's players. The questions has been tested to the respondents as follow: challenge to get cooperation from others construction parties, lack of expertise in green technology, lack of research and development to be conduct in green area, lack of basic knowledge towards green concept, and lack of activities involve in transferring technology and knowledge. The highest percentage goes to lack of expertise in green technology with 74% follow by 67% for lack of activities involve in transferring technology and knowledge. 60% said that lack of basic knowledge towards green concept, 53% said lack of research and development to be conduct in green area. Unfortunately, 53% said 'no' to the statement of challenge to get cooperation from others construction parties.

CONCLUSION

Several recommendations that can be speed up to overcome the stated issues; providing knowledge and training like organizing seminar, talk or workshop and conferences to educating the and offering to the targeted construction's players on sustainable transportation principles on the concept and the benefits can be generated from implementing this concept in their project and at the same time may increase the potential in implementing the concept in Selangor state itself. Actions must be initiated to enable this concept to be applied efficiently in future construction projects. Provide as assistant to government, contractors and consultants in incorporating the sustainable issues at the project conceptual stage and planning stage. Even sustainable concept in transportation field it's a slightly higher investment at initial stages, but then, it is still a good investment to be consider for long-term and by implementing this concept it brings different character and interpretation from normal practices.

Furthermore, government's representative actions are influenced by the market situation and budget approve from the federal government as in Malaysia all the transportation matters are fully control by government. To increase the momentum in order to implementing the sustainable concept, a little bit of pushing factors must be acting upon to the government representative and also contractors to improve the specification of the current practices, method and technology may use for future project as what sustainable concept may offer to that future project. The modern and modest design and technology must be play in the design of the transportation so that can fulfil the need and to enhance to potential of sustainable transportation itself.

In summary, more efforts are necessary to enhance the level of environmental awareness and civic consciousness among the Klang Valley's people to build sustainably and greener project in the future. These are the point that should put into an account to make them ready to be implementing this concept. It's should start from the most important people in that particular state so that this concept can be successfully implementing in their area.

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ASSESSING THE ADOPTION OF GREEN TECHNOLOGY AMONG THE CONTRACTOR IN CENTRAL REGION OF SARAWAK (MUKAH, SIBU AND BINTULU)

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Abstract

A higher demand for new developments in Sarawak has led to the increase in construction activities, which result in a significant impact towards the environment. This situation has made it a major contributor to the increasing occurrence of environment issues. Hence, sustainable development is required to be implemented to overcome this issue. The term of sustainable development means the ability to enhance and protect our natural environment without damage and destruction. Since the application of green technology towards development in Sarawak is still low, thus, it is important for the Sarawak government to address this issue. The aim of this research was to assess the adoption of green technology among the contractor in Central Region of Sarawak. In order to achieve the stated aim, the objectives outlined in this research had been cascaded to identify the current level of awareness on adoption of green technology and to investigate the level of readiness construction players to adopt green technology in development of Sarawak. Quantitative research design by way of questionnaire was adopted. There is a gap in terms of what has been planned and actions in particular application of green technology we have. Hence, it can be anticipated that this research will generate interests from green technology researchers as it will provide fundamental elements towards development in Sarawak. The obtained results indicated that most of Sarawak's construction players were knowledgeable pertaining to green technology. Unfortunately, only few of them applied it into practices because of ignorance to adopt, financing issue and lack of expertise.

Keywords: *Green Technology; Sustainable Development; Construction, Sarawak Development*

INTRODUCTION

The construction industry is important for economic growth because it increases the standard of living and allows opportunities in providing jobs. Unfortunately, the increase of developments in Malaysia has caused damage to the environment and has affected the ecosystem. This damage, eventually, has become a major problem in these recent years (Nagapan et al., 2013). Implementation of green technology in construction project is one of the key of sustainable development approaches to avoid negative impacts to the environment (Yuan, 2013). Nevertheless, according to Sa'adi & Zainordin (2017), ignorance among construction players especially in Sarawak upon application of green technology has led to unsuccessful sustainable development. As we know, Sarawak is one of the largest states in Malaysia which will contribute more development in the future. Hence, it is vital to effectively adopt green technology in construction project to minimise negative impacts towards environment and also to implement advance technology we have in the most effective manner (Gentil et al., 2011).

REVIEW ON GREEN TECHNOLOGY

Nowadays, application of green technology is not a new technology for a global since the application of it were widely implemented internationally by the developed countries. Green

technology is one of the key practical solutions to protect the environment used in development of project (Osman et al., 2012). Nguyen et al. (2017) also claimed that green technology is one of environmental application in order to minimize the impacts towards the environment and used to conserve and preserve the natural resources. Green technology can be categorized as a product, equipment or any system which are function as protection towards the natural environment and resources (Zailani et al., 2015). Since the global warming and greenhouse effect were becomes a serious problem nowadays, some of the people become aware of their detrimental effects toward the environment (Sansaniwal et al., 2017). Green technology was intended to reduce the effects of human activity on the environment (Birchi, 2015).

In addition, green technology also used to conserve the natural resources by using the renewable energy such as solar energy, water energy, wind power and bioenergy. Renewable energy means energy that collected from resources that are renewable which naturally replaced the natural resources (Mekhilef et al., 2014). On the other hand, green technology can facilitate the use of renewable resources to let the people keep using the resources (Gentil et al., 2011).

The intensive use of green technology aims to slow down global warming. Thus, the greenhouse effect will be significantly reduced. The implementation of new technologies that preserve the natural resources will be beneficial for the general health of our planet and for the well-being of people (Dasy, 2016). As one of the recent advancements in 'Green' technology, green roofs are considered to be a well-known technology which can result in the enhancement of the environment associated with wide range of palpable and impalpable advantages to the environment, economy and society. In literal, green roof is one of the 'Green' technologies which implements the idea of adding green space to regions of a human-made structure. In other words, it is simply inserting a vegetative layer on top of building with the purpose of utilizing the unused area in the mean of enhancing the environment (Rezai et al., 2013). In brief examples, the major contributions of green roofs are cutting down energy usage, air pollution and greenhouse gas emissions. Besides, it improves the management of storm water as well as water quality, regulates temperature for the roof and regions nearby in reducing greenhouse effect and creates aesthetic value towards the current environment. Green technology continues to expand in use as material innovations allow for more low costs applications (Sim et al., 2015).

GREEN TECHNOLOGY GUIDELINES AND INCENTIVES IN MALAYSIA

In recent years, many countries has try to implement green technology to further proceed for sustainable development (Sim et al., 2015). As in other parts of the world, Malaysia also become one of the country that concerns with the environment for future generations by introduced green technology (Rezai et al., 2013). Introduction of green technology in Malaysia shows the government response towards the environmental issues nowadays (Hossein et al., 2014). Study conducted by (Aini et al., 2017) indicated that traditional construction methods has led to serious environmental problems which contribute to global warming. A higher demand for new developments in Malaysia has led to the increase in construction activities, which result in a significant impact on the environment. Malaysia has generated 25,600 tons of waste from various sources, including construction activities, on a daily basis (Md Zain et al., 2012). Nonetheless, the National Solid Waste Management agency

has recognised that the landfills could not be the ultimate option any longer. Malaysia had started the initiative of being sustainable to solve this problem by introducing several strategies in promoting green technology. In response to that, the Construction Industry Development Board (CIDB) had further reinforced the commitment of the industry to sustainable development by introducing the CIMP 2006-2015. The CIMP was introduced to improve the performance of the construction industry by providing a series of seminars, workshops, training courses, and awareness upraising events. By virtue of Strategic Thrust No. 3, it was aimed to improve the quality of work, safety and health, as well as environmental practices. However, this guideline was not enforced by the government. Consequently, the Malaysian contractors seemed to apply their own policies and guidelines pertaining to construction waste management, which clearly do not reflect the existing initiatives implemented by the Malaysian government (Mallak, Ishak, Mohamed, & Abdullah, 2014).

In fact, various initiatives have been implemented by the government to resolve the issues concerning implementation sustainable development in Malaysia. In September 2015, the CIDB had launched the Construction Industry Transformation Programme 2016-2020 (CITP) as the continuation of CIMP 2006-2015 to ensure continuity and consistency with the national agenda in achieving the Eleventh Malaysian Plan thrusts. In fact, four strategic thrusts have been introduced in the CITP to lead the transformation of the construction industry; which are a) Quality, b) Safety and Professionalism, c) Environmental Sustainability, as well as d) Productivity and Internationalisation. In recent years, much of the built environment has remained susceptible to poor environmental sustainability levels. Thus, the strategic thrust No 2 in CITP was developed to achieve sustainable infrastructure. Other than that, five strategic initiatives have been carefully designed to tackle the issues holistically, which are a) drive innovation in sustainable construction; b) drive compliance to environmental sustainability ratings and requirements; c) focus on public projects to lead the charge on sustainable practices; d) facilitate industry adoption of sustainable practices; and e) reduce irresponsible waste during construction (Sa & Ismail, 2015). However, the results have not been translated into the form of legal instruments and enforcement. As we know, green technology is one of the advance technologies that can help to reduce the production of waste. Hence, adoption of green technology is indeed a key to address this issue.

RESEARCH METHODOLOGY

This research was adopted quantitative research design. The methodology was conducted in two stages as follows:

i. Stage One: Theoretical Framework

A body of knowledge on the implementation of green technology in development will be explored. Theoretical framework on the application of green technology will be investigated and identified. Comparative studies will be made between implementation of green technology in developed countries and Malaysia and identification of gaps in literature.

ii. Stage Two: Quantitative Research Design – Questionnaire and Case Study

This second stage will be addressing objectives of the research. The quantitative data and findings will be contextualised and triangulated with literature review to address the research questions. This quantitative research design will be divided into two stages:

A. Questionnaire

Samples will be selected based on construction practitioners involved in development of Sarawak. Sampling frame of the target group will be identified before the actual data collections take place. Due to the nature of quantitative research, the data will be collected until saturation point is achieved.

B. Case Study

Observation parameter will be established to observe the current status of application green technology in Sarawak development. The research will be focussed on selected project in Central Region of Sarawak such as Mukah, Bintulu and Sibul.

RESULTS AND DISCUSSION

In order to obtain further understanding on the adoption of green technology among the contractor in Central Region of Sarawak, quantitative approach was conducted. A set of questionnaire survey was distributed to 300 respondents in Mukah, Bintulu and Sibul using emails. The selection of the respondents was made from the list of registered contractors that was retrieved from the official website of CIDB. However, only 200 respondents participate in the survey. Next, the second stage of data collection was involved the case study on selected project in Mukah, Bintulu and Sibul. However, due to difficulty in arranging for appointments with the company due to various commitments of work, there are only three projects selected for each district for a comparison known as project A, project B and project C. The data and responses gathered from the questionnaire survey and case study were pointed out a significant output that is valuable and relevant to this research. Results and discussion were discussed as depicted in figures below by percentage analysis.

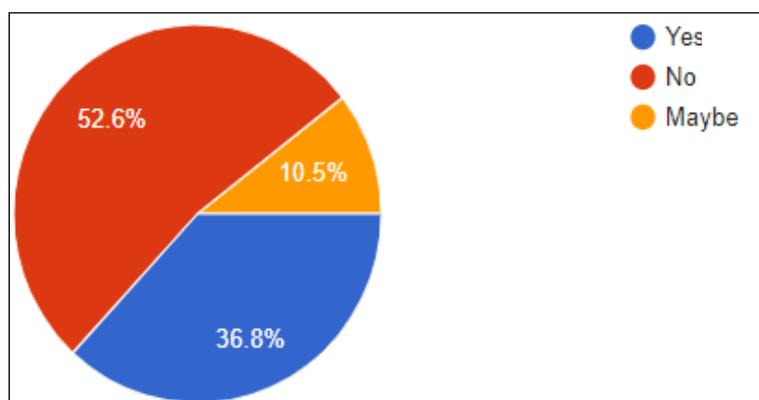


Figure 1. Experienced in adopt green technology in construction project

Figure 1 showed the percentage results of the respondent's experience in adoption of green technology in their construction project. 52.6% of respondents said 'Yes', 36.8% of respondents said 'No' and 10.5% respondents said 'Maybe' on this statement. It's clear shown that mostly construction practitioner in Central Region of Sarawak still do not adopt green technology in their project. Some of them stated that they have experienced in using green technology such as programmable thermostats, solar photovoltaic, station solar hybrid, green building and hydroelectric.

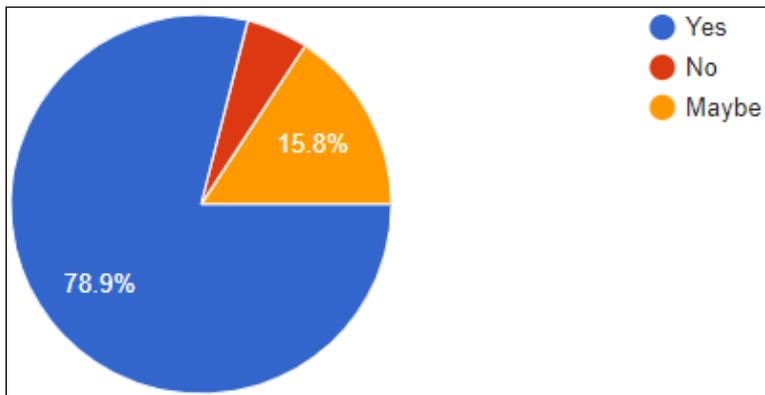


Figure 2. Level of readiness to adopt green technology in construction project in the future

Figure 2 discussing on the level of readiness respondents to adopt green technology in construction project in the future. Most of the respondents are ready to adopt green technology in their project while only 5.3% respondents do not really interest on green technology adoption in development project.

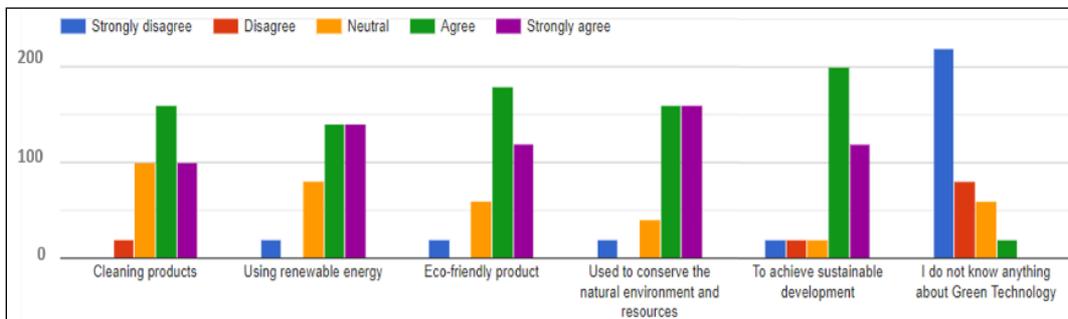


Figure 3. Knowledge on green technology

Part of knowledge, most of the respondents admit that they aware on the green technology practices in industry especially the benefits of using green technology. Unfortunately, the level of practices and application were still low.

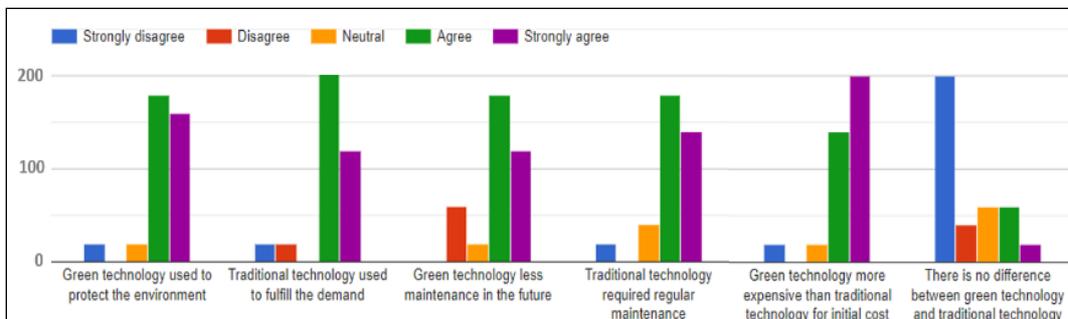


Figure 4. Comparison between green technology and traditional technology

By referring to the Figure 4, it is showed the respondents also knows the different between traditional technology and green technology. Most of them agreed that green technology is more benefits rather than traditional technology.

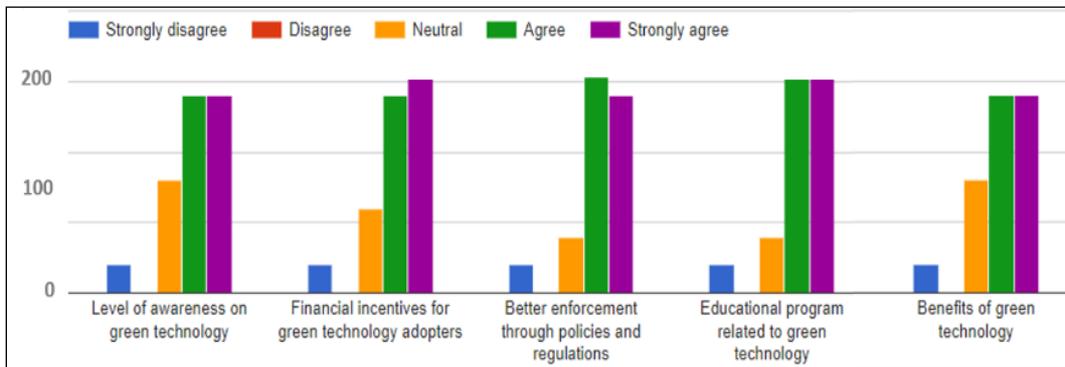


Figure 5. Factors to attract the construction stakeholders implemented green technology in their project

Figure 5 showed the factors attract the respondents to adopt green technology in development of Sarawak. Most of them agreed on the level of awareness, financial incentives, better enforcement, educational program and benefits of green technology are the factors that can attract the construction practitioner to adopt green technology in their project.

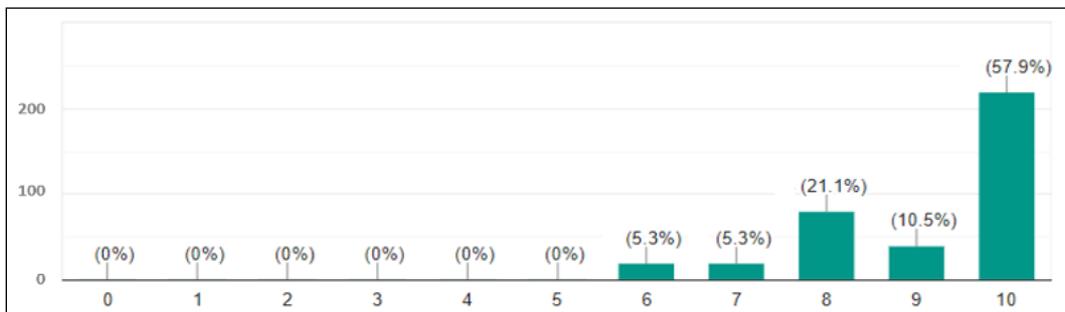


Figure 6. Recommendation to use green technology in development of Sarawak

As shown in Figure 6, all of the respondents recommended to use green technology in development of Sarawak. There is respondent commented that the fresh graduates require to propose on application of green technology for future benefits. Other than that, by referring to others country on application of green technology also benefitted since we still lack implementation.

In addition, by referring to the second stage of data collection, case study conducted on project A, project B and project C showed that all of these three projects did not used any green technology in their projects. In fact, all of them have no experienced in using green technology in any development project. Some issues that were highlighted pertaining to the application of green technology were lack of exposure in terms of use, lack of finance and lack of expertise to implement it. Some common problems faced by the construction practitioner are due to lack of awareness to adopt any recent green technology as well as insufficient knowledge and expertise. Thus, based on this issues that were raised, it is vital to find a solution to disclose the application of green technology in development project in Sarawak for a better development in the future.

CONCLUSION

Green technology is a key solution to achieve sustainable development and protect our natural resources. The adoption of green technology also will offer protections towards our environment. The findings are expected to be the cornerstone for application of green technology in development of Sarawak. There is a gap in terms of what has been planned and actions in particular application of green technology we have. Hence, it can be anticipated that this research can generate interests from green technology researchers as it will provide fundamental elements towards development in Sarawak. Creating awareness on adoption of green technology is very important in term of knowledge and application. Although the government has made variety of efforts toward promotion of green technology, the application is still at the low level. It is essential to find ways to attract construction stakeholder to implement green technology into their project. Hence, it is vital to investigate the level of readiness to adopt green technology in construction industry especially in Sarawak development and to find a way to attract the construction practitioner to implementing green technology in their development project. To conclude, this research intendedly to provide background information on implementation of green technology in development of Sarawak. It is expected to provide preliminary findings for potential solution to attract construction practitioner using green technology in spite of traditional ways.

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ANALYSIS ON THE ISSUES OF CONSTRUCTION DISPUTES AND THE IDEAL DISPUTE RESOLUTION METHOD

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Abstract

Construction is a complex and high-risk industry as it involves multiple parties in its implementation. Due to this, the construction process is seldom smooth, and disputes are unavoidable. Disputes are common occurrences that arise due to disagreements between parties in a contract both in the public or private sector projects. In order to mitigate the risk of disputes and minimize the possibilities of it arising, all parties in a contract need to take precautionary steps by identifying the common factors or issues that can trigger construction disputes. Disputes often lead to negative impacts such as time-consuming, harmful to a contractor's reputation or worse, it can damage the good relationship between client and contractor. Once a construction dispute arises, the parties involved will have to consider the avenues available and to choose the best option to resolve the issue effectively and efficiently. Therefore, the main purpose of this study is to establish which dispute resolution method most preferred by the industry players in terms of time, cost and satisfaction. This study is carried out through quantitative surveys among the key players in the industry. The findings from this research will hopefully give an insight to parties in a contract to be wary of the common issues that contribute to disputes arising and thereafter to be able to decide which dispute resolution method that is most beneficial and most commonly resorted to in dispute resolution in the industry.

Keywords: *Construction Industry; Dispute; Issues; Impacts; Dispute Resolution Method.*

INTRODUCTION

Construction in Malaysia spans a wide activity stretching from renovation works for private homes to high rise construction projects. Every building activity may create its own unique set of requirements and circumstance. Rajoo (1999) explained that different sectors including employer groups, contractors, suppliers, manufacturers, professionals have their own interests which often divergent and competing in nature. Harmon (2003) in his study mentioned that all parties involved in a construction project strive for the same aim, which is to successfully deliver the project within the original time span and within cost. However, construction process seldom progresses smoothly as what is desired. Since there are many parties involved in a construction process from the client or developer to the end consumer, the risk of disputes and disagreements occurring is also very high.

This is also supported by Cakmak and Cakmak (2014) who stated that due to the complex environment in construction industry, which consists of participants with different views and knowledge, it is unavoidable for conflicts to occur. Cakmak and Cakmak (2014) further said that if the conflicts are not properly managed, it can quickly turn into disputes. Diekmann and Nelson (1985) stated that the construction industry constantly fails to figure out the actual costs incurred in relation to dispute occurrences. Therefore, it is important for the parties involved in a construction project to be aware of the issues that can contribute to construction disputes and the significant impacts that can arise from it.

ISSUES

Ashworth and Hogg (2007) mentioned that construction is a risky business. Ashworth and Hogg (2007) further explained that even though the construction projects are identical, but the variables contained at the sites are different and may produce various kinds of circumstances. This may lead to construction disputes. Arising from such disputes, Yiu and Cheung (2017) explained that concurrent related effects also arise such as suspension of construction works, increase of construction costs and affecting the relationship between the parties involved in a construction project.

Disputes should be avoided and eliminated at all cost (Cox & Thompson, 1998). Cox and Thompson also mentioned that disputes should be handled in the most efficient manner as disputes only bring losses to the parties involved. Wrinkler and Chiumento (2009) added the best methods in resolving dispute is through early prevention and a suitable resolution method that are “saving-friendly” to the conflicted parties.

RESEARCH AIM AND OBJECTIVES

The aim of this study is to establish the dispute resolution method preferred by industry players in terms of time, cost and satisfactorily resolve the construction disputes that arise. Specifically, this research aims to accomplish the following objectives:

- To identify the common issues of construction disputes arising in the construction industry.
- To investigate the impacts of construction disputes to the construction industry.
- To identify the commonly used resolution method by industry players in resolving the construction disputes.

FACTORS OR ISSUES CONTRIBUTING TO CONSTRUCTION DISPUTES

Variations

Tony (2013) stated, “variations are almost inseparable in a construction project as the architect or employer’s representative need to issue further drawings, details and instruction for some other reason regardless of how well the project has been planned”. Mohamed (2001) also mentioned that the variation orders cannot be avoided completely in a project. This is supported by Ssegawa et al. (2002), where they pointed out that the provision of a variation clause in the contract form is admitting that no project can be completed without changes. Several authors have also highlighted the negative impacts of variations in a construction project. Ibbs et al. (1998) stated that variations can bring about subsequent impacts to the contract duration, direct and indirect cost or both. A research done by O’Brien (1998) also revealed that variation order works have negative impact on labour productivity and increase in project cost.

Payment Issues

The issue of payment has always been the main subject of disputes (Kennedy, 2005). A study by Abdul-Rahman et al. (2011) found that the top three issues of late payment were

caused by withholding of payment by client, client's poor financial and business management and contractor's invalid claim. This shows that payment issues are not only caused by client but can also be attributable to the contractor. According to the Construction Industry Working Group on Payment (2007), late payments will cause severe cash flow problems and affect the entire delivery chain in a project. This is supported by the report of Davis Langdon & Seah Consultancy (2003), where it highlights that the payment problem has domino effects on the entire chain of a construction project. Therefore, Ameer Ali (2005) urges 'everyone in the construction industry to pay all appropriate amounts due in a timely manner'.

Time Overrun

Time is one of the criteria in determining the accomplishment of a project. Al-Momani (2000) mentioned that time overrun occurs when the actual completion date exceeds the stipulated date in a contract. Al-Momani (2000) further asserted that one of the biggest contributing factors in the failure of construction projects have been identified as time overrun. Ramanathan et al. (2012) also agreed that late project deliveries have caused poor time performance in the construction industry.

Cost Overrun

Apart from time and quality, cost is also a major concern to the client or employer in a construction project. Becker et al. (2014) emphasized that cost is one of the important criteria in measuring the success of a project. Cleveland (1995) revealed that the inaccuracy of cost estimation at the earlier stages will encourage the occurrence of disputes in the later stage.

Poor Workmanship

Issues of poor workmanship or quality of finished products that is below par, is a common dispute that occurs between client, contractor, end consumers and other parties involved in a construction project. In addition, a study done by Ali and Wen (2011) showed that poor workmanship issues frequently arise due to contractors' fault. Furthermore, the significant factors contributing to low quality are caused by the lack of experience and low competency of construction labours, budget constraint (low contract rates) and poor project management (Ali & Wen, 2011).

Design Errors

In the opinion of Herren and Cooper (2000), design work is not easy, and it requires a great deal of experience to be done well hence it is better not to change the design after construction has started. However, if errors in design become obvious during construction, design modifications must be made. According to Bramble (1995), the prevalence of disputes can be minimized by positive actions taken in the design and preconstruction phases, especially design errors, utility conflicts, unknown site conditions, and other common types of disputes encountered during construction progress.

Discrepancies or Mistakes in Contract Document

Chappell et al. (2001) defined discrepancies as differences or inconsistencies. According to Loots and Charrett (2009), there would also be a discrepancy in Contract document if there are works which is not included in the entire Contract documents.

IMPACTS OF CONSTRUCTION DISPUTES

Project Delays

Project delay is one of the impacts that occurs from disputes in a construction project. Aibinu and Jagbora (2002) explained delay as a construction project, which was not successfully delivered within the agreed completion duration in a contract. A survey done by Al-Khalil and Al-Ghafly (1999) showed that financial-related matters are the biggest contributing factors to the project delays. Late payment by the client to the contractor is one of the issues contributing to the late delivery of a construction project (Ahmed et al., 2003).

Increased Project Cost

As described by Feld and Carper (1997), the nature of disputes is seen as time consuming process, costly and involving many different and confusing aspects to resolve. In addition, Rossi (1991) revealed that both conflicting parties who are client and employer suffered a huge amount of additional cost throughout the process in resolving construction disputes.

Damage Business Relationship

Every party involved in a construction project aims to maintain a good business relationship for the future benefit of a business. However, Emmitt (2010) states that due to the occurrence of dispute, which is caused by one party over another, a good business relationship can be damaged. Chern (2008) also added that not only business relationship will be destroyed; construction conflicts are also time consuming and increases the chance of project abandonment.

Damage Company Reputation

Ali, Smith, Pitt and Chan (2010) mentioned that “a company reputation is one of the most important intangible assets”. A research conducted by Davis, Rachel and Frank (2010) found that due to the controversial issues of a company, investors will lose confidence in investing into the company hence the market share also will fall. This is further supported by ASIC (2015) which stated that reputation of a business is intertwined with a company’s name.

Project Abandonment

Abandonment of a project occurs when the construction process is suspended for a certain time frame (Spelman, 1993). Moreover, Hess et al. (2007) proposed that “a substantial number of project abandonment, construction claims and cost overruns can be minimized if the client make an effort or spend sufficient time and resources to accomplish certainty during

design stage because the changes made to the scope during design phase have lesser financial consequences”.

DISPUTE RESOLUTIONS METHOD

Negotiation

Negotiation is a process that is conducted through settlement between two parties in a dispute without the involvement of an independent third party. Goltsman et al. (2009) mentioned that negotiation process takes place by “the parties engaging in (possibly arbitrarily) face-to-face cheap talk”. Wright (2004) in his book revealed that negotiation is the ideal option for two conflicted parties to choose as it is not only time and cost saving but also produces the best chance of satisfaction. In addition, Wright (2004) also highlights that it is cost effective since there are no legal procedures involved in this method. However, a study by Bercovich and Jackson (2001) showed that when the conflict is too complex, the chance for both parties to reach an agreement is low.

Mediation

Mediation process is almost the same as negotiation process. However, in this method, a mediator who is an independent third party is appointed to assist the parties in dispute to reach a solution. Goltsman et al. (2009) described mediation process as “the parties communicate with a neutral third party who makes a non-binding recommendation”. Ismail et al. (2010) stated that the acceptance and application of mediation method in the Malaysian construction industry is not fully recognized although it is a more friendly approach than arbitration method. Even though this approach is not widely used in Malaysia, mediation has been widely used in the international including in business transactions.

Adjudication

Adjudication normally deals with disputes matter regarding payment issues (Uher & Brand, 2005). Owens (2008) stated that the decision made by an adjudicator is not final and is only temporarily binding unless the decision have been revised through arbitration or litigation process.

Arbitration

Ismail et al. (2010) mentioned that arbitration approach is increasingly popular choice in resolving disputes among the industry player. Goltsman et al. (2009) stated that under arbitration approach, “the two parties commit to conform to the third-party recommendation”. Chong and Zin (2012) mentioned that in an arbitration approach, the parties suffering disputes “need an arbitrator, an independent expert to act as the decision maker”. Chong and Zin (2012) further added that any decision made by the arbitrator is final and legally binding.

Litigation

Litigation is the final stage of dispute resolution method. Gebken and Gibson (2006) mentioned that the process of litigation takes a long time to resolve, risky and incurs a

substantial amount of money. However, litigation procedure may be the best resolution method if the dispute involves legal issues or requires decision that is best determined by a judge (Harmon, 2004).

RESEARCH METHODOLOGY

A combination of qualitative and quantitative research method was used to achieve the objectives of this research. An online survey questionnaire was conducted to collect the data. The survey questionnaire produced to conduct this research produced both qualitative and quantitative data. Close-ended questions will produce quantitative data while open-ended question which is suggestion question will produce qualitative data. The reason for conducting survey approach is that the respondents were given a flexible time to answer the survey since they are preoccupied with works and also the data obtained are more reliable due to large sample size. This research was conducted from the perception of registered consultant QS Firms in Selangor that is obtained from Board of Quantity Surveyors Malaysia (BQSM) website. This target population was chosen due to their expert knowledge and involvement in contract. Quantity surveyors also are chosen due to their frequent dealings with disagreements or argument on construction works between employers and contractors. Furthermore, the survey was conducted on QS Consultant Firms in order to reduce bias in giving opinion either from employers' or contractors' perspectives.

In this research, both primary and secondary data was adopted in order to meet the objectives of this study. Primary data was collected through a survey questionnaire, which was sent out to the experts in construction industry. On the other hand, secondary data was also used in this research to support the primary data collected from the respondents. The survey questionnaire was separated into 3 sections. Section A and C are multiple choices questions and it utilized the nominal scale to measure and analyse the data obtained. These sections were intended to acquire the background information of the respondents and the resolution method that is most commonly used by the key players in resolving disputes in terms of time, cost and satisfaction. On the other hand, Section B adopted an ordinal scale approach which is the Likert scale approach to evaluate the respondents' perception on the issues contributing to construction dispute and the consequential impacts of dispute. The collected data from the survey questionnaire were analysed by using Statistical Package for Social Sciences (SPSS) in order to carry out the data analysis in this research. Frequency analysis method was used to present the demographic profile questions and presented in a bar chart or pie chart. Moreover, mean score analysis was used on data gathered from Likert scale question. This method was used to identify the ranking of the data collected from the most significant to the least significant causes.

FINDINGS

Factors or Issues that Contribute to Construction Dispute

Nine factors or issues which can play a part in the occurrence of construction disputes are listed. The respondents were asked to rate the significance of each of the factors or issues in accordance to five-point Likert scale. Table 1 below shows the analysed data.

According to the tabulation in Table 1, it shows that the most significant factor is regarding ‘payment issue’ with a mean score of 3.88. According to Kennedy (2015), the issue of payment has always been the main subject of disputes in a construction project. ‘Variation’ issue is ranked second with a mean score of 3.83. It is not a surprising that variations issue is ranked in second place as variation works are inevitable in a construction project as mentioned by Mohamed (2001) and Tony (2013).

Table 1. Factors or Issues Contributing to Construction Disputes

Factors/Issues	Mean Score	Rank
Payment Issue	3.88	1
Variations	3.83	2
Cost Overrun	3.60	3
Design Errors	3.56	4
Discrepancies or Mistakes in Contract Document	3.50	5
Time overrun	3.48	6
Poor Workmanship	3.46	7

Following in the third position with a mean score of 3.60 is ‘cost overrun’. As mentioned by Becker et al. (2014), cost is one of the major factors determining a project success. The respondents also ranked ‘design errors’ in a construction project as a significant issue with a mean score of 3.56. The other factors, ‘discrepancies or mistakes in contract document’, ‘time overrun’ and ‘poor workmanship’ are ranked in the 5th, 6th and 7th position with a mean score of 3.50, 3.48 and 3.46 respectively. Although poor workmanship is ranked at the 7th position, it is still rated as a significant issue as stated by Ali and Wen (2011) the factors contributing to low quality problems are caused by lack of experience and low competency of labours, low pricing by contractors (limited budget) and poor project management.

Impacts of Construction Dispute

Based on the objectives set out in this research, five impacts of construction disputes were listed in this question. The respondents were asked to rate each of the impact by using Likert scale from strongly agree to strongly disagree. Table 2 below shows the mean score of each impact with its ranking.

Table 2. Impacts of Construction Dispute

Impacts	Mean Score	Rank
Increase in Project Cost	3.23	1
Project Delays	3.17	2
Damaging Business Relationship	2.90	3
Damaging Business Reputation	2.88	4
Project Abandonment	2.85	5

The respondents ranked ‘increase in project cost’ as the most significant impact arising from construction dispute with a mean score of 3.23 as shown in the Table 2 above. This is supported by Feld and Carper (1997) where they stated that one of the major outcomes of disputes is it is costly. The second significant impact with a mean score of 3.17 is ‘project delays. In addition, the respondents also agree that ‘damaging business relationship’, ‘damaging business reputation’ and ‘project abandonment’ are resulting effects of

construction disputes with a mean score of 2.90, 2.88 and 2.85 respectively. From the gathered data and information, all of the respondents agreed that construction disputes can give rise to the increase in project cost, project delays, damaging business relationship, damaging business reputation and project abandonment.

Dispute Resolution Methods

Commonly Used Dispute Resolution Method

In this question, the respondents were asked on the resolution method that is most commonly used in settling the disputes that arise. Figure 1 illustrates the methods of resolving construction dispute incorporating negotiation, arbitration, mediation, litigation and adjudication.

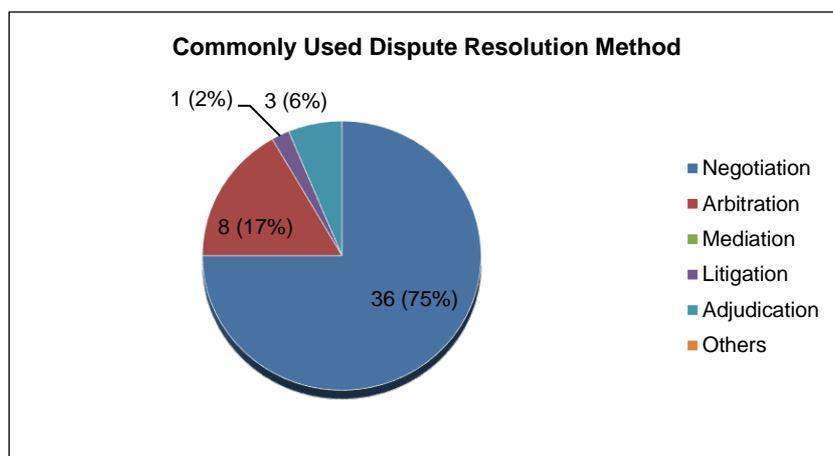


Figure 1. Commonly Used Dispute Resolution Method

According to the results shown in the Figure 1, more than half which is 75% (36 out of 48) of the respondents said that they frequently used negotiation to resolve any disputes that arise. This result is supported by Goltsman et al. (2009) where they mentioned that negotiation is a “face-to-face cheap talk”. Apart from that, arbitration is selected as the second mostly used resolution method with 17% (8 out of 48) responses. With a percentage of 6%, only 3 respondents answered that they used adjudication to cope with construction dispute followed by litigation which is only 2% (1 out of 48) responses. Meanwhile, no respondents chose mediation as the commonly used resolution method. It is consistent with the study shown by Ismail et al. (2010) where mediation is not widely adopted in the Malaysian construction industry.

Duration of the Chosen Resolution Method to Resolve Dispute

The respondents were asked to rate the duration of the chosen dispute resolution method in the previous question. (1) represent less than 1 year, (2) represents 1 to 3 years and (3) represents more than 3 years.

Table 3. Time Taken to Resolve Dispute Based on the Chosen Resolution Method

Resolution Method	Duration			Mean Score	Rating Scale
	(1)	(2)	(3)		
Negotiation	20	16	0	2.56	Less than 1 year
Arbitration	2	3	3	1.88	1 – 3 years
Mediation	0	0	0	-	-
Litigation	0	1	0	2.00	1 – 3 years
Adjudication	1	2	0	2.33	1 – 3 years
Others	0	0	0	-	-

From 36 respondents who answered negotiation as their commonly used resolution method, 20 respondents stated that this method only takes less than a year to solve a dispute. The remaining 16 respondents stated the dispute normally took a year up to 3 years to settle. While, no respondent answered that this method takes more than 3 years to resolve the dispute.

As for the 8 respondents who chose arbitration as their commonly used resolution method, 2 out of 8 respondents said that the disputes cases are able to be resolved within a year. Another 3 respondents said that the arbitration method took a year up to 3 years while another 3 respondents highlighted it can take more than 3 years to resolve a dispute.

The third chosen resolution method is through adjudication. In this group, only one respondent stated that disputes can be resolved within a year while another 2 respondents stated that adjudication procedure normally takes 1 to 3 years to settle. On the other hand, the only respondent who chose litigation commented that dispute can be resolved in a range of 1 year up to 3 years.

Cost of Resolution Method

The respondents were asked to rate the cost of the chosen dispute resolution method in the previous question. (1) Represents very low, (2) represents low, (3) represents medium, (4) represents high and (5) represents very high.

Table 4. Cost of the Chosen Resolution Method

Resolution Method	Significance Level					Mean Score	Rating Scale
	(1)	(2)	(3)	(4)	(5)		
Negotiation	4	12	18	2	0	2.50	Medium
Arbitration	0	0	3	4	1	3.75	High
Mediation	0	0	0	0	0	-	-
Litigation	0	0	0	1	0	4.00	High
Adjudication	0	0	3	0	0	3.00	Medium
Others	0	0	0	0	0	-	-

Table 4 demonstrated that half of the respondents who had chosen negotiation revealed that the cost to resolve dispute using this method is medium. 12 out of the 36 respondents have responded that the cost of this method is low. Concurrently, another 4 respondents stated that it involved a very low charge for a negotiation method. However, only 2 from 36 responses claimed that the cost of using this approach is high. From the point of view of arbitration method, 4 out of 8 respondents agreed that the cost for this method is high. Another 3 responses showed that from their experience, the cost of solving dispute is only medium while the remaining respondent stated that cost for this method is very high. As for adjudication, all of the respondents agreed that the cost of adjudication process is medium

while the respondent who chose litigation responded that this method involves a high cost to carry out.

Satisfaction of Resolution Method

The respondents were asked to rate the satisfaction of the chosen dispute resolution method in the previous question. (1) represents very poor, (2) represents poor, (3) represents average, (4) represents good and (5) represents very good.

Table 5. Satisfaction of the Chosen Resolution Method

Resolution Method	Significance Level					Mean Score	Rating Scale
	(1)	(2)	(3)	(4)	(5)		
Negotiation	3	0	18	15	0	3.25	Average
Arbitration	0	0	5	3	0	3.38	Average
Mediation	0	0	0	0	0	-	-
Litigation	0	0	0	1	0	4.00	Good
Adjudication	0	0	3	0	0	3.00	Average
Others	0	0	0	0	0	-	-

Table 5 conveys the results of the respondents' satisfaction based in their commonly used resolution method to deal with disputes. In terms of negotiation method, half of the respondents rate this method as an average only. Another 15 respondents evaluate the overall quality of this method as good and the remaining 3 respondents stated this method is very poor to use despite its popularity among the construction players. For arbitration method, 5 out of 8 respondents considered this method as an average only while another 3 respondents said that this method has a good quality. As for adjudication, all of the respondents agreed that the satisfaction of adjudication process is average while the respondent who chose litigation responded that this method is good to be used and able to satisfy the party in dispute.

Suggestion for Improvements

Table 6. Suggestions to Manage Construction Disputes

No. of Respondents	Suggestions
5	Understand the contract deeply
3	Maintain a good communication and relationship among the project's team members
1	Provide a systematic project management
39	None

A total of nine respondents have responded to this question. Five of the respondents suggested that in order to manage or control construction disputes, the most important thing is that the parties involved in a construction project which is client, contractor and consultant must understand the contract deeply. On top of that, all parties must ensure that they are clear and aware on their respective obligations, roles and responsibilities before entering into their contract. Once the parties entered into a contract, they must strictly follow as per the bound contract to avoid any disagreements.

Meanwhile, three of the respondents proposed that a good communication and relationship should be maintained amongst the team members of construction projects. The respondents suggested that teamwork and communication skill must be improved and every

party including client, consultants and contractor must cooperate to deliver a project in a cost effective and timely manner.

Lastly, only one respondent suggested that a systematic project management should be provided from the beginning of a construction project to reduce the possibility of disputes in a project. This suggestion is consistent with a study done by Ali and Wen (2011) where it revealed that poor project management as one of the factors contributing to the problem of poor workmanship (and thus disputes) in a construction project.

RECOMMENDATION AND CONCLUSIONS

Recommendations for Future Work

Several potential improvements can be done in future similar research studies. The future researcher is encouraged to classify the parties in construction disputes into several groups such as client, contractor and consultant teams. Furthermore, instead of focusing on the impacts of construction disputes, the future researchers should instead recommend to study on the preventive measures on how to mitigate or minimize disputes in the construction industry as per the wisdom of this phrase ‘prevention is always better than cure’.

Additionally, it is also recommended to conduct the survey from the opposing parties’ viewpoint such as client and contractor. The future researcher can also use other data collection method such as case study, interview or observation to increase the accuracy of the data obtained.

CONCLUSION

This study was conducted in order to raise awareness and provide the big picture on the likelihood of construction disputes occurring and the subsequent impacts that follow. Additionally, this study could also assist the parties in dispute on the choices of resolution methods available in the industry that they could use to settle the conflict. Moreover, this study also highlights the ideal resolution method in terms of time, cost and quality that the construction industry often adopts in resolving disputes.

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RISK ASSESSMENT AND MANAGEMENT PRACTICE (RAMP) OF INDUSTRIALIZED BUILDING SYSTEM (IBS) IMPLEMENTATION

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Abstract

Construction is one of the high-risk industries among others. Risk assessment and management practice (RAMP) was found to be helpful in controlling the risks. Implementation of new technology; Industrialised Building System (IBS) will undergo distinct risks. Unknown risks in IBS implementation lead to the project failure tendency. This leads to the low adoption rate of IBS in Malaysia. IBS was introduced and practiced in Malaysia serves to increase the performance of construction industry to solve the issues of high intake of non-certified foreign labours and high housing demands. Nonetheless, previous researches on IBS paid very little attention to risk aspects. Therefore, specific study on RAMP of IBS becomes crucial to identify the potential risks, significant level of the risks and its relative controlling method in order to increase the project success. The research aimed at G5 to G7 contractors in Malaysia who practice IBS project in residential, commercial, industrial and other types of development. 19 risks factors related to IBS were identified and the significance level for each risk was calculated using risk significance index (RSI). The top significant risks highlighted by the respondents are related to economic risks. The risks control methods mostly practiced by the contractors are risk avoidances and risk reduction method. The novelty of this study is that the RSI were explored in regard to IBS in Malaysia Construction industry which are more sophisticated in Malaysia's study, and the RSI findings differed from other Asia countries such as China.

Keywords: *Risk Assessment; Industrialized Building System; Construction; Risk Significance Index.*

INTRODUCTION

Construction industry comprises different complex activities which are extremely dynamics and risky. Ali et al. (2015) indicated that the construction industry is having the highest rate of challenging projects among all industries. This is due to the involvement and collaboration of different parties in the construction project. For instance, consultants, architects, engineers, Quantity Surveyors, contractor, sub-contractors and etcetera (Liu & Low, 2009). Effective communication among all parties is hard to achieve due to miscommunication, cultural shock and so on, and thus, leading to different kind of risks. Positive risks occur during the construction project will generate a greater outcome on the cost, time and quality if compared to the initial expectation. Nonetheless, in case the negative risks arise, the organization may suffer from lost, delay or low quality (Adedokun et al., 2013). Therefore, determining the latent risks and control it has become tremendously crucial in order to ensure the success accomplishment of the construction project.

The conversion of traditional building method to the new, innovative IBS method is crucial and essential for the country in order to overcome the current existing issues of the construction industry in Malaysia. For example, overuse of low productivity and non-certified

foreign labour (Zawawi, 2009; Abdullah & Egbu, 2011) and high demand for housing (Azman et al., 2011). Nawi & Lee (2013) mentioned that Malaysia will need 4,964,560 units of new housing from now in the year of 2020 due to increased population rate.

Unfortunately, implementation of IBS is still in the infancy stage in the industry. In 2003, only 15% of total construction projects, applied IBS (CIDB, 2010). According to Bash (2015), 70% of the architects did not own the knowledge of IBS design in 2005. During the following year, only 10% of the projects managed to apply more than 70% of IBS elements (Kamar et al., 2014). In fact, the targeted plan by CIDB was to have 50% of IBS implemented projects in 2006 and 70% in 2008. In addition, Mohamad et al., 2009 stated that less than 30% of projects, applied at least one IBS component at the same year. Nawi & Lee (2013) stated that the usage of IBS is still very low in Malaysia at present.

All the data have shown that the acceptance rate of IBS implementation is still low in the Malaysian construction industry. Some of the clients and practitioners claimed IBS as not economical and caused the delay of the project. (Abas et al., 2013). The root cause of limited adaptation of IBS is due to the uncertainties risks that may occur during the implementation process and the practitioners failed to mitigate it. (Li-zi et al., 2015). This has seriously affected the attitude of contractors toward the usage of IBS since they may need to bear with the risks lead to project failure or low profit margin.

As long as the unknown risks are not identified, it will be hard for the IBS implementation rate to be raised up even if the country put in great efforts in promoting this innovative construction method. The Malaysian construction industry is still undeveloped comparing to other countries (Abas et al., 2013 and Kamar et al., 2010). The construction industry is significant in determining the economic status of a country. It provides different types of infrastructures to the country; hospitals, schools, offices and etcetera. The devotion of the construction industry to the Gross Domestic Product is about 5% per annum (Yunus et al., 2011). It as well contributes to the increment of employment rate (Wibowo, 2009). Kamarul et al. (2011) indicated that this industry is contributing employment rate up to 8%, a rough estimate of 1.03 million of community are the beneficiaries. Hence, it is important for us to improve the standard of the Malaysian construction industry. Application of IBS has no doubt is one of the methods to increase the performance (Hamid et al., 2010).

Thus, this study becomes crucial to investigate the potential risks during the implementation process of IBS in the construction project and then, to construct a guideline for the adopters to mitigate the risks. Once the contractors got the chance to know more about the hidden risks and its solution, it will definitely increase their confidence level to use IBS in the construction project. Research on the risk management of implementing IBS will then eventually lead to promotion of IBS in Malaysia.

LITERATURE REVIEW

IBS is the mass production (Azman et al., 2009) of prefabricated construction components (Kamar et al., 2010) using advanced systems and technologies (Nor et al., 2011) in a controlled environment (Kamar & Hamid, 2011) so that to accomplish excellent quality control (Kamarul et al., 2011) of end products to be transported to construction site for on-site installation (Fallis, 2013). IBS is always a hot topic to be investigated by the researchers.

72 journals from year 2009 to 2016 discussing IBS have been categorized into 10 groups; definition, implementation strategies, decision making, barriers, prospective analysis, policies and guidelines, perspective, manufacturing, sustainability and risk of IBS. Among these 10 groups, implementation strategies of IBS are the issue that the academicians investigated the most. Policies and guidelines, definition and risk of IBS were found to be the least investigated topic. Definition of IBS is no longer hot in recent years might due to the numerous researches that had been carried out in the years earlier than 2009. It is truly obvious that the focus on risk implementing IBS is very low. Nevertheless, risk assessment and management (RAMP) of IBS is tremendously crucial and should be paid for attention since it will affect the success of the project. And thus, this research becomes essential to study the issue about the risks of IBS.

RAMP of IBS

Risk in fact, is the merging of the occurrence frequency and impact value (Tummala & Schoenherr, 2011) of an unplanned and unexpected event (RMA, 2011) that may bring either positive (Aloini et al., 2012 & Work Safe Act, 2012) or negative consequence (Jarkas & Haupt, 2015; Cartans, 2012) to the objectives of project in future (Adedokun et al., 2013). RAMP is a professional act involving risk assessment (Liu & Low, 2009; Berg, 2010) to determine a significant level (Kululanga & Kuotcha, 2010) of problematic issues (RMA, 2011) and risk management (Aloini et al., 2012) to treat the risks (Ehsan, 2013 & Work Safe Act, 2012) so that the project could accomplish success. RAMP process by The University of Adelaide (2009), Berg (2010), Buc et al. (2009), Deloitte & Touche (2012), Aine et al. (2011) and Work Safe Act (2012) were reviewed. The processes proposed by them are most likely the same. Every method covers the risk assessment and management practice. Risk assessment involves risk identification, analysis, evaluation, prioritization and characterization. Risk treatment or response or control, communication, documentation process, monitoring and reviewing fall under the practice of risk management.

Nevertheless, there is a slight arguing statement, which is risk acceptance. Buc et al. (2009) divided the risk acceptance and risk treatment into different steps while others categorized risk acceptance in risk controlling process. Besides, The University of Adelaide, (2009) and Berg (2010) emphasize on the establishment of context, such as the goal and objectives of the project in the initial stage before carrying out the risk assessment process. They claimed that this step enables the organization to better prepare the needed documentation and information so that the assessment process could provide more accurate information. As for Aine et al. (2011), the authors highlighted the problem formulation process in the preliminary phase. This procedure assists the risk managers have a better understanding and picture of the issues that will lead to risk. Moreover, option appraisal was added before the phase to treat the risk. In the appraisal of options, each alternative will be evaluated for its benefits of economic, technology, organization, social and environment. Then, regarding to what the organization aims to achieve the most, the suitable option will be selected in risk addressing process. In a nutshell, there is only a very slight difference between the RAMP process. Thus, RAMP process can be concluded as follow: establishment of context, risk identification, risk analysis, risk evaluation, risk treatment, risk communication and risk monitoring.

The risk identification is done by reviewing the literature review. In this study, 21 risks are categorized into economic, supplier, design, management and on-site technical risks. Then, risk evaluation is carried out to categorize the priority level of risks by combining both the probability and impact of the risks. According to Li-zi et al. (2015), the design risk of inaccuracy of coding in the design sheet has to be highly prioritized since it is having a great impact and often happens in the construction project. The other design risks; defect and errors of design and incapability in altering the design during the construction phase falls under the status of moderate in the prioritization levelling. This is because their impacts are moderate and the probability to occur are not high. The on-site technical risk of incapable of using a high technology machine is under the same levelling status as the later as well. The management risk of damages to the construction components during transportation process is less likely to happen and the upshot is minor and thus, it is not a significant risk. Delayed payment which is under economic risk is a critical risk among all. The probability and upshot of it is relatively very high to the construction project. Poor performance of manufacturer and safety risks are at a moderate level. Moreover, low quality risk is likely to occur, nevertheless the impact that it causes is insignificant. And so, it is categorized under low significance level (Salihudin et al., 2009).

Risk treatment or in other term risk response is a process used to control the occurrence frequency or the negative impacts of identifying risks. There are 4 types of risk treatment; risk avoidance, risk reduction, risk retention and the last but not least, risk transference (Deloitte & Touche, 2012). Risk acceptance applied when there is a change in taxation rate. Besides, the excessively high cost of treatment will make up the mind of the organization chooses to just accept the risk. Next, if the risk impact is insignificant, then the organization will sometimes just ignore it (Buc et al., 2009).

According to Li-zi et al. (2015), risk avoidance could be applied to solve the risk of incompetency of labours in installing and assembling the IBS components by employing skilled and experienced labours. Besides, the role of government in setting a standardization level is crucial to avoid the economic risk due to low standardization of IBS components. Further, strict qualification for consultants and designers help to ensure their competencies in accomplishing the tasks. Thus, risks due to low level of knowledge could be avoided. Besides, utilization of quality function deployment (QFD) (Haron et al., 2012) and Quality Assessment System in Construction (QLASSIC). (Ali et al., 2012) ensures the design quality.

Cartans (2012) indicated that design risk, such as errors of design sheet could be mitigated by communicating well with the surveyor in order to get accurate surveying information and documentation. Additionally, the designers have to carry out surveys on the land, types of soil and etcetera on their own when it is needed. Economic risks, for example, high material costs, labour fee and machinery costs could be mitigated by reduction of the project timeline. The decrease in days of construction reduces the employment days of labours and rental fee for machines, thus, overall project costs could be deducted (Li-zi et al., 2015). On the other hand, closer relationship with supplier and designer should be developed in order to ensure their competencies (Mohamad et al., 2009). Selection of capable manufacturer and designer could help to mitigate the supplying and design risks. Moreover, effective organization structure that is open to the adaptation of changes situation and innovation technology that improves planning, communication and decision making process is crucial in reducing various risks (Anuar et al., 2009).

Purchasing of insurance is a popular risk transference process. The insurance company will pay for indemnity when accidents occur. Therefore, the employer may not need to suffer from financial lost (Iqbal et al., 2015). Risk avoidance is always the 1st risk treatment method that comes into consideration as it will not cause any lost to the company. In case the risk could not be avoided, then risk reduction becomes the 2nd choice. In this controlling method, the organization will still have to undergo losses, but the negative impact will be mitigated. The next one is a risk transference method and followed by the last one, risk acceptance; when there is no way to solve the problematic issues.

RESEARCH METHODOLOGY

Questionnaires will be distributed to G5 to G7 IBS registered contractors in Malaysia. Judgmental sampling method will be utilized. It is used when the respondents have to be experienced in the particular field so that the answers obtained are with high accuracy based on the judgement of the researcher. The 1st objective was already achieved in literature review. Then, the 2nd objective; significance level of risks will be calculated using frequency and impact level of each risk. Frequency level of identified risks will be expressed using Cronbach's coefficient α (Ritter, 2010) while impact level will be utilizing the denotation of β . The value of these 2 parameters will be calculated based on the collected data in the 5 points Likert scale (Boone & Boone, 2012). For frequency level, the respondents will need to determine the probability level for the risks to occur by selecting 0.1 (rare), 0.3 (unlikely), 0.5 (possible), 0.7 (likely) or 0.9 (almost certain). And for impact level, the respondents will need to rate within the 5 options to judge the extend of lost will the construction project face through the selection of 1 representing insignificance effect to 5 standing for catastrophic. Cronbach's coefficient α is having a value of 0.91 and is higher than the 0.5 threshold. This has shown the dependability of the Likert scale in 5 points with 5% of significance level (Gliem & Gliem, 2003). This statement has proved that the collected data is suitable to be used in producing accurate answers.

Then, the formula of the risk significance index will be used to calculate the priority level of all the identified risks.

$$RSI^i = \frac{\sum_j^N = 1 \alpha_j^i \beta_j^i}{N}$$

RSI^i ; risk significance index, α ; frequency of risks to be occurred, β ; impact level of risks, I ; denotation of risk 1, risk 2, risk 3, ..., j ; denotation of respondent 1, respondent 2, ... and N ; total number of valid respondents. RSI is named as a weighted average score. It was proved by the previous researches that the limitation of using this type of scoring formula is that it does not take the degree of variation among each respondent in the consideration. To solve this problem, 2 similar algorithm mean values are compared by merging coefficient of variation (Grela, 2013). The combination of the values of RSI^i and coefficient of variation will be indicated as R_{co} .

$$R_{co} = RSI^i + \frac{RSI^i}{\sigma_i}$$

σ_i is the standard deviation of RSI for risk i

Discrepancies are likely to happen during the judging process from the respondents. In this case, Kendall's concordance test was created in order to examine the acceptability of the opinions discrepancies among respondents (Legendre, 2005). Consistency of answers provided by distinct respondents could be measured by this formula.

$$W = \frac{12 \sum_i^n R_i^2 - 3m^2n(n+1)^2}{m^2n(n-1)}$$

W; concordance (ranging from 0; no consensus to 1; complete consensus, $W \leq 0.05$, consensus is acceptable.) R_i ; summation of ranks numbered by the respondents for the risk I and n; number of identified risks.

Thematic analysis is a process to understand the data, then dissect and synthesize the collected data into groups of information (Braun & Clarke, 2006). It is crucial to plan the thematic analysis process systematically in order to ensure there will be no errors. It is used to accomplish the 3rd objective. There are 6 steps in the analysis; understanding of data, generation of initial coding, seeking of themes, themes reviewing, definition of themes, and report production.

Repeat reading the collected data enables the researcher to have a better understanding of the information. Specific words will be highlighted among the answers provided by the respondents. For instance, provide training to the labours to improve their competency in installation of IBS components. Wording of training will be coded. The coded wordings will be grouped under different themes. Then, themes will be further refined. Risk mitigation is the final title for the category of improvement. The theme will be further explained so that the readers will have a better understanding towards them. Lastly, report will be written base on the themes; for instance, risk reduction and risk acceptance.

RESULTS AND DISCUSSIONS

From the research findings, the 1st risk factor that is most significant is the high transportation cost risks. In fact, risk factor R3, R4, R2 which are cost related risks factors as categorized in Table 1 and 2 showed that cost related risks are significant in a particular Industrialised Building System (IBS) construction project directed to the contractors. The least significant risk is R10, the difficult employment of skilled labours in this study. The standard deviation value of less than one (>1) indicates that the respondents shows a small standard deviation from each of their answers. In a sense, the value of < 1 indicates that the respondents are having the same knowledge and understanding on the asked questions, which related to the risk's occurrence in a certain IBS project and its relative impact.

For most of the design related risk, R9, R7, R6 were ranked above 10, which shows its risk significance is lesser than cost related risks. For other categories of risks, there is no generalization in their ranking. However, from table 2, among the top 5 ranking there is one ranked 4th from design related risk, which is the lack of coordination between design and construction stage. This finding indicated two implications which are cost related risks are heavily important and the coordination of the design and construction stage may affect the whole IBS construction process, which will cause the cost related risks to occur. Cost issue may have concerned as IBS project requires high initial cost output (Jaillon and Poon, 2009; Pan and Sidwell, 2011).

Table 1. Classification of Risks Factors' RSI based on Ranking in Descending Order

Risk Factor	Types of risks	
R3	High Transportation Cost	} Most significant risks
R4	High Machinery Cost	
R2	High Skilled Labour Cost	
R8	Lack of coordination between design and construction stage	
R1	High Material Cost	
R13	Incapable in using the high technology machine	
R14	Quality issue	
R5	Incapability of changing design during construction phase in case needed	} Average significant risks
R17	Delayed payment	
R12	Improper assembly or installation of construction components	
R19	Poor performance of suppliers	
R11	Damage to construction components during transportation to the site	
R15	Safety and Health	
R9	Inaccuracy of coding and standardization of IBS in design sheet	
R16	Shortage or late supply of construction components to the site	} Least significant risks
R18	Low standardization of construction components	
R7	Defects & errors in design	
R6	Delayed design stage	
R10	Difficult employment of skilled labours	

Table 2. Categorization of risks factors

Risk Factor	Category
R1, R2, R3, R4, R17	Economic risk
R11, R18, R19	Supplier risk
R5, R6, R7, R9	Design risk
R8, R10, R15, R16	Management risk
R12, R13, R14	On-site technical risks

However, the contractors are unable to predict, aware, or sense the outcome from the design related risks as they are not part of the consultant team. Furthermore, it is said that most of the changes in designs are due to design deficiencies, unforeseen conditions including site conditions, criteria change etc. which the roots of the risks or faults are unable to be defined clearly (Stephen et al., 2010).

Among the top 10 risks factors with higher risk significance value, R13, R14, and R17 can be generally caused by their employers' decision as we l. For instance, R13 incapable of using high technology machine, in this case the contractor may be required by the developer to deploy such measurement in the contract, however the contractor may not have such skills and knowledge to deploy but still go for the bidding of the contract due to business and commercial decision. Whereas for R14 Quality issue and R17.

Delayed payment issue is arguably undefined in the Malaysia construction industry. For instance, developer may agree and satisfied with the contractors' construction quality without implementing assessment scoring such as Qlassic and CONQUAS. And for delayed payment

case, as it is a norm in the Malaysia construction industry (Mohammed Nor Azhari Azman et al., 2013) the risks arise even more where the contractor has to bear such operation cost for months before acquiring profit. The effect of delayed payment may result to delay in project and creates negative chain effect to other parties in the construction.

CONCLUSION

Of the 19 identified risks, the most significant risks are cost related risks. The risks control methods mostly practiced by the contractors are risk avoidances and risk reduction method. Most of the contractors do not adopt risk transfer methods or risk acceptances probably due to several reasons, the risks are already transferred by binding black and white agreement between the construction parties, the risks that are accepted are norm practices to the Malaysia construction industry's contractors, the risk avoidances and risk reduction method impose lesser cost and time implication as an overall solution for the identified and unidentified risks in their own project etc. Therefore, identifying their risk impact impression with regard to their risk control method is important. A new risk assessment model was proposed to the contractors for them to improve their risks management.

The risk significance level of cost related risks indicates that the contractors have to improve their cost management practice to reduce its significance level, as their significance level is relatively high compared with the risk factors with lowest RSI figure. This study becomes crucial for investigating the potential risks during the implementation process of IBS in the construction project and then able to construct a guideline for the adopters to mitigate the risks.

As IBS practice in Malaysia may be defined as a full IBS construction practice or partial IBS construction that may even differs for companies in one project, it is even more crucial to draw a clear line defining the risks control method taken in which related to the scope of the IBS construction project so that successful risk control method may be used or proposed.

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BLOCKCHAIN POTENTIALS IN ENHANCING CONSTRUCTION STAKEHOLDERS COLLABORATION

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Abstract

Trust, being one of the missing links in construction highlights the need of construction collaboration. Although practices have been conducted, there are still issues with the current construction collaboration. Collaboration in the form of tender, document control, drawings still potentially arises arbitration or litigation matters. Newer approach to solve the current construction collaboration issues is needed. Blockchain technology relies on the mistrusts between nodes of users in the network to validate and reach consensus between one another to create the trust links. Such terminology is exquisite for construction, as mistrust is the main issue, and the mistrusts disadvantage can be used to create trust link between construction parties. The study reflects the construction collaboration issue and limitation of implementing technologies in construction industry versus the blockchain terminology and advantages to solve those issues. More advance technological change is definitely needed in construction industry, more so ever with the emergence of new technologies.

Keywords: *Blockchain; Collaborative relationship; Construction; Stakeholder Management.*

INTRODUCTION

Collaborative gaps in construction arises from dispute between construction parties. Dispute in construction industry particularly highlights the need of quality assurance throughout the project life cycle. The disputes may due to payment delay, lack of effective communication channel, lack of corrective information sharing on site, poor document control systems, and subjected to contractual obligations of a certain construction project (S. Mitkus and T. Mitkus, 2014). The outcome of these fundamental problems leads to one another such as inconsistency of the drawings, irregular memo or written instructions, delay of project, mismatch in onsite scheduling, and other potential construction site issues (V. R. Perumal and A. H. A. Bakar, 2011). One of the main challenges in the construction industry is that most firms' practices cost-based investment strategy, only focus on tangible outcome, leading overall industry to slow pace in adopting new practices or technologies (S. Durdyev et al., 2018).

Quality of assurance is often associated with the effectiveness of collaborative measurements (H. Al-khaddash et al., 2013). Collaborative measurements practices can overcome dispute between construction parties. Collaborative measurements include efforts such as willingness to share information, increased site productivity with collaborative scheduling, reduction of communication bureaucracy indicates lower dispute in a construction project (S. H. A. Rahman et al., 2014). The degree of collaboration determines the collaborative measurements taken in a construction project (S. H. A. Rahman et al., 2014). Firms may incorporate joint-venture practice and share their resources, strategic alliance, or even acquisition of potential partners in order to form good collaboration relationship which will then impact on the quality of the project (S. H. A. Rahman et al., 2014). The collaborative

measurements were meant to overcome construction issue which potential causes dispute, arbitration or even unintended litigation procedures to be faced between construction parties.

Collaborative measurements such as tender contracts, sharing problem solving method, cross-functional participation were all meant to overcome mistrusts issue between construction parties (S. H. A. Rahman et al., 2014). Tender contracts noted down the details of the negotiation and administration to govern the whole project life cycle. However, most tendering methods are still limited to traditional procurement as some of the alternative procurement methods' disadvantages were not reflected in traditional procurement. The compatibility of the resources, technology, contractor's background, culture, relationship, increases the complexity of construction projects (F. Rahmani et al., 2016). Such complexity and increase numbers of project limits the choices of procurement methods (P. Coates et al., 2016).

The collaboration relationship between construction parties can also be enhanced through the help of technology adoption (P. Coates et al., 2016). Software such as AutoCAD and BIM used to maintain the consistency of the drawing information shared within the construction parties, allowing the practitioners to draw, edit and view construction drawings virtually and easy-printable version available after consensus forms between design team. Such effort improves one single truth of information and enhances site coordination (F. Rahmani et al., 2016). By maintaining the consistency of the information, potentially the practice will reduce the site coordination error, thus increase the collaboration relationship between construction parties (P. Coates et al., 2016).

In relation to technological implementation within construction organization or any other industry, the purpose of digitalizing is to smoothen the workflow, and allowing the process to flow in a more cost-efficient manner (D. R. Lombardi et al., 2014). Digitalization of business process are often customized, and the elements of digitalization should suit the business' core value and core issue (J. Gantz & D. Reinsel, 2013). In construction industry, the process of traditional documentation and verification of project completion are conducted manually, in labour intensive manner. Many tools of computing devices, software and databases, such as enterprise system, drawing software were used to improve construction performance digitally (A. Güney, 2014). Construction productivity and quality had increased through the help of technology implementation in collaborative measurements (D. R. Lombardi et al., 2014).

Quoting manufacturing's industry 4.0 from the advancement of technology, the construction industry 4.0 can be realized too. One technology particularly, blockchain relies on the concept of distrusts between all the users in the network to create trusts between each of the users (M. Dobrovnik et al., 2018). The terminology use of blockchain is due to status quo on existence of distrust between all construction parties. Distrust is the most common relationship, or the missing link in construction industry (D. R. Lombardi et al., 2014). Blockchain in overall provide a sustainable trust environment which allows the technology itself to act as trust governor, without relying traditional labour-intensive administration (M. Dobrovnik et al., 2018). The idea of blockchain in construction is due to the potential to act as a trust governance technology over a project lifecycle (V. Gatteschi et al., 2018). The blockchain can either administrate project financing, subcontract works, project scheduling, or even building performances (M. Dobrovnik et al., 2018). Blockchain has the potential as an IT governance tool for construction project with its ability of immutable auditing trail and

consensus-based model. However, there are yet exploration of Blockchain application towards solving construction issue in Malaysia industry.

To further discuss, it is important to understand what the current technological issues faced by construction industry as well as to review the current blockchain infrastructure on the ability to fill in the gaps.

LITERATURE REVIEW

In construction collaborative environment, the word trust can be associated with many other keywords such as “procurement”, “communication”, “contracts”, “knowledge sharing” and “information sharing” (R. Soares, 2012). The trust concept in construction industry is shallow with tender contracting alone, as arbitration processes, guidelines and law were kept in check as alternative to contracts when dispute arises (R. Soares, 2012). R. Soares (2012), identified that trust is one of the missing links in contributing to success in construction. Distrust is a norm within the industry and often solved with negotiation and administration (D. R. Lombardi et al., 2014).

Construction process requires the collaboration between construction parties and exchange information through systematic channel (K. C. Goh et al., 2014). The most basic construction collaboration is the exchange of 2D drawings and documents between construction parties in a certain project (K. C. Goh et al., 2014). Building Information Modelling (BIM) is one of the collaboration tools examples to replace traditional collaboration exchange (N. Bui et al., 2016). The role and effectiveness of communication has the ability to determine the outcome of the project quality (N. Bui et al., 2016). Collaboration also means communication and info exchange in order to carry out a certain trade (R. Soares, 2012).

The virtue of communication in construction is related to the ability to visualize, understand, evaluate and coordinate onto the subjects (K. C. Goh et al., 2014). Client, consultant, and contractor communicate with each other and share the same 2D construction drawing. For instance, all users in the BIM is able to access real-time changes on the drawing, and the visualization is more real world compared with AutoCAD (N. Bui et al., 2016). All the parties will understand the final construction visualization with the drawing, understand how the construction phases and material works, and able discuss to effectively do site coordination, collaborate in order to expedite the project.

The basis of construction communication is also subjected to procurement method and contracts. The procurement method of a project will predetermine how the relationship between client, main contractor and consultants work together (R. Soares, 2012). The contract will outline the conditions firstly based on procurement method, secondly based on negotiation terms between contractual parties. In Malaysia construction industry, the standard form of contracts used were PAM, CIDB, and JKR projects depending on the nature of development. The context of the contracts different from one another. Standard forms of contract purpose are for standardization, uniformity, stability and well-established terms that allows predictability and greater certainty in legal relation (R. Sebastian, 2013). The contract thus forms collaboration through legal relationship between construction parties.

Common practices are construction participants make modification of the contracts for various purposes, mainly to favour their own benefits (R. Sebastian, 2013). However, modification of standard forms of contract could potentially increase the complexity of the construction as the clauses becomes harder to be interpreted and lack of clarity in certain subjects or sub-trade (R. Rameezdeen and A. Rodrigo, 2014). Most of the activities of modification of the standard form of contracts is to omit inapplicable clauses, include additional obligation for quality control, and to delegate risks (V. Rastogi, 2015). Another legal related collaboration is the document control throughout a project lifecycle. Document control can mean by minutes of meeting, issuance of memo, request for information (RFI) which outlined by client to perform paper-work trail for the governance of project deliverables such as quality, time, and cost (R. Rameezdeen and A. Rodrigo, 2014).

CONSTRUCTION INDUSTRY COLLABORATION ISSUES

In collaboration relationship, it is also important to understand how construction supply chain line flows. The initiator and the service providers play the main role in most of the project, namely the client or owner and the contractor (Y. Hong & D. W. M. Chan, 2014). The roles and nature of the project would decide the very challenges in the construction supply chain. Different parties combined together in a single construction project to contribute success (R. Rameezdeen and A. Rodrigo, 2014). Collaboration relationship also can be defined as joint effort in construction industry (D. R. Lombardi et al., 2014). According to Y. Hong & D. W. M. Chan (2014), stated that joint effort has many disciplines in construction which includes financing, design, construction, consultation, and other sub-trades. Often many traditional construction practices can affect the major outcome of a project from three elements, which is the time, cost and quality of the project. The lack of construction collaboration could cause issues right from the start of the project, to construction stage or even post construction stage. Traditional procurement method requires labour-intensive administration, particularly in works such as verifying the work done (M. Dobrovnik et al., 2018).

Some of the issue associated in post construction stage are incomplete documentation and audit (M. Donato et al., 2015). Often the contractors will not able to justify variation order and final account without proper documentation, exposing contractor subjected to budget-risk concern (A. H. Memon et al., 2014). Contractor may need to cost in the losses from subcontractor bad practices as well, such as lack of proper site management and waste of material. The governance of subcontractor including payment, documentation is another domain which needed to be discussed extensively, as client has no authority of governance over those subcontractors. This is due to the straight-line supply chain relationship in the construction for the subcontractor case as illustrated in the diagram below.

In construction collaboration, the traditional practices often lead to construction communication issue which results in collaboration issue, causing serious cases such as arbitration and litigation cases (M. Donato et al., 2015). If the control of drawings, contracts and document were not done properly, potential collaboration issue may occur. The collaboration issue could range from minor incident such as incomplete document and auditing trail to major incident of cost overrun (K. C. Goh et al., 2014). Take a scenario where contractor may find out site issue which will affect the changes of the design. By normal practice, contractor should counter-propose the site issue with new drawings and be verified

by third party consultant in place of client, and since the variation is initiated due to site issue, the contractor will be entitled for claim. Instead real case study shows that contractor is subjected to budget-risk when initiating variation order (A. H. Memon et al., 2014). Client can exercise his rights or be abusive depending on the terms outlined in the contract, rendering the contractors' variation claim in this case. This thus causes dilemma between variation in design versus initiating variation order (A. H. Memon et al., 2014).

All of which the above and many other issues can result in potential serious arbitration cases (M. Donato et al., 2015). The main factor which increases such complexity and issues may due to many reasons including the compatibility of the resources, technology, contractor's background, culture, and relationship between construction parties (D. R. Lombardi et al., 2014). As highlighted earlier although collaboration effort such as BIM technology and D&B procurement were introduced, construction industry still subjected to mentioned issue most of the time. Below summarizes the identified construction collaboration related issue:

- Traceability - Incomplete documentation and audit trail
- Compliance – Subcontractor may not subject to full compliance of the tender contract and affects indirectly the collaboration relationship of contractor and client; being not visible in contractual relationship
- Flexibility – Both traditional procurement and alternative procurements such as D&B still has its own limitation
- Stakeholder relationship – Contractor still subjected more to risks in cases like variation order

TECHNOLOGICAL ADOPTION ISSUE IN CONSTRUCTION INDUSTRY

Dispute in collaborative relationship eventually affects the quality assurance of the project. The combination of good management practice with good IT governance ensures a project's quality (D. R. Lombardi et al., 2014). For instance, Malaysian Administrative Modernisation and Management Planning Unit (MAMPU) shows positive result from IT governance and investment within government agencies (F. Veerankutty et al., 2018). IT governance benefits the quality assurance of a project by solving repetitive tasks and simplifying the human's involvement in a business process (F. Veerankutty et al., 2018). Although IT in general changes the way business carries around in between five to eight years, yet there is phenomenon where managers are obsolete in adapting towards such technological changes (F. Veerankutty et al., 2018).

The adoption of technology in construction industry has substantially lagged behind the development and utilization by management decision (A. Rojko, 2017). Technology investment, whether software or hardware is controversial in construction industry due to many unclear investment payoff consideration (A. Rojko, 2017). However aside from that, the construction industry also may not have the awareness and drive to invest technology as compared to other industry, due to its complexity and cost-driven nature (V. Rastogi, 2015). The other challenge is on how much training needed before the user able to use the app effectively. The effectiveness of an app relies on the customization of the developer, which will affect the apps' performance, compatibility and effectiveness (V. Rastogi, 2015). The

consideration is the development of that certain app has to be as simple as possible, more user friendly in order to reduce training and maintenance cost.

Another challenge is the generalization of the app, where the app has to be able to have a suitable format to obtain accurate data in a usable format following a repeatable process (V. Rastogi, 2015). Generalization of app may be as simple as the format of data entry, the use of industry jargons and language. The main purpose is to allow the process of recall management to spend less time in crunching the data, carrying out auditing process more efficiently (M. Dobrovnik et al., 2018). By having the suitable format, it will form a more user-friendly feature which allows cost saving from traditional labour-intensive processes such as data cleaning and perform audit. Also, the consideration is without having user-friendly software, the cost-time investment for the software may not be sensible, as policy makers of the construction industry does not require the adoption of such technology (A. Rojko, 2017). The principle of thinking here should not be limited to the importance of policy makers to obligate the use of technology, but rather discuss on the limitation of technologies to close the technology adoption gap for construction industry.

Whereas other concern is the security versus accessibility of the data itself. The security of the data, particularly the drawing requires intellectual property control. The consideration of using technology often associated with how secure the intellectual property can be protected (M. E. Peck, 2017). A proper traditional way of keeping documents may even produce better result of intellectual property as compared to digital solution. The contradict situation of accessibility and security of digital data incurs possible high cost for business owner, which is also true for construction industry (M. E. Peck, 2017). In the scenario where security of technology fails, customer may loss trust, litigation issue may arise, court martial may be a daily routine, and essentially the efforts which had been made for a project will gone down to waste (M. Dobrovnik et al., 2018). Below shows the summary of challenges in adopting new technology in construction industry:

- Construction industry complex in nature and distrusts surfaces all the time
- May not have the awareness and drive to invest technology compared to other industry
- Managements' decision
- Consideration of generalization of the application – to reduce cost of auditing trail
- Possible high cost of maintaining data security

BLOCKCHAIN APPLICATION IN OTHER INDUSTRIES

Although there was not clear evidence on the application of blockchain in construction industry, in other sectors can be seen for the effective application. The blockchain technology act as an enabler to improve the industry's practices respectively (University of Malaya, 2018). Below outline the several applications of blockchain use case across different industries.

Table 1. Blockchain application use case

Sector	Enabler	Use Cases
Financial Services and Commerce	<p>Creation of peer to peer economy and elimination of intermediaries.</p> <p>Ability to Decentralize the market thus lower overall transaction cost</p>	<ol style="list-style-type: none"> 1. Corda - digital ledger platform for recording management and synchronization of financial agreements between regulated financial institutions. 2. OpenBazaar – free E-commerce; no listing fee, no intermediaries fee for goods sales.
Supply Chain Management	<p>Decentralized recordkeeping with all entities in the chain validating the transactions and traceable transaction records.</p>	<ol style="list-style-type: none"> 1. Energy sector – LO3 Energy company microgrid ecosystem using blockchain that connects prosumer and consumer energy assets. 2. Healthcare sector – In US. five health care organizations pilot test applying blockchain to improve health care provider demographic data.
Government Services	<p>A more efficient, transparent and accountable government system.</p>	<p>Dubai – Smart Dubai initiative to shift 100% of government transactions to blockchain networks by 2020.</p> <p>Estonia – I-Voting system since 2017</p>

(source from: University of Malaya, 2018)

Taking an instant outlook on blockchain application in insurance industry, relevant strength, weakness, opportunity, threat (SWOT) analysis content from scholar (V. Gatteschi et al., 2018), into terminology of construction application. As presented in the table of SWOT analysis on adoption of blockchain, the weakness and threat of the blockchain are mostly associated to the nascent stage of blockchain technology, as the technology application itself is still fairly new across global. This is supported by a regulatory research report from Malaysia (University of Malaya, 2018).

Table 2. Blockchain SWOT analysis (adopted from: V. Gatteschi et al., 2018)

	Positive	Negative
Internal	<p><u>Strength</u></p> <p>Fast and low-cost money transfers</p> <p>No need for intermediaries</p> <p>Automation (by means of smart contracts)</p> <p>Accessible worldwide</p> <p>Transparency</p> <p>Platform for data analytics</p> <p>No data loss/modification/falsification</p> <p>Non-repudiation</p>	<p><u>Weakness</u></p> <p>Scalability</p> <p>Low performance</p> <p>Energy consumption</p> <p>Reduced users' privacy</p> <p>Autonomous code is "candy for hackers"</p> <p>Need to rely to external oracles</p> <p>No intermediary to contact in case of loss of users' credentials</p> <p>Volatility of cryptocurrencies</p> <p>Requires mastering technical skills like programming and blockchain concepts</p>
External	<p><u>Opportunities</u></p> <p>Competitive advantage (where reduction of backend blockchain complicity)</p> <p>Possibility to address new markets</p> <p>Availability of a huge amount of heterogeneous data, pushed in the blockchain by different actors</p>	<p><u>Threats</u></p> <p>Could be perceived as unsecure/unreliable</p> <p>Low adoption from external actors means lack of information</p> <p>Governments could consider blockchain and smart contracts "dangerous"</p> <p>Medium-long term investment</p> <p>Not suitable for all existing processes</p> <p>Customers would still consider personal interaction important</p>

In addition, towards the review of blockchain application, SWOT analysis, another consideration that should be look upon whether to implement blockchain technology adoption is the regulation outset by the country. Regulation outset can have mainly three nature which is the economic regulation, social regulation and administration regulation, and also categorized into principle based or outcome based (University of Malaya, 2018). Certain outcome-based regulations like command and control regulation is ineffective at this stage, while many advance countries such as Japan and South Korea considering introducing self-regulation in blockchain for their country (University of Malaya, 2018).

RESEARCH METHODOLOGY

Blockchain system has solved several core issues including transparency, anonymous, consensus, real-time, and hard to tamper auditing trails provide the community a solid ecosystem which does not require intermediaries to govern the whole transaction processes between users (M. Dobrovnik et al., 2018). Conceptually construction industry faces the same issue of needing transparency of information, needing of consensus between parties to expedite on works, needing of real-time information sharing, and maintain good auditing trail for potential dispute settlement (V. Gatteschi et al., 2018). Within a collaborative relationship that based on contract, dispute may arise due to disagreement in information shared. Thus, the importance of maintaining one source of truth will be the solution to dispute in digitalizing business process truth (M. Dobrovnik et al., 2018). Blockchain in potential has the capability to do so with its immutable auditing trail (M. E. Peck, 2017). Using blockchain, one could reshape the supply chain of the industry from linear to dynamic relationship (Kehoe et al., 2017). One of the examples which has been practiced in US government, is as shown in the Figure 1.

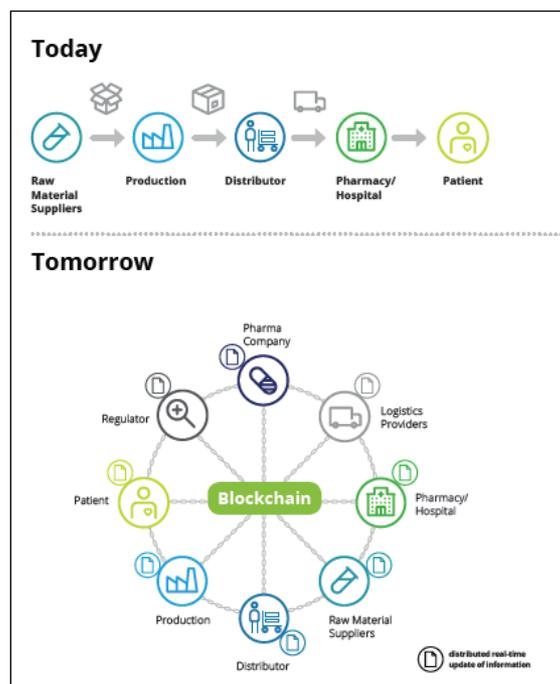


Figure 1. Review of Blockchain shaping new Supply Chain in Pharmaceutical Industry
(Source from: Kehoe et al., 2017)

As concluded by Kehoe et al. (2017), most of the supply chain in any industry faces problem of recall management, compliance, flexibility and stakeholder management. Similarly, to the identified problems, recall management is equals to the traceability of the data. The blockchain potential for solving supply chain pain points is shown in Figure 2.

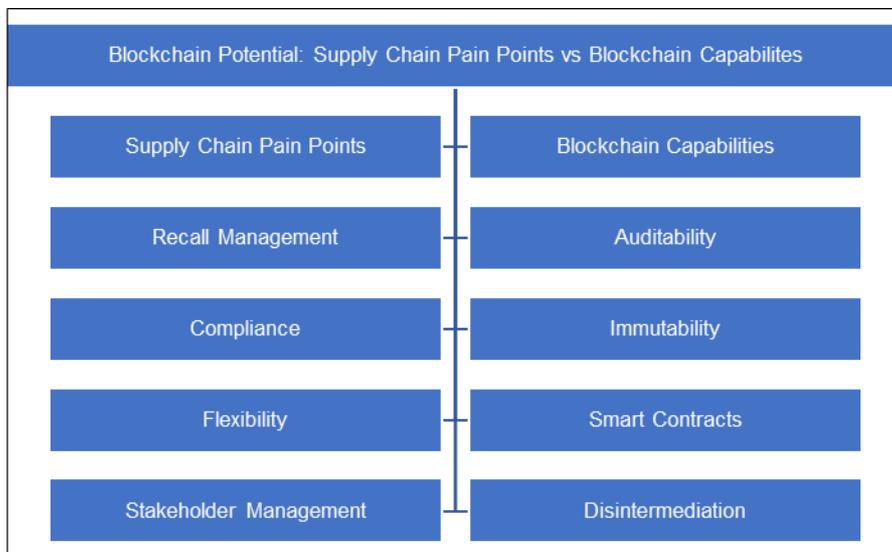


Figure 2. Supply Chain Pain Points versus Blockchain Capabilities
(Source from: Kehoe et al., 2017)

A. Maruchek et al. (2015), also highlights the importance of maintaining the traceability of the data, supplier relationships and proper regulations and compliances for the success of the data. Z. Wei and W. Xiang (2013), indicated that there is a need to address the importance of supply chain as to combine the dynamic supply chain processes, obtain efficiency, which relevant towards the corporate revenue.

RESULTS AND DISCUSSIONS

For the adoption of blockchain technology, the digitalization should allow provision to a certain degree of customization as each companies' business process are different (A. Güney, 2014). Collaboration issues between construction parties were discussed along with the potential of blockchain to be able to solve it. The identified collaboration issues are associated with several problems, traceability, compliance, flexibility and stakeholder management. It is expected that blockchain will have the ability to improve construction supply chain to incorporate a more dynamic structure to the overall supply chain in a project (L. Kehoe et al., 2017). The use case and SWOT analysis serve as an awareness for scholars and industry players for the potential of blockchain to be implemented into the construction industry.

In Malaysia, some key roles such as government initiative organization will push the blockchain technology adoption. For instance, The Malaysian Industry-Government Group for High Technology (MIGHT) is a newly formed task force to drive the initiative of driving blockchain technology into industries such as Islamic finance, renewable energy, and agriculture. Consideration of other collaboration of organization between government entities such as Construction Industry Development Board of Malaysia (CIDB), Malaysian Global

Innovation and Creative Centre (MaGIC), any other entities that practices blockchain, plays another supporting role to contribute towards blockchain technology adoption infrastructure in Malaysia construction industry.

CONCLUSION

Technology advancement will continue to impact the business processes, increase in productivity, more transparency, and lack of overhead cost (A. Güney, 2014). Construction industry's technology implementation has lagged behind years compared to manufacturing industry's technology implementation (A. Rojko, 2017). Such implication highlights the potential of moving upward the construction industry from current practices. Technology of automating repetitive human intensive work, potentially reducing human overhead cost, improve recall management in complex environment like construction industry (D. R. Lombardi et al., 2014).

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DESIGN FOR MANUFACTURING AND ASSEMBLY (DFMA) FOR MALAYSIA CONSTRUCTION INDUSTRY

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Abstract

Pakatan Harapan (PH) government pledged to work together with developers and state government to build one million affordable homes across Malaysia within two terms (2018–2027 years). According to Property Stock Report published by National Property Information Centre (NAPIC), for Q1 and Q2 in 2018, the industry completed 40,710 residential property. If the productivity of the industry maintains throughout the year, there will be a forecast of 81,420 of residential units completion in year 2018. With this rate, there is a deficit of 18,580 units to reach 100,000 houses a year. In the effort of reducing foreign workers, how the construction industry can catch up with the productivity at the same time maintained the cost and the quality of the construction of affordable houses? This paper review if Design for Assembly and Manufacturing (DfMA) is the answer to current condition. This paper also reviewed the current condition in term of productivity and capacity of the construction industry and the current economy condition, social expectation and housing affordability. Hence examine if DfMA is the answer to the question. The finding also proposes the optimal condition to optimize benefits of DfMA toward construction industry in Malaysia.

Keywords: *DfMA; Malaysia; Construction*

INTRODUCTION

The global construction industry is facing different challenges including cost increase, delay, environment & sustainable issues, health & safety issues. On top of those, Malaysia construction industry also facing challenges comprising high dependency on foreign workers, low technology adoption, sub-standard product, and supply demand imbalance issue.

On the other hand, Pakatan Harapan (PH) government pledged to work together with developers and state government to build one million affordable homes across Malaysia within two terms (2018–2027). Averagely, the construction industry needs to have the capacity to build 100,000 affordable house per year to realise this promise. Does the industry have the capacity to accomplish this target?

According to National Property Information Centre (NAPIC)'s Property Stock Report, the total number of residential units built in Q1 and Q2 in year 2018 is 40,710 units. If the productivity of the industry maintains throughout the year, there will be a forecast of 81,420 of residential units completion in year 2018. With this rate, there is a deficit of 18,580 units to reach 100,000 houses a year. Not mentioning the forecast of 81,420 consist all types of housing including detach, semi-detach, 2-3 storey terrace, town house, which is not categorised as affordable housing. With current conditions, can the construction industry catch up with the productivity at the same time maintains the cost and the quality of the construction of affordable houses?

Table 1. Completed Residential Property in Q1 and Q2 Year 2018 in Malaysia

Type	Total
Single Storey Terrace	5,350
2-3 Storey Terrace	11,204
Demi-Detach	4,397
Detach	1,002
Town House	904
Cluster	790
Low Cost House	1255
Low Cost Flat	152
Condominium	15,656
Total	40,710

CURRENT CONDITIONS AND LIMITATIONS

Construction industry in Malaysia has high dependency on foreign workers (Rajah, 2015). Partly because construction industry often relates to 3D: Dirty, Dangerous, Difficult, therefore not many young Malaysian willing to join the industry. Currently most of the construction sites hire foreign workers in which this has delay the technology engagement and development in the construction industry.

The productivity of the industry is affected (Abdul Kadir, 2015). The industry trapped as labour intensive industry instead of technology intensive, which relies on huge amount of foreign labour and may derive undesired social issues (Hamzah, 2012).

All construction projects need to strike a balance between time, cost and quality. The most desirable state is to improve time, cost and quality at the same time. What is the possible paradigm shift that improve time, cost, quality at the same time increase productivity but do not increase or even decrease the dependency towards foreign workers?

DESIGN FOR MANUFACTURING AND ASSEMBLE

In year 1960, some people started to use the term manufacturability. About year 1985, Design for Manufacturability (DfM) were widely used in the manufacturing industry. Design for Assembly (DfA) is practise of design product with assembly in mind. Combining DfM and DfA – Design for Manufacturing and Assembly (DfMA) is widely used design concept for manufacturing industry.

For construction industry, RIBA (2016) defines DfMA in construction as approach that facilitates greater off-site manufacturing and minimizing onsite construction. Following are levels of offsite DfMA categorised by RIBA: 1) component manufacture, 2) sub-assembly, 3) non-volumetric preassembly, 4) volumetric preassembly and 5) modular building.

In Singapore, Building and Construction Authority (BCA, 2018) defines DfMA as where construction is designed and detailed for a substantial portion of work to be done off-site in a controlled manufacturing environment. DfMA is a new approach that, by planning ore works offsite, manpower and time needed to construct buildings are reduced, while ensuring work sites are safe, conducive and have minimal impact on surrounding living environment. DfMA is promoted in Singapore construction industry as a way to improve productivity in a traditional manpower intensive industry.

Prefabricated Prefinished Volumetric Construction (PPVC) is one of the game-changing technologies that support the DfMA concept to significantly speed up construction. Complete modules made of multiple units complete with internal finishes, fixtures and fittings are manufactured in factories, and are then transported to site for installation in a Lego-like manner. In the hierarchy of DfMA methodologies, DFMA is one of the most efficient and complete principles in improving productivity. (BCA, 2018).

BENEFITS OF DFMA

Completed in 2017, the Crowne Plaza Changi Airport hotel extension is one of the success stories of PPVC. The onsite construction takes only 156 hours to complete the structure of 243 rooms. The hotel operates in 3 months times.

As stated in RIBA Plan of Work (2016), DfMA in construction can reduced up to 70% of labour onsite, with subsequent improvements in health and safety. DfMA also enable 20% – 40% construction cost reduction, at the same time providing higher construction quality.

The benefits were further confirmed by BCA's Design for Manufacturing and Assembly (2018), the benefits of DfMA recorded by Singapore are: i) productivity improvement, ii) reduction of on-site manpower, iii) better construction environment, iv) better quality control.

PARADIGM SHIFT FOR MALAYSIA?

DfMA adoption can transform the industry in term of time, cost and quality. It can meet the high standard of quality required. More importantly, without import more construction workers. This highly expanded the capacity of the industry without scarify the quality. DfMA is a construction method whereby flats or modules made up of multiple units complete with internal finishes, fixtures and fittings are manufactured in factories, and are then transported to work site for installation in a Lego-like manner.

Else than shorter construction period, higher quality, and lower cost if it hits the economy of scale, DfMA has many other advantages. As DfMA main activities are carried out in controlled environment, chances of accident significantly reduced and promotes a safe working environment. With minimal wet construction, the site will be tidy and clean. DfMA can convert construction activity into manufacturing activity. Hence, dust and noise pollution can be minimized as more activities are done off-site.

The productivity escalated, the requirement of labour shift from quantity to quality. The manpower needed are skilled and knowledge workers, in which workers can earn more than conventional construction industry and encourage Malaysian to work in safety enhance high worth career. So, it will reduce the dependency of foreign workers in Malaysia.

Construction cost reduced. Manufacturing of module in controlled environment will greatly reduce construction wastage. On the other hand, many costs in construction are related to the construction period, i.e.: machinery rental, labour, office rental and other overhead, finance cost, etc. DfMA highly reduce construction period that successfully reduce unnecessary variable cost during construction period. With manufacturing concept of DfMA, the cost per unit of house can be more stable as it relies on lesser variables and uncertainty.

DfMA adoption is a paradigm shift for industry. But what is the problem? Why Malaysia construction industry is not using it?

THE SECRET BEHIND THE TECHNOLOGY

DfMA is too good to be true. If there is such superior technology, why won't the industry adopt it earlier?

DfMA in construction need the following before assembly start onsite: factory land, factory building, storage yard, mould, mould modification tools, concrete mixing facility, high tonnage and special crane in factory, high tonnage and special crane on site, prefinished factory, installation technology. The initial capital is high. In order to achieve cost effective DfMA, economy of scale is also needed. A project should have high frequency of repeat module in order to dilute the initial cost for a mould and factory set up. If utilise in proper manner, a volumetric mould can be reuse at least one thousand time.

The chances of a contractor to invest in DfMA volumetric construction is low unless the contractor secure sufficient order to break even the initial investment. Anyway, once breakeven, the industry is going to enjoy the benefits of the paradigm shift. Government affordable housing is definitely an opportunity to initiate DfMA in Malaysia. The demand of affordable housing is 100,000 a year and 1,000,000 in ten years. Affordable housing can be designed in a few fixed structural designs and the cladding of the building can be different to add on aesthetic value. This definitely a golden opportunity for Malaysia to achieve the paradigm shift along the ambition to provide 1,000,000 affordable housing to Malaysian.

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