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The Revolution of Quantity Surveying Profession in Building Information Modelling (BIM) Era: The Malaysian Perspective

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Abstract: Building Information Modelling (BIM) has becoming the current trend in the construction industry where quantity surveying serves as important discipline. Undeniably, BIM adoption has brought many advantages due to automation of multidimensional model platform that helps Quantity Surveyors (QS) to reduce arithmetic errors and removes many tedious tasks in conventional approach such as tendering and the production of bills of quantities (BQ). BIM will soon replace the traditional measurement done by QS if the Standard Method of Measurements (SMM) could be integrated in BIM. As a result, it is concerning that unemployment of quantity surveyors might be an issue if there is no revolution or adaptation of quantity surveying practices with the blossoming of BIM implementation in Malaysia. Hence, this research is carried out to determine the new skills needed by a quantity surveyor in order to keep pace with the implementation of BIM in Malaysia. Qualitative research method is used in this study in which semi-structured interview was carried out with 20 experienced QS that applies BIM technology in their practices. Data abstracted from the transcript of interviews was then coded though NVivo 12 Pro and analyzed by using content analysis method. At the end of the study, the findings revealed that the QS must attain IT skills and BIM software knowledge to align with BIM drive. It is thus recommended that thorough provisions of integrating traditional methods of quantifying and costing building projects with cutting edge technologies must be included in BIM standard to ensure that BIM can be adopted at its best in the profession with increase performance.

Keywords: Building Information Modelling (BIM), revolution, adaptation, quantity surveying, Malaysia

1. Introduction

Building Information Modelling (BIM) is a method of information sharing between different parties using information technology or a technique with the elements of technology, organization and management (Al-Ashmori et al., 2020; Wong & Gray, 2019). It is a set of digital tools that can be used to manage the construction projects effectively (Latiffi, Mohd, Kasim, & Fathi, 2013). It is also defined as a collaborative approach based on a variety of software solutions employed by the Architectural, Engineering and Construction (AEC) industry (Latiffi et al., 2013). Cho et al. (2011) described BIM as a collection of technology developments and processes that have altered the method of how a building or infrastructure is planned, designed, constructed, analyzed and managed. A more comprehensive definition is given byIsmail et al. (2018), in which BIM is defined as a modelling technology and a related set of processes for the production, communication and analysis of digital information for construction purposes.

BIM has potential to improve and enhance the planning process, design and execution of construction projects (Latiffi et al., 2013). BIM is utilized in pre-construction (design and planning), construction and post-construction (operations and maintenance) phases of the project. During the planning stage, BIM can be implemented in evaluating space and understanding the complexity of law, regulations and standards of land and space, hence saving time and providing the team more flexibility to produce the value-added tasks (Azhar, Khalfan, & Maqsood, 2012). In this

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phase, sophisticated 3D laser scanning equipment is used to scan the site to accurately determine the location of current facilities and then incorporate them into the BIM model. In addition to the extensive application of BIM in planning, the user could conduct a detailed quantity assessment to generate accurate figures and estimation which can be calculated directly from 3D models. The user may plan for site logistics and recognize possible on-site risks, thus aiding in the preparation of the safety plan. With the support of 4D and 5D models, project managers may benefit from the task monitoring, tracking and scheduling. During the post-construction phase, BIM is utilized to transfer data such as spaces, structures, and components into facilities management processes, keeping track of building assets, allowing scheduled maintenance and providing information about the building maintenance history.

BIM offers some advantages or benefits, including improved project execution speed, which saves time and cost, improved work reliability due to less mistakes, better cooperation between all parties participating in project development, and guarantees higher productivity and quality of work results. Via constant developments in technology, the building industry cannot ignore the improvements, but must follow them. Being the latest development in the building industry, BIM will help to enhance the construction process in so many aspects, for instance visualization and simulation, improved decision-making support, quick and precise monitoring and updates, improved and more effective collaboration, and many more. All these aspects meant to improve and secure the overall quality of the project, making local construction project to be more competent in international construction industry. Not only does BIM prioritize the planning level but it is also a robust system that encompasses the entire pre-implementation, implementation and post-construction stages of a project.

In 2007, the Director of Public Works Department (PWD) proposed the concept of introducing BIM in Malaysia (Latiffi et al., 2013). AEC industries began implementing BIM in construction projects by the mid-2000s (Azhar, Behringer, Sattineni, & Maqsood, 2012). The earliest BIM projects in Malaysia was reported by the Construction Research Institute of Malaysia (CREAM, 2016). The first initiative to include the implementation of BIM in Malaysia is the National Cancer Institute of Malaysia in Putrajaya, preceded by other projects under BIM Pilot program such as the Administration Complex of *Suruhanjaya Pencegah Rasuah Shah Alam* and Healthcare Centre Type 5 in Pahang (Raphael & Priyanka, 2014). BIM was implemented in these pilot projects for site planning, visualization, design concept evaluation, clash analysis, 4D schedule and simulation, and planning of documents (Ahmad Latiffi, Brahim, Mohd, & Fathi, 2014). According to Amiruddin (2019) all 20 local authorities in Malaysia with city status will be using BIM for their initial project submission by 2021. It is the government aim through CIDB to promote BIM implementation to enhance professionals and organizations' awareness and encourage them to adopt BIM process in their work environment (Al-Ashmori, et al., 2020). The next section discusses further on the implementation of BIM among quantity surveyors in Malaysian construction industry.

1.1 Problem Statement

In this era of globalization and digitalization, the construction industry is undergoing a transition period with the advanced of technologies. Technology is developing rapidly by rooting to all sectors and industry across the world and making all the practical jobs easier than they were (Nigam, Dixit, & Sachan, 2016). In developed countries, BIM has become the norm in the construction industry as building design and works are becoming more difficult and complex. It is inevitable that the roles of all kinds of professions in the building sector are also affected including quantity surveyors (QS). In Malaysia, the use of BIM among QS is vigorously encouraged by the Royal Institution of Chartered Surveyors (RICS), the Royal Institutions of Surveyors of Malaysia (RISM), and the Board of Quantity Surveyors (BQSM). It shows that there is no escape for the profession to face the period of change that BIM has brought.

The history of quantity surveyor and the method of performing a quantity surveying practices provides ample proof to demonstrate how the quantity surveyor has been influenced by digital technology. The successful implementation of BIM will however not happen without affecting the quantity surveying profession in some way or another. Olatunji et al. (2010) described that, BIM is a major challenge to the services conventionally provided by quantity surveyors and other construction disciplines as the adoption of BIM may redefine traditional professional boundaries in construction. A recent study by (Ismail, Adnan, & Bakhary, 2019) found that majority of quantity surveyors were aware of BIM usage, and have moderate knowledge of BIM but they did not use it in their practice.

Services for quantity surveyors traditionally include preparation of feasibility studies, preliminary estimates, bills of quantities, cost plans and schedules (Olatunji et al., 2010). Documentation for construction contracts are drafted and compiled by quantity surveyors. They also prepare and analyze tenders for construction contract. Advice will be given on the selection of contractors. Financial supervision of all construction projects and related documentation, including audits, cost plan and index, are provided by QSs. Additionally, services like construction project management, construction dispute resolution, value management, management contracting, facilities management and other types of consultancy services are offered by QS (Nkado, 2000).

Cost estimation, feasibility studies, tendering, cost planning, value management, and dispute resolution are the core activities carried out by quantity surveyors, making them a key contributor to any construction ventures.

BIM consists of 3-dimensional design functions (3D), programming and scheduling functions (4D) and cost estimating functions (5D). According to Raphael & Priyanka (2017), BIM's fifth dimension (5D) which is cost related has stimulated new working style in quantity surveying practices, transforming the traditional functions of a quantity

surveyor. The cost-management functions of BIM would alter the cost management mechanism for construction projects and shift the duties of the personnel concerned. To be specific, it forces quantity surveyors to work on other aspects of the cost management and generate new tasks and opportunities for themselves while reshaping the system under which they work. Align with the flourishing of BIM in the sector, it is expected that BIM would be embraced in QS firms where the QSs should merge the trend with their practices to boost up the effectiveness in term of cost and value of construction processes. In order for that to succeed, immense knowledge is needed by a quantity surveyor (QS), followed by skillful interpretation and practical use of the vast knowledge (Raphael & Priyanka, 2014).

According to Gee (2010), BIM's capabilities of automating the production of bills of quantities, which is one of the quantity surveyors fundamental tasks, will have both positive and negative effects on the quantity surveying discipline. Unfortunately, the automatic processing for bills of quantities also often brings pitfalls to the table. Bill production is typically one of the most common activities undertaken by quantity surveyors. The automation of this task will enable them to get more work done with a smaller production team. That would lead to a decrease in the number of workers required, which is resulted from the scale reduction of the quantity survey activities. As a result, unemployment of quantity surveyors might be an issue if there is no evolution or adaptation of quantity surveying practices with the blossoming of BIM implementation in Malaysia. In brief, it can be seen that BIM has a profound influence on the QS profession. For QS profession to remain relevant, the profession must continue to evolve and adapt to cope with increasing demands and changes in technology. This study therefore aims to identify the new skills needed by QS profession to cope with BIM implementation in Malaysian construction industry.

2. Literature Review

2.1 Integration of BIM in Quantity Surveying (New Skills for Adaptation)

Apart from equipping themselves with the requisite skills, it is essential for the QS profession to improve their roles and practices by adding competencies in order to complement the take-off speed benefits of BIM. Practitioners ought to be much more versatile and able to change their usual professional procedures in the past. Harun & Abdullah (2006) also mentioned quantity surveyors these days have to adapt to shifts in trends of practice. To secure their future in the technologically growing market, it is crucially significant for the profession to possess the following skills.

2.1.1 Computer Literacy / ICT skills / Technology skills

As a quantity surveyor, it is important to link the models to other data, as there is a lot of information about the project, such as drawings, RFIs and spec sheets, living outside the model. A quantity surveyor needs to think of the way in which these documents can be linked for a more complete model in BIM. Owners may insist on receiving a 3D model but, for the full picture, it should be linked to all of the other data generated and collated from the project.

Smith (2004) perceived that first and leading companies must ensure that their quantity surveyors have adequate professional knowledge in the key competencies and expertise of the profession and carry on developing this skill. As technology progresses, it has introduced e-Tendering into the procurement equation. E-Tendering works as a productivity-enhancing tool to quantity surveyors Nonetheless, quantity surveyor needs to grasp well throughout the tendering phase in order to apply E-tendering (Seah, 2008).

When the construction parties including architects, quantity surveyors, developers, contractors, engineers and consultants gradually adopted software in their practices, it is unavoidable that the duplication of data will happen, thus there is a need for data integration. Smith (2004, 2006) suggested that sooner or later, all building professionals would need to learn and extend CAD abilities. In the future, virtual projects and information management systems will focus on CAD systems such as AutoCAD, Microstation, ArchiCAD and so forth. Professionals would then require the knowledge and qualification of CAD to be the industry player.

Currently, there are numerous commercially developed software and programs aimed at improving the efficiency of quantity survey practices (Odeyinka & Doherty, 2008). According to Tse & Wong (2004), it is important to develop Information Technology (IT) and Information Communication Technology (ICT) in order to deliver a better service. Graduates nowadays are requested to equip themselves with more advanced IT skills. Grant (2004) concluded that employees must be trained and cultivated to maintain optimal flexibility, so that they could work under a dynamic business model. Resources are therefore essential for training the employees. Based on the study of Smith (2004), a plenty of firms claim time and cost needed to obtain knowledge of CAD and other software as the key obstacles in adopting IT in their business. Apart from CAD systems, the three most widely used applications for automated quantities reported by Smith (2006) are CostX, Eclipse and Buildsoft Take off System (BTOS).

2.1.2 Diversification of Services

Nowadays, the world is changing fast and the pace appears to be accelerating more than ever before. Over the last few years, change management has become a very vital aspect in the course of study of organizational behavior, and the same applies to qualified quantity surveyors' practice. Goals and targets for quantity surveying related areas like

facilities management which can provide the QSs with a steady stream of earnings enabling the profession to become less reliant and more independent from the rise and fall of conventional revenue areas are also proposed by Grant (2004). Diversification will correspondingly be a part of the additional strategies. According to Smith (2004), many have recognized the importance of diversification to the future of the QS field as a whole. Quantity Surveyors should diversify their services to better meet the demands of the industry or client and protect their long-term profession's prospect.

2.1.3 Continuing Professional Development (CPD)

Organisation like the RICS mandates its member to attend a certain number of hours of CPD training every year. Currently, this is treated as a mechanistic mechanism that must be pursued to ensure the quality of profession is not jeopardized. CPD is a genuine extension of the professional's education by continuing preparing them with development courses in order to enhance and support their professional practice (Chong, 2014). Throughout any event, the person undertaking CPD must not only fulfill the standards of their professional organization, but must also preserve credibility with colleagues and employers, improve existing work outcomes, expand and strengthen their potential to play their current role and build up future capacity to advance in their jobs (Roscoe, 2002).

This is confirmed by Pearl (2004) that CPD will serve as a guiding factor in improving the quality standard of the quantity surveyor if the CPD projects are carried out carefully. It is important to review submissions and ensure that registered practitioners obtain considerable insight into the content that can strengthen their expertise and knowledge base. Grant (2004) clarified that strategic assets such as training and education should be boosted to ensure that the role of the professions is really workable, dynamic and efficient. Darus et al. (2009b, 2009a) further indicate that the high-quality workforce performance is commonly assumed to be accomplished by the advancement of education, training, and CPD. On the basis of this belief, the Malaysian construction industry has initiated several projects in favour of its players.

Verster, Kotze, & Hauptfleisch (2008) conveyed that the function of South Africa 's Quantity Surveyors is experiencing a transformation with a heavy emphasis on broadening education, research and training. It is proposed that in order to be recognized as a developed society, a profession should ensure that the five pillars of which consist of education, research, training, mentorship and CPD, are developed to its maximum level and in parallel with world-class professions. The five foundations could assist the quantity surveying profession to develop its status as an educated society.

2.1.4 BIM Skills for Quantity Surveyors

Undoubtedly, to be involved in BIM projects, quantity surveyors must be equipped with BIM skills or capabilities. Succar, Sher & Williams (2012) define BIM capabilities as the essential capacity to execute a function or produce a BIM service or product. In this report, the BIM skill is clarified as the basic ability to carry out tasks in quantity survey practices to enhance their job efficiency by BIM adoptions. Identification of quantities from BIM models, model manipulation for quantities extraction and development of modelling design are the BIM skills that the QS should master. Besides, it is an essential competence to be able to operate in the common data environment (CDE), adjust cost plan to represent fluctuating project data, modify cost estimates, verify the reliability of the model and the details it provides. The ability to identify contingency and model problems, as well as a systematic and consistent approach to the procedures are both noted as the critical aspects of BIM performance for QS by the Australian Institute of Quantity Surveyors (AIQS) and New Zealand Institute of Quantity Surveyors (NZIQS) (Exactal, 2018). Table 1 below shows 11 BIM capabilities for quantity surveying practices that were listed according to a study done by Fung et al. (2014):

Table 1 - BIM capabilities in QS

No	BIM capabilities in QS
1	Cost appraisal can be prepared quickly at feasibility stage.
2	Preliminary cost plan can be prepared by extracting quantities from model.
3	Easily update cost plan more details as design developed.
4	Easily generate accurate cost estimates for various design alternatives
5	Design changes reflected consistently in all drawing views
6	Cost implication of design changes can be generated easily without manually re-measurement
7	Clash detection reduces design errors and cost estimates revisions.
8	Cost checking performs quickly to ensure all items are captured
9	Improve visualization for better understanding of design.
10	Automatically quantification for BQ preparation.
11	Intelligent information management allows data to be stored in a central coordinated model.

3. Methodology

A qualitative research was adopted to address the aim of the study because it is subjective in nature, it emphasizes more on the opinion and experiences of the interviewees which is often described verbally. Semi-structured interview is the most ideal technique for this research as the in-depth and adequate information were required and collected to further identify the new skills needed by a quantity surveyor in order to keep pace with the implementation of BIM in Malaysia. In addition, open-ended questions were chosen for this research because it allowed for the respondents to express their opinions or views freely during the interview.

The list of respondents was retrieved from the professional boards include Construction Industry Development Board (CIDB), Board of Quantity Surveyors Malaysia (BQSM) and Real Estate and Housing Developers' Association Malaysia (REHDA). The reasons for choosing registered firm is that the assessment quantity surveyors should encompass wider range within each category and the registered firms that have the financial ability to employ BIM and having experienced in applying BIM in their projects. Purposive, non-probabilistic sampling was selected in this study in order to select people who are most likely to be able to provide enough and best information. The respondents are conditioned to those who are senior and experienced in the quantity surveying field such as senior quantity surveyors and have applied BIM in their work or are involved in BIM project. The selection of the respondents also based on their willingness to participate in the interview. A total of 20 respondents were chosen for the interview.

Data collected from the interview sessions were transcribed and content analysis was used to analyze the data with Nvivo 12 Pro software. The transcribed data was categorized and arranged according to several themes and coded into nodes in Nvivo 12. According to O'leary (2017), the best way to analyze complex data from sources such as interviews is by using content analysis method. According to nodes and data summary sheet, tabulation was done to indicate the frequency of a new skills required by the quantity surveyors.

4. Results

4.1 Adaptation of New Skills Needed by A Quantity Surveyor To Keep Pace with The Implementation of BIM in Malaysia

Adaptation is referred to how a quantity surveyor should acclimatize with the changes brought by BIM to fulfil the QS tasks. The researcher identified the new skills and extra knowledge suggested by interviewees and analysed how these new skills could be implemented to assist QSs to perform their tasks and its benefits. This section also includes the findings of the integration process or strategy of BIM in QS, the evolving roles of QS after integration and the original QS knowledge area to be secured throughout the transformation. Table 2 below shows the 14 new skills needed by a quantity surveyor to keep pace with the implementation of BIM in Malaysia. The sub-section below will discuss the results further.

Table 2 - New skills needed

No	Categories	Percentage (%)
1	IT skills & knowledge	95
2	BIM software knowledge	95
3	CPD skills	75
4	Multitasking skills	70
5	Additional knowledge	65
6	Latest construction technology and innovation	50
7	Diversification of service	45
8	Specialization of service	45
9	Model reviewing skills	25
10	Data and documentation management skills	20
11	Different BIM tools knowledge	15
12	Visualization and imagination skills	15
13	BIM contract, law and regulation	10
14	Critical and creative thinking skills	10

4.1.1 IT Skills

Majority of the interviewees acknowledge the need to pick up Information Technology (IT) skills and knowledge for a QS to keep pace with BIM implementation. The reasons are that the skills are essential to handle BIM tools and to adopt it in their practice more easily. The interviewees exemplified by stating *"...the skills will fasten the work of a QS in preparing BQ."* It was further explained that the adoption of BIM involves utilization of software and management of computer data which require QS to have competent IT skills to control it. Supporting statement are given by the interviewee, *"...the ability to use the computer software and training is required."*

While the BIM technology is constantly upgrading, IT skills are a prerequisite for the QS to keep up with the advance technology to prevent being stuck in traditional practices. With the skills, the QS tend to learn and understand the software faster. Some of the interviewees revealed that the version of the BIM tools continues to update to the latest version, therefore it is important for them as a QS to have up to date skills and knowledge.

4.1.2 BIM Software Knowledge

It is declared by 95% of the interviewees that BIM software knowledge and skills is one of the fundamental qualities needed by the QS with the rise of BIM implementation in the country. A QS is required to have knowledge on the basic function of the software and how to operate it. As per described by several interviewees, this knowledge includes the 3D modelling, BIM setting skills, BIM information abstracting skills, BIM measurement method and BIM scheduling skills. Taking an example of BIM setting skills, a QS must understand the calculation setting and rules of the BIM models and system to change it to suit the needs of different projects. This is particularly important to prevent errors from occurring for quantity take-offs purpose. It is also necessary for them to learn how to check the setting and make sure all the measurements are correct. The interviewees also explained that BIM is not a ready-to-use system, so certain BIM knowledge is required in order to use this tool. Besides, as per propounded by the interviewees, the skills and knowledge would help them for in depth software utilization.

Based on the findings, it was found that majority of the interviewees have used Glodon software which marks 80% of response rate. Whereas Cost X ranked second with 30% and Revit ranked third with 20% of response rate. Besides, Vico and Solibri have the least status of application by the interviewees with 10% and 5% of response rate respectively.

4.1.3 Continuous Professional Development (CPD)

It was explained by the interviewee that CPD is a scheme that helps to maintain the capability of a QS so that it is always up to date with the latest knowledge. It will enhance the knowledge and skills required to deliver a professional service in BIM projects. Based on the interviewee's experience, professional bodies like RISM would usually have this kind of scheme which involves arranged training or seminar for topics like BIM. The interviewee revealed that he/she once participated in the one of its activities that made a visit to a QS company in Singapore to understand how they implement BIM because they are much more advance than Malaysia in terms of BIM implementation.

The findings correspond with Chong (2014) in which he described that CPD is a genuine extension of the professional's education to enhance and support the QS professional practice.

4.1.4 Multitasking Skills

According to 75% of the interviewees, multitasking skills are the mandatory skills for BIM implementation. This is because the area of task to be handled by a QS at one time will increase post-BIM application. Therefore, multitasking skills are undoubtedly demanded. Furthermore, it was divulged that the skill is needed to survive in the industry as the number of QS hired will be reduced after BIM implementation so one must be the best out of many who can serve the most value and purpose as a QS to the employer. The interviewee explained that the competency of a QS equipped with multitasking skills will highly increase.

A fact unfolded by one of the interviewees is that a QS has the responsibility in helping clients to coordinate with all the consultants such as issuing instruction especially in BIM projects although it is not exactly within the scope of a QS. Therefore, a QS needs to multitask in order to complete their own work, as well being the middleman between the construction parties. Since BIM integrated the whole construction stages, s QS needs to plan their work sequence by considering which task should be completed first followed by another in a project, thus it requires multitasking skills. However, a few interviewees indicated that multitasking skill has always been the norm for the profession which is not limited to the implementation of BIM. The multitasking skill is needed for a QS to work efficiently and manage the working time wisely.

4.1.5 Additional Knowledge

Almost all the interviewees agree that additional knowledge is important to adopt BIM in QS. It was explained by the interviewees that additional skills are required in giving professional advices to client as BIM involves a lot of

disciplines including sustainability (6D) and facility management (7D). Besides, justification is given that a QS can notice any error, mistake or weakness in a BIM project and provide proper advice. This is proved by the statement of another interviewee saying, *"...It will be a credit for a QS. With extra knowledge, one can easily handle BIM with high Level of Detail (LOD)."* With that, the QS would gain more trust as a consultation for the client justified by the interviewees.

Unlike conventional contractual arrangement where QS can focus on their part of work, QS need to know more for smooth implementation of BIM. Having the additional knowledge, will assist QS to understand the BIM cycle. One of the interviewees clarified by adding the statement that BIM for QS is not only for quantity take-off, it also comprises linking all the construction stage. Thus, it is significant for the QS to keep track of everything about a project. It is useful if a QS possess more skills. With that, the QS would obtain the project overview and see things clearer.

Several additional knowledges are specified by the interviewees. One of the additional knowledges mentioned by the interviewees is project management skills. It was explained by the interviewees that BIM encompasses many parties like the designers, contractor, and developer. Therefore, the project management skills are significant to deal with the condition. Another interviewee stated, *"...project management is not an additional skill, but a required skill,"* which shows the significance of the skills. Some also regarded Mechanical and Electrical (M&E) knowledge as one of the important additional skills in order to understand the functionality of building services. Several interviewees stress upon the importance of commercial management skills to be acquired by a QS. This is because life cycle cost is the element most considered for the owner to maximize the profit and minimize the utilizing cost. Besides, the interviewees also proposed that additional sustainability knowledge may be needed when dealing with projects that needs high marks for achieving sustainability goal. As those skills are crucial in the modern project delivering strategy, the QS needs to digitalize these processes in accordance with BIM requirement or process. Having the additional knowledge is also an advantage for diversification of services by QS in which was suggested by Smith (2004) and discussed in section 4.1.1.7.

However, there are some interviewees who alluded that it not essential for the QS to have those additional skills. In their opinion, a QS should focus on cost management and administration of construction contract.

4.1.6 Latest Construction Technology and Innovation

It was also suggested by the interviewees that knowledge of latest construction technology and innovation is the key in adopting BIM. The interviewee explained that it is because BIM forces the synergy between advance technology and enhancement of personnel skills. The QS must have the skill to keep up with technological changes as technology is changing day to day. The industry is also constantly driven by technology. For instances, there is a construction site which applies virtual reality for coordination. As revealed by the interviewee numerous benefits can be gained when a QS can master the skills and knowledge. In addition, BIM itself is one of the advance technologies in construction sector. By acquiring the skills, a QS could understand the function of BIM better. This is particularly important in the incorporation of BIM in construction projects as BIM can be used in many stages in construction, and each stage may have different uses on BIM.

4.1.7 Diversification of Services

Another interviewee said that since BIM involves the whole construction procedure, QS need to diversify their service area to keep pace with BIM adoption. They should develop alternative roles other than quantity take-offs. One interviewee justified that QS need to improve their competency corresponding to the current market requirement where QS practices need to be furnished and polished accordingly. This is done by equipping the QS with variety of skill like technical skills, management, planning, consultation and advisory so that the discipline is able to compete with others. The interviewee further explained that it would be difficult to adopt BIM if QS just specify on certain services. A QS is encouraged to further and explore beyond their scope with the purpose of surviving in the industry. One interviewee commented that diversification can increase the possibility of getting a job which counter the threat for QS in losing job. Besides, supplementary rationale is given where the pros of having diversification is that it would widen the services of the profession. One of the interviewees disclosed that her company does diversified their service. Apart from providing conventional QS services, the company also have branches of services comprising project management, legal advice in construction project such as dispute, and audit services in a small scale. It is important to note that the industry requirements are changing especially after the arrival of BIM and are requesting different services from professional QSs.

4.1.8 Specialization of Service

According to the opinion of some interviewee, specialization of services is much more important to secure the QS profession in the industry. One of the interviewees mentioned, *"In my point, QS knowledge is an anchorage for the profession while other knowledge is an additional credit for job achievement."* The interviewee think that contractual

and costing advice is the core competitiveness of QS to be paid attention. In addition, the interviewee believes that with the broadening of scope happening in the profession, QS can choose the field they wish to specialize in, for example, in procurement, planning or modelling. Besides, it is also viewed by them that specialization of QS services is significant to provide a professional service to the construction industry.

4.1.9 Model Reviewing Skills

It was mentioned by several interviewees that the model reviewing skill is the new skill needed for a QS in the BIM era. According to one the interviewees, model reviewing skills is referred as the ability to read 3D models. QS need to be good in interpreting a model and mastering a basic model drafting skill for a better result.

4.1.10 Data and Documentation Management Skills

Some interviewees also acknowledged the necessity of having data and documentation management skills by the QS in BIM implementation which includes the knowledge of data storage and management. The interviewee explained that it is because all the project's information is in the format of softcopy in the server or in the cloud system such as One Drive, Dropbox, or Autodesk. When BIM is implemented for a project, there will be one common database where all the consultants would be able to access the same folder, one needs to know how to monitor the access of information, in terms of uploading, reading. Editing and downloading the file. Adoption of BIM involves utilization of software and management of computer data which requires QS to have good technological skills and computer literacy to control it. The other interviewee also mentioned that these skills are important as it is connected to areas like data visualization and data analysis.

4.1.11 Different BIM Tools Knowledge

Moreover, the interviewees explained that a QS must know and understand all types of BIM tools and understand each of their function since there are a varieties of BIM software used by every construction parties. One interviewee gave examples by saying, *"...like they have to know Cost X and Glodon are for extracting quantities while Revit is for design."* The main reason a QS must know about Revit rationalized by the interviewees is that they would know what to request from the architect.

4.1.12 Visualization and Imagination Skills

It was suggested by 15% of the interviewees that visualization and imagination skills should be acquired by a QS in order to imagine and visualize 3D pictures based on the drawing provided.

4.1.13 BIM Contract, Law and Regulation

The interviewees emphasized that QS must be prepared to adopt the new legal and contract matter once the BIM is fully utilized in Malaysia. It was explained that the current conventional contractual will not meet the requirement of the BIM, thus new legal and contract will need to be enforced. Only by studying and understanding all rules and regulations of BIM, the QS can then integrate the BIM standards and the current construction law in the contract of a project.

4.1.14 Critical and Creative Thinking Skills

Critical and creative thinking skills are also deemed by 10% of the interviewees to be imperative for a QS to adopt BIM. The interviewee narrated, *"...if a QS cannot think creatively, how he or she would be able to interpret technical drawings. Some architectural designs are unique, and the QS may have not seen before, he or she need to think creatively in order to visualize the drawings."* The interviewee further explained that analytical work of QSs would require them to think critically. It was also revealed by another interviewee that a QS needs to be to align the measurement work with BIM as every project has different layout and details exists.

5. Discussion

Based from the results discussed in the above section, the adaptations identified to incorporate BIM efficiently into the quantity surveying profession requires extra skills and knowledge to be acquired besides enhancing their core skills.

There are two most popular answers equally ranked at the first place which are IT skills and BIM competencies. This is not unusual as IT skills and BIM skills are complementary skills where they correspond with each other. BIM skills are needed by the QS to operate the BIM tools efficiently and to incorporate the tools' function in their practices

whereas IT skills are needed to support application of BIM tools and also to allow them to follow the always bettering technological approach.

It was also found out that there are several results from the fieldwork matches with the findings.. The data analysis of the necessity of IT skills to support the application of BIM tools and also to allow them to follow the always bettering technological approach discussed in the above section supports the claim of Tse & Wong (2004) as per mentioned in the literature review that IT skills are required to provide a better service as a supporting skill.

Next, the outcomes of BIM skills being a prerequisite to handle the BIM tools efficiently and to incorporate the tools' function in their practices fit with the theory stated by Succar, Sher & Williams (2012) as cited in literature review that one is able to understand the procedures and detect errors and mistake with BIM skills.

Moreover, the results of interviewee suggesting that Continuing Professional Development (CPD) helps to develop their skills and enhance professionalism has confirmed the statement presented in the studies of Chong (2014) that the importance of CPD in strengthening the professional practice.

In line with the hypothesis in the studies of Smith (2004) stating that the diversification of services is important to reduce the reliability on core services, the results of analysis indicate that diversification of services could combat with the risk and competition, providing QS not be eliminated.

The results of this study also proposes that different BIM tools knowledge is essential to improve communication between parties in a project design team. It is similar with the previous studies of Smith (2004, 2006) that different BIM tools knowledge are needed to integrate all the information to prevent duplication of data. The findings clearly show that QS profession need to evolve to cope with the pace of technology. Continuous learning and open to adapt to changes are very important for the profession to remain competitive and relevant to the industry.

6. Conclusion

Based on the findings, there are two new skills with regards to the adaptations needed by a QS in BIM environment, equally rated as the most which are IT skills and BIM competencies. This can be explained where the adoption of BIM is equal to the use of software and technology in the process of delivering a construction project. Therefore, IT skill have become the most important skill required by a QS towards embracing BIM technology. Corresponding to IT skills, BIM competencies are also very significant for the QS in carrying out tasks. It is related to how a QS would manage the information in the system including building models and abstracting data for the purpose of performing their practices.

Nevertheless, the success of the revolution of QS profession in the BIM era adoption of BIM competencies in QS) is very much dependent on the commitment and willingness to overcome the resistance to change by the employers and personnel in QS firms. These efforts are geared towards supporting the industry and government initiatives of BIM implementation in Malaysia. This change will diversify the function and the route of specification of the profession while raising the value of the profession. This paper also recommends an increase in the awareness of the occurrence of BIM and are prepared to tackle the new situation by equipping themselves with the necessary competencies. Future research could be directed towards the comparison of the evolving roles of quantity surveying profession with the incorporation of Building Information Modelling between countries.

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