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ADOPTION OF BUILDING INFORMATION MODELLING (BIM): FACTORS CONTRIBUTION AND BENEFITS

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***Abstract:** Building Information Modelling (BIM) is a technological breakthrough that is needed to modernize the construction industry which will increase the productivity and value across many stakeholder groups. It provides significant benefits towards the industry players but seems that it is not fully implemented yet in the Malaysian construction industry. There are limited studies conducted that investigate the benefits of BIM adoption in general. Hence, this study intended to analyse the benefits of BIM adoption in the construction industry within the Northern region of Malaysia which are Perlis, Kedah, Penang and Perak. Quantitative method had been used for this study by distributing questionnaires to the contractor company of G4 to G7 in the Northern region of Malaysia. All data obtained from the questionnaire distributed were then analysed by using IBM SPSS tools such as descriptive analysis and correlation analysis. The findings from the result obtained revealed that the benefits of BIM are in accordance with the project management knowledge areas while success factors are project delivery time, project cost and project quality. This study mainly focused on project time, cost and quality as the benefits of BIM adoption in Northern region of Malaysia, which have not been studied in past researches.*

***Keywords**: Building Information Modelling (BIM), Contractors, Factors, Benefits*

Introduction

Building Information Modelling (BIM) may greatly affect the evolution of the construction industry as it is a globally rising phenomenon (Rogers, Chong and Preece, 2015). The adoption of BIM can make the construction industry more efficient, effective, flexible and innovative (Takim, Harris and Nawawi, 2013). Building Information Modelling (BIM) is a technological innovation that is needed to modernise construction which will increases the productivity and value across many stakeholder groups (Osman, Khuzzan and Sapian, 2015). Building Information Modelling (BIM) can be classified as a computer-aided modelling technology to manage the information of a construction project focusing on production, communication and analysis of building information models (Eastman, et al., 2008)

Many studies have investigated the factors that contribute to the adoption of Building Information Modelling (BIM) within organisations. Studies by (Osman, Khuzzan and Sapian, 2015), (Song, et a., 2016), and (Goswami and Dutta, 2016) stated that there are three factors that contribute to BIM adoption. These factors are based on Technology-Organisation-Environment (TOE) framework. It is stated that TOE are the main elements that affect firms' adoption of a new technology and is more widely used in terms of new technology adoption.

BIM can be considered as an effective and powerful tool in the project management in the Architectural-Engineering-Construction (AEC) industry (Rokooei, 2015). His research further stated that since the nature and role of each items are alike, abilities of BIM on construction projects are parallel to the Project Management Institute's (PMI) Project Management Body of Knowledge (PMBOK) Knowledge Areas such as project time, project cost and project quality. Benefits of BIM adoption can be derived by a list of success criteria related to the output of the project, such as time, cost and quality objectives (Bryde, Broquetas, and Volm, 2012).

The developing country which include Malaysia, the adoption of BIM is quite rare (Nam et al., 2016) Prior to year 2013, there are still very few researches on BIM adoption by construction players in developing countries such as Malaysia and the scope of the research limited to topic related to technology only (Nam et al., 2016) (Zahrizan, et al.,2013). Past studies are rarely investigating the inhibitors or motivators for BIM adoption (Osman, Khuzzan and Sapian, 2015). Besides that, lack of widespread uptake of BIM in Malaysia are closely related to the risks and challenges that are hindering its effectiveness, the few amounts of clear evidence on the benefits of BIM and its effectiveness to the construction industry appear to be one of the reasons why BIM is growing slowly (Ghaffarianhoseinia, et al., 2016). Thus, this study aims to explore the BIM adoption in construction industry. The objectives are to identify factors contribute to adoption of BIM and analyse the benefits of BIM adoption in construction industry.

Literature Review

Definition of Building Information Modelling (BIM)

Building Information Modelling (BIM) is a technological innovation that is needed to modernise construction which will increases the productivity and value across many stakeholder groups. BIM symbolises the development, utilisation and sharing of digital models between stakeholders during the lifecycle of a facility (Julian, et. al., 2015). Building Information Modelling (BIM) can be classified as a computer-aided modelling technology to manage the information of a construction project focusing on production, communication and analysis of building information models (BIM Handbook, 2008). BIM can also be defined as a dependable, digital, three-dimensional, virtual representation of a project to be built.

Building Information Modelling (BIM) is a concept which originated from Professor Charles Eastman at the Georgia Tech School of Architecture in late 1970 (Reddy, 2012). After BIM has been introduced, the BIM concept has developed into wide perspectives. There are relatively six perspectives of BIM concepts which are design, estimation, construction process, building life cycle, performance and technology (Aryani, Suzila, Narimah & Mohamad Syazli, 2013).

Application of BIM

Fernando & Haibo (2014) has identified several aspects and contributions which also known as applications of Building Information Modelling (BIM). BIM helps in enabling coordination and clash detection of a construction project, able to design information between disciplines, have better drawing production as it provides more accurate data, and lastly have single source of truth using Common Data Environment (CDE). Applications of BIM differ through wide scope of works. The application of BIM can be seen in design visualisation, site planning and site utilisation, scheduling and sequencing, cost estimating, systems coordination, layout and fieldwork, and operations and maintenance (Matthew, et. al., 2013). Based on Dongping et al. (2014), most commonly BIM application are on clash detection in the construction stage and 3D presentation for design stage followed by construction system design, design coordination, design option analysis, site analysis, and site resource management. It can be said that the application of BIM in most areas is still limited.

Factors Contribute to Adoption of BIM

Many studies have investigated the factors that contribute to the adoption of Building Information Modelling (BIM) within organisations. Past researches show that BIM adoption were enhanced by various factors and tools. Julian et al. (2015) stated that most past researches were either exploring the benefits, drivers, barriers, or uses of BIM adoption. According to Zakaria et al. (2013) the concept of BIM adoption mainly focused on general factors such as organisation culture, people, technology, and government recognition. Meanwhile, Wallace, Godwin, Kherun & Yusuf (2014) stated that factors that contribute to BIM adoption are generally people, process, technology, strategic Information Technology (IT) planning, and collaborative process.

The research was mainly focus on IT aspects which was adapted from previous literature review. Mainly, there are three factors that contribute to BIM adoption. The significant factors that contribute to BIM adoption are technological, organizational, and environmental. This factor is based on Technology-Organisation-Environment (TOE) framework. It is stated that TOE are the main elements that affect firms' adoption of a new technology and is more widely used in terms of new technology adoption (Julian, et. al., 2015; Jiule, Guangbin, Zhenwei & Hanchao, 2016; Ahuja, Jain, Sawhney & Arif, 2016; Rehema, Charles & Carol, 2017).

Technology Factor

According to Zakaria et al. (2013), selection of hardware, software and infrastructure are important for technology aspect as to adopt a new technology in an organisation. Meanwhile, according to Wallace et al. (2014), human interaction with a new technology influence the rate of implementation of a certain new technology by an organization. Based on Julian et al. (2015), technology factor refers to the internal and external technologies which are relevant and are currently in-use within an organisation as well as those available in the market. It is further stated that the current in-use technologies may affect the technological change to be taken by an organisation.

Besides that, based on Jiule et al. (2016), there are five features of technology factor which are comparative advantage, compatibility, complexity, testability, and observability. Basically, those are the five major factors in technology that influence a new technology adoption in an organisation. The research further explains those five major factors. Comparative advantage can be defined as the ability of an organisation to produce a particular service at a lower opportunity cost than another organisation. Compatibility can be defined as the consistency between the innovative technology and the organizations' existing experiences. Complexity refers to the barrier for technology adoption while testability is the experimental practice of new technology in a limited range. Lastly, observability is the results of a new technology where it can be more clearly to be observed or measured.

Organization Factor

Based on Zakaria et al. (2013) research, it is stated that context that lies under organisation culture are awareness programmes, trainings and education strategies. Government support consist of standards availability and guideline enforcement. Julian et al. (2015) stated that organisation factor describes the characteristics and resources of the organisation which includes networking structures between employees, intra-firm communication processes, firm size, and the amount of slack resources. Organisation factor can be described by various features such as top management support, organisation structure, organisation's readiness, perceived risks, and training.

In contrast, Jiule et al. (2016) stated that organisational factor is important to be considered as one of the factors that affect the BIM adoption behaviour of an organisation as there is a large amount of Architectural-Engineering-Construction (AEC) industry available. Organisation factor involves features such enterprise scale, IT ability, top management support, and organisational motivation. As for enterprise scale, an enterprise with large scale is easier to adopt a new technology. Enterprise scale is the reflection or an organisation. As for IT ability of an organisation, technology adoption may be constrained if the IT condition of an organisation is poor. Top management support is important in adopting new technology such as providing training, practice and skilled person to increase perceptions of the technology is easier to use. It is stated that top management support will increase persons' support of a new technology usefulness. Organizational motivations can be divided into two categories which are intrinsic motivation and extrinsic motivation. Basically, organisation motivations are the most important factor that affect BIM adoption in AEC industry.

Environmental Factor

According to Julian et al. (2015), environmental factor defines the settings where an organisation conducts their businesses which are the structure of the industry, the presence or absence of technology service providers, and the regulatory environment. It is also stated that the environment factor involves the industry such as its competitors or its dealings within the organisation. Meanwhile, Jiule et al. (2016) stated that, environment factors feature that affect the BIM adoption are competitive pressure, external support and adopters' effect. From the research, competitive pressure can be defined as the degree of pressure feels from industry. As there is an increase in competition between organisations, an organisation should take more effective technology to improve its core competitiveness in the AEC industry. External support is mainly from software suppliers, consulting company, scientific research institutions and government and external support is one of the important factors that brings to the BIM adoption. As for adopters' effect, an organisation which adopt BIM might affect other organisation such as material suppliers and design institute.

Benefits of BIM

Building Information Modelling (BIM) gives many benefits in construction projects and its implementation can increase the quality of projects as it is useful in assisting construction players to construct small or high-risk projects successfully (Aryani, et. al., 2013). Aryani et al. (2013) also states that, there are five main benefits of using BIM. The benefits of using BIM can be seen in design, budget, communication, documentation, and scheduling. Meanwhile, according to Ali et al. (2016), the strong current benefits of using BIM can be seen from technical aspect, knowledge management, standardisation aspect, diversity management, integration aspect, economic aspect, planning and scheduling, and decision support aspect. According to Syed, Nasir, Muhd Fadhil & Noor Amila (2014), BIM adoption can be beneficial to three categories of AEC main stakes holders which are project owners, project designers, and contractors and sub-contractors.

Saeed (2015) stated that BIM can be considered as an effective and powerful tool in the project management in the Architectural-Engineering-Construction (AEC) industry. Since the nature and role of each items are alike, abilities of BIM on construction projects parallel to the Project Management Institute's (PMI) Project Management Body of Knowledge (PMBOK) Knowledge Areas (PMI, 2008) such as project time, project cost and project quality**.** David et al. (2012) also stated that benefits of BIM adoption can be derived by a list of success criteria related to the output of the project, such as time, cost and quality objectives. Abdulsame et al. (2014) also stated that success criteria which were time, cost and quality was created based from the Integration Management PMBOK Knowledge Areas.

Project Time

According to PMI (2008), project time management is the processes that are required to ensure the timely completion of the project. Hadzaman, Takim & Nawawi (2015) stated that time is one of the major criteria of project success by the clients, contractors, and consultants. Project time should include schedule development and schedule control which derived from PMI (2008). Schedule development involves analysing activity sequences, resources, and requirements to create the schedules of the project. Schedule control involves controlling the project schedule if there is any changes occur. Based on David, Marti & Jurgen (2012), the benefits of BIM towards time is that it provides time savings in project construction. Meanwhile, Aryani et al. (2013) stated that the benefits of BIM towards time management is that it helps in scheduling aspect as the rapidity of designing can be increased when using the database provided by BIM where less communication with engineers is required. Hadzaman et al. (2015) stated that, the benefits of BIM adoption towards project time is that it helps in improving design reviews, faster and effective process, impact of clash detection and better collaboration. The adoption of BIM in helps early picking up of potential clashes between different trades or disciplines in the design phase in a project (Kym & Nicholas, 2012).

Project Cost

Based on PMI (2008), project cost management is the process that is required in order to ensure the project is completed within the agreed budget. According to Hadzaman et al. (2015), clients commonly are concerned with the overall profits and accountability of the project. Nevertheless, through an organised project cost management, the expenditures of cost on the projects will be reduced.By referring to the PMI (2008), project cost management should include cost estimation, cost budget and cost control. David et al. (2015) stated that BIM adoption gives benefits to cost as it helps in cost reduction and cost control.

The uses of BIM are often giving a positive effect towards cost. Meanwhile, Hadzaman et al. (2015) stated that due to the ability of BIM in coordination that would reduce conflicts between stakeholders, project cost saving is substantially high at the early stage of a project such as design phase. BIM also helps in reducing the errors in take-off estimation and visualisation of the project which usually involve highest cost in a project. Adoption of BIM also allows the decreases in cost of utility demand and demolition and gives better tracking of cost control and cash flow (M M Mering, et. al., 2017).

Project Quality

By referring to PMI (2008), project quality management involved the processes that are required in order to ensure the project fulfil the needs for which it was undertaken. Project quality management involved the quality planning, quality assurance and quality control. However, according to Hadzaman et al. (2015), quality is a vague term as it can be understood differently by different people.

Hadzaman et al. (2015) also stated that the benefits of BIM adoption towards the project quality is that it helps in providing future building visualization in terms of performance quality. Meanwhile, David et al. (2015) stated that the benefits of BIM towards project quality came from design and documentation quality aspects. It is said that BIM adoption gives more accurate design and provides higher quality of deliverables. The benefits of BIM adoption towards project quality also can be seen in the terms of sustainability of the construction and operation of a building (David, et. al., 2015). According to Saeed (2015), in terms of quality, BIM helps synchronising the design and construction planning, detects any design errors, and implement construction techniques in the construction stage of a project. It is also stated that the main advantage of BIM in pre-construction phase is the increased in building performance and quality. Besides that, BIM provides benefits towards the architects as it removes manual checking work and it enhances quick decision-making and execution on many project stages (Lancine. Guoping & Changsheng, 2016).

From these past studies, the research framework which is the independent variables are developed based on TOE framework which have been used by most past researches. An often-used theory which is TOE theory that proved its firmness across multiple areas at an organisational level is used as the basis of this research. Meanwhile, the research framework which is the dependent variables is developed based on PMBOK Knowledge Areas which is also the success criterion such as project time, cost and quality. The success criteria were grouped based on the PMBOK Knowledge Areas as to provide framework to aid data analysis and presentation of the results. PMBOK Knowledge Areas were chosen as they provide a wide-ranging high-level framework covering all the scopes of success.

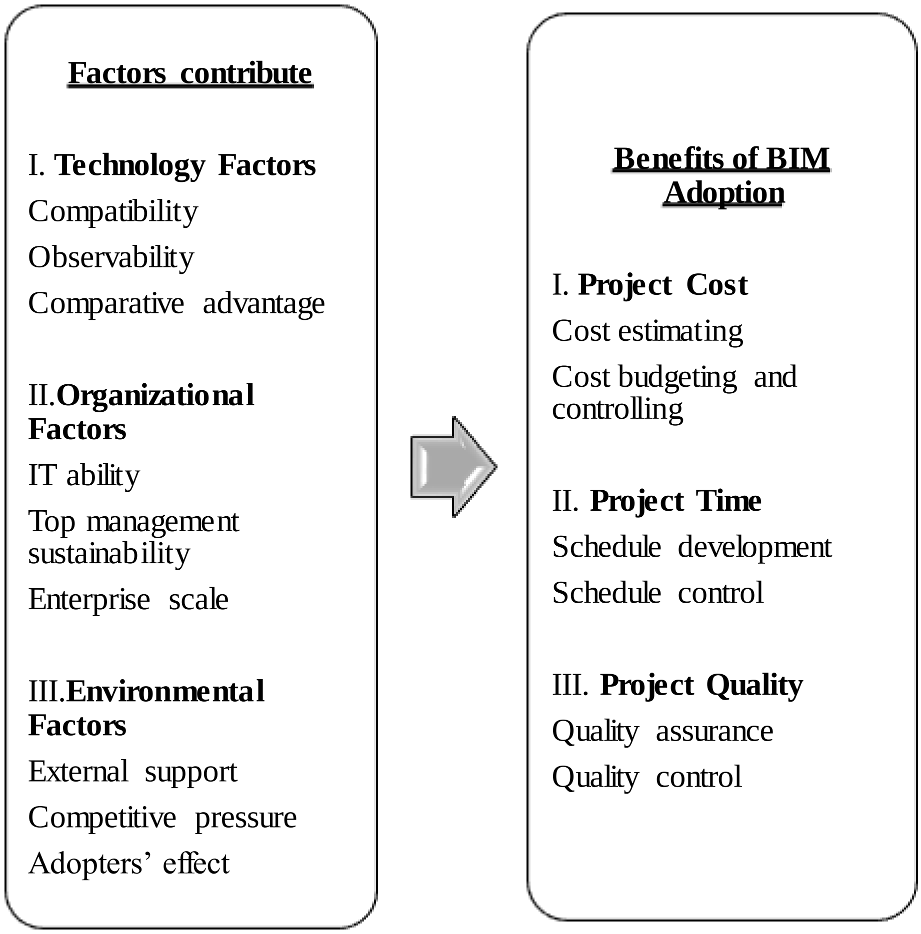

Figure 1: Conceptual Framework

Methodology

Research Design

In order to achieve the objectives of this study, descriptive method was used and the data were collected by using quantitative research to obtain relevant information of aspects studied. Quantitative research used in this research was questionnaire survey where it was distributed to contractors from G4 to G7 in Northern region of Malaysia which are Perlis, Kedah, Pulau Pinang and Perak that constitute a total of 345 questionnaires. The questionnaires were administered personally and electronically distributed. To obtain the samples required, probability sampling was used. In addition, this research also used cluster sampling as one of the methods. Then, stratified random sampling was used in calculating the amount of questionnaire that need to be distributed for each grade of contractors. Lastly, from the list of data obtained from CIDB, the contractors from grade G4 to grade G7, are randomly chosen by drawing two random numbers from two boxes to form a set of number, until a total of 345 company were picked. Out of 345 questionnaires distributed, a total of 68 questionnaires were received back representing a response rate of 20%. The data collected analysed by using IBM Statistical Package for the Social Science (SPSS) method.

Research Instrument

The questionnaire was construct based on five-point Likert scale and restructured from previous researches. The questionnaire was designed based on the framework developed which was based on the success factors and PMBOK Knowledge Areas. The questionnaire was then undergoing validity and reliability tests to ensure that it was valid and reliable before distribution.

Results and Discussion

Demographic Profile

Table 1: Demographic Profile

Demographic Profile	Frequency	Percent
Age		
18-27	45	66.2
28-37	23	33.8
Gender		
Male	33	48.5
Female	35	51.5
Education level		
Master	33	48.5
Degree	21	30.9
Diploma	14	20.6
Experience with BIM		
No experience	50	73.5
1-2 years	14	20.6
3-5 years	4	5.9

Based on Table 1, out of 68 respondents, 45 respondents are age range between 18-27 years old with percentage of 66.18%, majority of the respondents were from Perak followed by Pulau Pinang, Kedah and Perlis with percentage of 44.12%, 22.06%, 19.12% and 14.71% respectively. Among the 68 respondents, 33 respondents have Master level with 48.53%, 21 respondents with 30.88% have Degree level and 14 respondents with 20.59% have Diploma level. In addition, majority of the respondents are from G4 company, with a total of 38 respondents (55.88%). More than half of the respondent are Project Executive/Site Engineer/Project Coordinator, with 60 respondents (88.2%), followed by Project Manager/Assistant Project Manager and Managing Director/CEO/Chairman/COO with 7 respondents (10.29%) and 1 respondent (1.47%) respectively. All of the respondents answered that they know what BIM is and, 14 respondents have experience with BIM for 1 to 2 years with 20.6% and 4 respondents have experience on BIM for 3 to 5 years with 5.9% and more than half have no experience with BIM.

Analysis on Factors Contribute to Adoption of BIM

Table 2: Technology Factors

	Mean
The consistency between innovative technology with the organization's experience	3.3235
Consistency between innovative technologies with existing technology.	3.3824
Consistency between work flow with innovative technology	3.2647
The ability of BIM in visualization	3.6471
The ability of BIM in clash detection	3.4265
The observability of BIM to organization top management	3.3971
Better visualization compares to traditional CAD technology	3.7500
Better schedule estimation than traditional CAD technology	3.6618
Better clash detection than traditional CAD technology	3.4265

The data in the Table 2 represents the technology features that contribute to adoption of Building Information Modelling (BIM). Based on the data, it is shown that the most contributing features under technology factor are "better visualization compare to traditional CAD technology", "better schedule estimation than traditional CAD", and "the ability of BIM in visualization" with mean value of 3.7500, 3.6618 and 3.6471 respectively. By referring to Grashiela, Evelyn, Conrado & Jake (2016), a mean scale is used to identify the description of each item: 1.0 – 1.49 (Not at all/NA), 1.5 – 2.49 (Very little/VL), 2.5 – 3.49 (Little/L), 3.5 – 4.49 (Much/M), and 4.5 – 5.00 (Very Much/VM).

Both better visualisation and schedule estimation compare to traditional CAD technology constructs fall into the comparative advantage features. With respect to the comparative advantage of BIM, majority of the respondents seemed to acknowledge that BIM gives better visualisation and schedule estimation. For the third most contributing factor to adoption of BIM which is the ability of BIM in visualisation, it lies under the observability feature. By referring back to the mean scale, all of the three items contributed "much" to the BIM adoption. According to Michael et al. (2017), the study stated that Malaysian construction industry are mostly using BIM in the design phase. By relating it back to the results obtained from this study, the three highest contributing technology factors lies in the design phase. Schedule estimation is one of the features of BIM which enable the project manager to visualise a project in time and will have more clear understanding on the project phases. The ability of BIM on visualisation especially on cost and time estimation help facilitating the decision-making process with minimum cost and time. These abilities of BIM stated all lies in the design phase of a construction project. In summary, the three highest technology factors that contribute to the adoption of BIM are better visualisation and schedule estimation than traditional CAD, and the ability of BIM in visualisation. These three features are included in the design phase where BIM is mostly used within Malaysian construction industry and is identified as "much' contributing to the adoption of BIM in the construction industry.

Table 3: Organisation Factors

	Mean
Enterprise scale reflects many elements of organization	3.5147
The competence and capacity of an organization	3.5735
The capability of financial resources	3.7353
Experience in BIM technology	3.5882
Training and practice on BIM technology	3.6618
The competency of technical resources	3.4559
Top management support	3.5000
Right environment for BIM application	3.2647
Top management's interest on BIM	3.5000

Table 3 shows the organisation factor that contribute to BIM adoption. According to the result, it is determined that the most contributing factors under organization factor are "the capability of financial resources", "training and practice on BIM technology", and "experience in BIM technology" with mean value of 3.7353, 3.6618 and 3.5882 respectively. The training and practice on BIM technology and experience in BIM technology constructs both are under Information Technology (IT) ability factors. Meanwhile, the capability of financial resources of an organisation construct is under the enterprise scale factors. By referring back to the mean scale stated, all of the three items contributed "much" to the BIM adoption. Lack of information technology application, experience and training might affect the rate of adoption of a technology. Zakaria et al. (2013) stated that training and practice is important for the success of adoption of BIM in an organisation. Training and practices on new technology should be provided in order to increase the client's or project manager's perception on that new technology. According to Juile et al. (2016), enterprise with larger scale is easier to adopt with new technology. By referring back to the result obtained, it can be said that enterprise scale contributes to BIM adoption. The resources of financial of an organisation should be capable to adopt a new technology. An organisation with larger scale of financial resources will be able to resist any risk that might happen when adopting a new technology. In summary, the three highest features in organisation factor that contribute to the adoption of BIM in construction industry are the capability of financial resources, training and practice on BIM technology, and experience in BIM technology. These features lie under IT ability and enterprise scale where both are important for the success of BIM adoption. Therefore, these three features are identified as "much" contributing to the adoption of BIM

Table 4: Environmental Factors

	Mean
Owners/sponsors requests	3.5441
External support from consulting company	3.4412
The desire to remain in business	3.3676
Design institute in AEC industry	3.3088
External support from software suppliers	3.2500
Competitive pressure	3.2500
Recognition as being innovators	3.1324
External support from scientific research institutions	2.9853
Material suppliers in AEC industry	2.9706

Table 4 represents the environmental factor that contribute to the BIM adoption. It is observed that the highest contributing factor under environmental are "owners/sponsors requests", "external support from consulting company", and "the desire to remain in businesses with mean value of 3.5441, 3.4412 and 3.3676 respectively. The highest contributing factor under environmental factors is owners/sponsors requests and this construct lies under adopters' effect features. Owners/sponsors plays the major role in requesting what type of technology he/she want to use for his/her project. Owners/sponsors also known as the clients, the one who are the most powerful and the one who gain more benefits (Agnese, Mladen & Mauro, 2014). Thus, the best person who would buy and promote BIM is the client due to his/her highest power in a project. Also, as stated from the mean scale, this item is "much" contributed to the BIM adoption. External support from consulting company is one of the most important environmental factors that contribute to BIM adoption and it is scaled that as "little" contribution to BIM adoption.

Consultant is important in the whole construction project by providing expert advices either giving new ideas or correcting certain mistakes. Thus, support from consulting company in using new technology in order to ensure a project is done according to requirement will influence the adoption of BIM. The third highest mean value of construct which was the desire to remain in business is under the competitive pressure factors and it is scaled as "little" contribution towards the BIM adoption. This shows that the respondents adopted BIM or to adopt BIM with a focus on improving their own competitive strength within the company and is not forced by other competitors or company (Liu, et. al., 2012). Hence, in the environmental factor, the respondents are to adopt or adopted BIM with intention to remain competitive in the market and are not caused by the pressure from other competitors. In summary, three most contributing environmental factors to the adoption of BIM in construction industry are owners/sponsors requests, external support from consulting company, and the desire to remain in business. These three features identified as "much" contributing factor to the adoption of BIM for owners/sponsors requests and "little" contribution as for external support from consulting company and desire to remain in business. All these features lie under adopter's effect, external support, and competitive pressure constructs

Analysis on Benefits of BIM Adoption

Table 5: Project Time

	Mean
More realistic start and finish dates of project activities	3.8971
Rapid consideration of many alternatives schedule.	3.9118
Helps determining the schedule changes in short amount of time.	3.8235
Helps managing the schedule changes when and as they occur thoroughly.	3.8529

Table 6: Project Cost

	Mean
Helps developing an approximation of cost of resources needed	3.9265
Helps identifying various costing alternatives.	3.9118
Helps ensuring that all appropriate changes are recorded accurately in the cost baseline.	3.8382
Helps managing the actual changes when and as they occur.	3.9853

Table 7: Project Quality

	Mean
Helps evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards.	3.8529
Helps to ensure that the quality-related activities are being performed effectively.	3.9853
Helps monitoring specific project results to determine if they comply with relevant quality standards.	3.8971
Helps controlling how the project perform in its efforts to manage scope, budget and schedule.	3.8382

The most beneficial features under project time are “BIM adoption allow for rapid consideration of many alternatives schedule”, and “BIM adoption gives more realistic start and finish dates of project activities” with mean value 3.9118 and 3.8971 respectively as shown in Table 5 above. Both items are scaled as “much” benefits of BIM adoption. The realisation of the respondents on the benefits of BIM towards project time proved that BIM is able to give an efficient and faster construction process. Meanwhile, the beneficial features of BIM adoption under project cost are “BIM adoption helps managing the actual changes when and as they occur”, and “BIM adoption helps developing an approximation of cost resources needed” with mean value of 3.9853 and 3.9265 respectively as illustrated in Table 6 above. Both items are classified as “much” benefits of BIM adoption. Adoption of BIM helps an organisation to achieve 3% of accuracy on cost estimation which will decrease the financial risks regarding the design, operation and construction process (Doumbouya., et, al,2016)

Items that give most benefits towards the project quality are “BIM adoption helps to ensure that the quality-related activities are being performed effectively”, and “BIM adoption helps monitoring specific project results to determine if they comply with relevant quality standards" with mean value of 3.9853 and 3.8971 as indicated in Table 7 above. Both items are scaled as "much" benefits of BIM adoption. BIM provides powerful tools in progress monitoring, which can be used to analyse construction performance, thus ensuring high quality product. Thus, this study identified that there are three significant benefits of BIM adoption which are project time, project cost, and project quality.

Correlation between Factors Contribute and the Benefits of BIM Adoption

Table 8: Correlation Between Factors Contribute and Benefits of BIM Adoption

		Technology	Organization	Environment	Benefits
Technology	Pearson Correlation	1	.285*	.427**	.337**
	Sig. (2-tailed)		.019	.000	.005
Organization	Pearson Correlation	.285*	1	.703**	.480**
	Sig. (2-tailed)	.019		.000	.000
Environmental	Pearson Correlation	.427**	.703**	1	.448**
	Sig. (2-tailed)	.000	.000		.000
Benefits	Pearson Correlation	.337**	.480**	.448**	1
	Sig. (2-tailed)	.005	.000	.000	

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 8 shows the correlation between factors contribute to adoption of Building Information Modelling (BIM) and the benefits of BIM adoption. Based on the data, there are positive relationship between technology factors and benefits of BIM with value of r = 0.337. According to Julie (2005), this value is positively medium which lies in range of 0.30 to 0.49. This proves that technology factor is closely related to the benefits of BIM adoption. From the hypothesis developed, it is proved that there is significant relationship between technological factor and the benefits of BIM adoption.

In addition, data are also showing that there is relationship between organization factor and the benefits of BIM adoption. The relationship between both variables are positively correlated with value of r =0.480. This value is positively medium in which it lies in the range of 0.30 to 0.49. This proves that organization factor is related to the benefits of BIM adoption. Thus, from the hypothesis developed, it is proved that there is significant relationship between organization factor and the benefits of BIM adoption. The data also show positive relationship to the variables of environmental factors and Benefits of BIM adoption with value of r = 0.448. Julie (2005) stated that, the value lies in the range of 0.30 to 0.49 indicated to have positively medium in correlation. Thus, it is proved that environmental factor is related to the benefits of BIM adoption. Hence, it can be said that technology factor, organisation factor, and environmental factor have significant relationship with the benefits of BIM adoption.

Table 9: Correlation Between Factor Contribute and The Benefits of BIM Adoption

		Factors	Benefits
Factors	Pearson Correlation	1	.523**
	Sig. (2-tailed)		.000
Benefits	Pearson Correlation	.523**	1
	Sig. (2-tailed)	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

The data in the Table 9 represents the correlation between factors contribute to adoption of BIM and the benefits of BIM adoption. From the results obtained, it shows that the factors contribute to the adoption of BIM is positively correlated with the benefits of BIM adoption with value r=0.523. Julie (2005) mentioned that the value which between in the range of 0.50 to 1.00 is considered as positively large of correlation. In summary, it is proved that there is positive relationship between factors contribute to adoption of BIM with the benefits of BIM adoption.

Conclusion

Hence, as to conclude the findings, benefits of BIM adoption can be determined based on PMBOK Knowledge Areas. The research provides an insight that the BIM adoption will improve project delivery time, provide cost competitiveness and ensure improvement in construction quality. This research proves that BIM adoption is a powerful process improvement that allow construction personnel to analyse project performances in ensuring project meeting their datelines. In addition, it helps to improve schedule estimation and thus, leading to the reduction of the process time. Any changes of cost that occur are updated in real-time and thus, helping in estimating cost of resources. Furthermore, the ability for BIM processes with the support of technology factor helps in quality improvement throughout construction period through aided visual models and the ability to do clash analysis in real time. The findings from this study will encourage industry professionals to be put into realisation on BIM as a knowledge management strategy for improving the delivery of sustainable building value.

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