THE IMPLEMENTATION OF BIM LEARNING MODULE IN QUANTITY SURVEYING DEGREE

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ABSTRACT

Building Information Modeling (BIM) is the hot topic of the construction industry of Malaysia in the recent years. The Construction Industry Development Board of Malaysia (CIDB) had taken the initiative to facilitate the adoption and implementation of BIM in Malaysia. Education sector is listed as one of the contributor in overcoming the BIM adoption barriers such as the lack of skilled man power. Taylor's University of Malaysia had implemented the BIM learning module in the Quantity Surveying (QS) degree in year 2017. However, there is no thorough study to prove whether the implementation of BIM learning module in the university is able to contribute in overcoming the lack of skilled man power. Therefore, the objective of this research seeks to identify the Individual BIM Competencies (IBC) of the final year QS undergraduates and the expectations of the consultant QS firms on the IBC of QS fresh graduates. The independent sample t-test was used to determine whether the IBC of final year QS undergraduates meet the expectations of the consultant QS firms. The results revealed that 86.7% of the IBC of the final year QS undergraduates are able to meet the expectations of the consultant QS firms. This indicates that the university can be an effective contributor in overcoming the BIM adoption barriers even though there are a few IBC required to be strengthened by the QS undergraduates.

Keywords: Overcome BIM Adoption Barrier, Education, BIM learning module, Quantity Surveying, Competencies

1. INTRODUCTION

Building Information Modeling (BIM) is defined by Construction Industry Development Board of Malaysia (CIDB, 2013) as a "modeling technology and associated set of processes to produce, communicate and analyze digital information for construction lifecycle". In technical terms, BIM will be a transition from the traditional computer aided two-dimensional drawings to modeling representations of actual building parts and pieces used to build a structure (Udom, 2012).

BIM is a tool that is used for model analysis, clash detection, product selection and whole project conceptualization (Weygant, 2011). The purpose of BIM is to break down the barriers created by segmentation of a project and replace it with a collaborative working process, where all designers, engineers, contractors, sub-contractors and specialist manufacturers working on a project work with the same information from the model (Udom, 2012). The entire system flows on the basis of supplying, receiving and sharing of information (Lukas, 2015). Ultimately, the processes of BIM will lead to a reduction in the initial and whole life cost of built assets and the time required to complete a construction project (Waterhouse, 2017).

BIM was officially introduced to Malaysia in a two-day construction event, "Infrastructure & Construction Asia's Building Information Modeling & Sustainable Architecture Conference" in 2009 (Ismail, 2015). Realizing the potential and benefits of BIM in the construction industry, CIDB established Malaysia BIM Steering Committee in July 2013. The main objective of establishing BIM Steering Committee is to facilitate the adoption and implementation of BIM in Malaysia. BIM Steering Committee took the initiative to develop Malaysia BIM Roadmap with the purpose of fostering the local construction industry towards a broader adoption of BIM by 2020 (Mohd et al, 2013).

Traditionally, quantity take-offs were performed manually from paper drawings provided by designers to quantity surveyors for cost estimation and cost management (Cummingham, 2014). With the existence and assistance of BIM tools, quantity surveyors are able to estimate cost and take-off quantities with a greater accuracy, speed, effectiveness and efficiency. For instance, each BIM construction object contains the dimensional information that is required by quantity surveyors (Walt, 2016). Information such as quantities can be extracted from the building model with mere few clicks (Roginski, 2011).

BIM also provides clash detection, the ability to spot clashes at an early stage in a construction project. This minimizes buildability error, thus reducing variation works and ensuring construction projects to be on schedule (Mcpartland, 2016). Quantity surveyors can utilize the model generated by BIM to visualize the construction project, allowing them to have a greater understanding of the project. Hence, producing a more accurate estimation (Bong, 2015).

The features of BIM will bring numerous benefits to the quantity surveyors. The benefits of BIM vary depending on the level of utilization by the quantity surveyors. High level of utilization of BIM from quantity surveyors will be the key taking the profession of quantity surveying to the next level.

2. PROBLEM STATEMENT

Table 1.1 – Past researchers' findings on BIM adoption challenges (Lack of skilled man power and lack of training or education)

Researchers	Scope	Research Findings
- Nurshuhada Zainon - Faizul Azli Mohd-Rahim - Hafez Salleh	Malaysia	-Lack of training for employees is one of the main BIM implementation issues.
- Reza Hosseini - Ehsan Azari - Linda Tivendale - Nicholas Chileshe	Iran	- Out of the 13 BIM adoption barriers: - Necessary training for BIM is not available ranked 3rd.
- Caroline T.W. Chan	Hong Kong	Out of the 12 BIM adoption barriers: - Lack of qualified in-house staff to carry out the BIM related works ranked 1st. - Lack of training / education ranked 2nd.

Based on the results from the past researchers' works as stated in Table 1.1, they concluded that lack of skilled BIM manpower and lack of training or education are the main challenges of BIM adoption across the globe. Educational sector and accreditation bodies or practice communities can coordinate and contribute to overcome the BIM adoption barriers by equipping students with BIM skills (Rogers, Chong, & Preece, 2015).

In year 2017, School of Architecture, Building and Design of Taylor's University of Malaysia took the initiative to implement BIM learning module in their Quantity Surveying degree course. This initiative can help to overcome the lack of skilled man power and lack of training or education for BIM. Besides being able to overcome the adoption barriers, the undergraduates equipped with the extra skillset have higher employment chance. The graduate jobs are competitive and the computer skills are one of the essential element in job application as employers seek for efficient employees (Shryane, 2017).

However, the effectiveness of this initiative is very dependent on whether the individual BIM competencies (IBC) of QS undergraduates of Taylor's University can meet the expectation of the consultant QS firms. There are no information on the standard on the IBC of Taylor's University fresh graduate and the expectations of the consultant QS firms available.

Therefore, this research study is established to find out the IBC of the final year QS undergraduates of Taylor's University and the expectations of the consultant QS firms on the IBC of QS fresh graduates. A t-test was conducted to determine whether the IBC of the undergraduates meet the expectations of the consultant QS firms.

Hence the research objectives are (1) to identify the expectations of Consultant QS Firms on the individual BIM competencies of QS fresh graduates; (2) to determine the individual BIM competencies of the final year QS undergraduates of Taylor's University; (3) to determine whether individual BIM competencies of the final year QS undergraduates of taylor's meet the expectation of Consultant QS Firms.

3. LITERATURE REVIEW

3.1 Individual BIM Competencies

Succar and Sher (2013) defined individual BIM competencies as "the personal traits, professional knowledge and technical abilities required by an individual to perform a BIM activity or deliver a BIM-related outcome. These abilities, activities or outcomes must be measureable against performance standard and can be acquired or improved through education, training and/or development." Succar et al. (2013) claimed that "it is important to identify the BIM competencies that need to be learn, applied on the job, and measured for the purposes of performance improvement."

3.1.1 Operational Competencies

Succar et al. (2013) defined operational competency as "the practices and efforts required to deliver a project or part/aspect of a project. Operational competencies include designing, analyzing, simulating and estimating (e.g. the ability to use models to generate BQ)". The operational competencies of a QS includes the abilities of the QS to operate the BIM based software to carry out tasks such as quantity take-off, producing Bill of Quantities, etc.

The quantity take-off with BIM based estimating software can be distributed into taking-off for Architectural Works, taking-off for Structural Works and taking-off for Reinforcement Bars (Glodon, 2015). The ability to do taking-off for Architectural Works includes the abilities to measure items such as wall finishes, floor finishes, windows, doors, etc.; the ability to do taking-off for Structural Works includes the ability to measure items such as column, beam, floor slab, etc.; the ability to do taking off for Reinforcement Bars includes the ability to measure items such as reinforcement bars for column, beam floor slab, etc.

The operation competencies of a QS also include the ability to extract the quantities from the BIM model or manual measurement with the BIM based on estimating software for the purpose of preparing BQ, interim valuation, etc. Additionally, Cubicost users can utilize TBQ to produce Bill of Quantities and TME to do taking-off for M&E services (Glodon, 2015).

3.1.2 Technical Competencies

Succar et al. (2013) defined the technical competency as "the individual abilities needed to generate project deliverables across disciplines and specialties." The technical competencies of a QS includes the ability to complete measurement within a shorter time frame, obtain accurate measurement quantities, visualize projects and detect design discrepancies of the drawings. These technical competencies are obtained through utilizing the features of the BIM software.

QSs with the assistance of BIM based estimating software will be able to do complete measurement at an increased speed, reducing the time required for BQ preparation (Walt, 2016). During the pre-contract stage, majority of the time is spent in quantity take-off for a complete and detailed Bill of Quantities preparation. BIM software allows QSs to do measurement with only clicking. The taking-off process is simplified and quickened because the calculation process is automatic.

BIM based estimating software is capable of ensuring the accuracy of measurement of QSs due to the automated calculation process (George, 2017). The automated calculation process removes the risk of human errors. This is extremely useful especially in large and complex projects where the calculation can be very tedious and complicated. Humans tend to make errors when they work under pressure. QSs often face time pressure because the complete Bill of Quantities is required for tendering. The highly accurate measurement quantities are valuable as it potentially minimizes the disputes among the client and the contractor.

The 3D BIM model allows the QSs to visualize the project in a 3D view (Ljeh, 2015). This grants the QSs a deeper and greater understanding towards the construction project. Even an inexperienced QS can visualize projects at ease through the actual BIM model of the project. Through the 3D visualization, QSs can identify whether all the elements are completely measured.

QSs can also be competent in detecting errors and discrepancies of the drawings with BIM. (Bong, 2015). Sometimes, the discrepancies between architectural drawings and structural drawings exist. BIM allows QSs to identify the discrepancies easily because both of the architectural and structural drawings measured using BIM software will be based on the same axis grid.

3.1.3 Functional Competencies

Succar et al. (2013) defined functional competency as the "the non-technical, overall abilities required to initiate, manage and deliver projects. Functional competencies include collaboration, facilitation, project management…" The functional competencies of QS includes the ability to provide clear and informative naming to the elements, distribute job, hand over projects and manage measurement data.

A clear and informative name of an element should include all the necessary information such as the types of materials, the specifications used, the complementary items within it, etc. (Glodon, 2015). The proper naming to the elements ease up the information sharing process. A higher quality of BIM model produced due to the higher level of details. This subsequently increases the collaboration quality as the collaborators can know the specification through the BIM model without referring back to the drawings.

For large and complex projects, the distribution of jobs with team members is very essential to ensure smooth work flow. BIM allows a team of QSs to distribute jobs to measure separate areas. The files can be merged together after all the team members have done their own parts (Glodon, 2015). Hence, the quantity take-off process can be done concurrently among the team members. This competency is required for good project delivery.

Besides that, the process of handing over of a project for QS can be very tedious due to the unorganized data and information. QSs can utilize BIM based estimating software to manage the quantity data systematically (Zainon et al, 2016). QSs can hand over incomplete projects while minimizing the loss of information because the information from BIM can be managed systematically at ease. The abilities of handing over incomplete projects and managing quantities or data systematically are required to manage projects information in a proper and clear manner.

3.2 Individual Competency Index

Succar et al. (2013) suggested that it is not ideal to determine an individual's competency through a binary proposition (competent/incompetent). Therefore, Succar (2013) had developed a simplified version of the performance model created by Benner and named it as the Individual Competency Index (ICI). The ICI includes five distinct levels as shown in Table 2:

Table 2: Individual Competency Index (Succar, 2013)

Scale	Level	Definition
0	None	Lack of competence in a specified topic
1	Basic	An understanding of concepts and fundamental with some initial practical application.
2	Intermediate	A solid conceptual understanding with some practical application.
3	Advanced	Significant conceptual knowledge with practical experience in performing a defined activity/task at a consistently high standard
4	Expert	Extensive knowledge, perfected skill and prolonged experience in performing a defined activity/task at the highest standard.

The Expert level was excluded from the Likert Scale of this research. The Expert level requires prolonged experience which is not possible for fresh graduates and undergraduates to achieve the level.

4. RESEARCH METHODOLOGY

4.1 Research Framework

Figure 1 shows the conceptual framework for this research study.

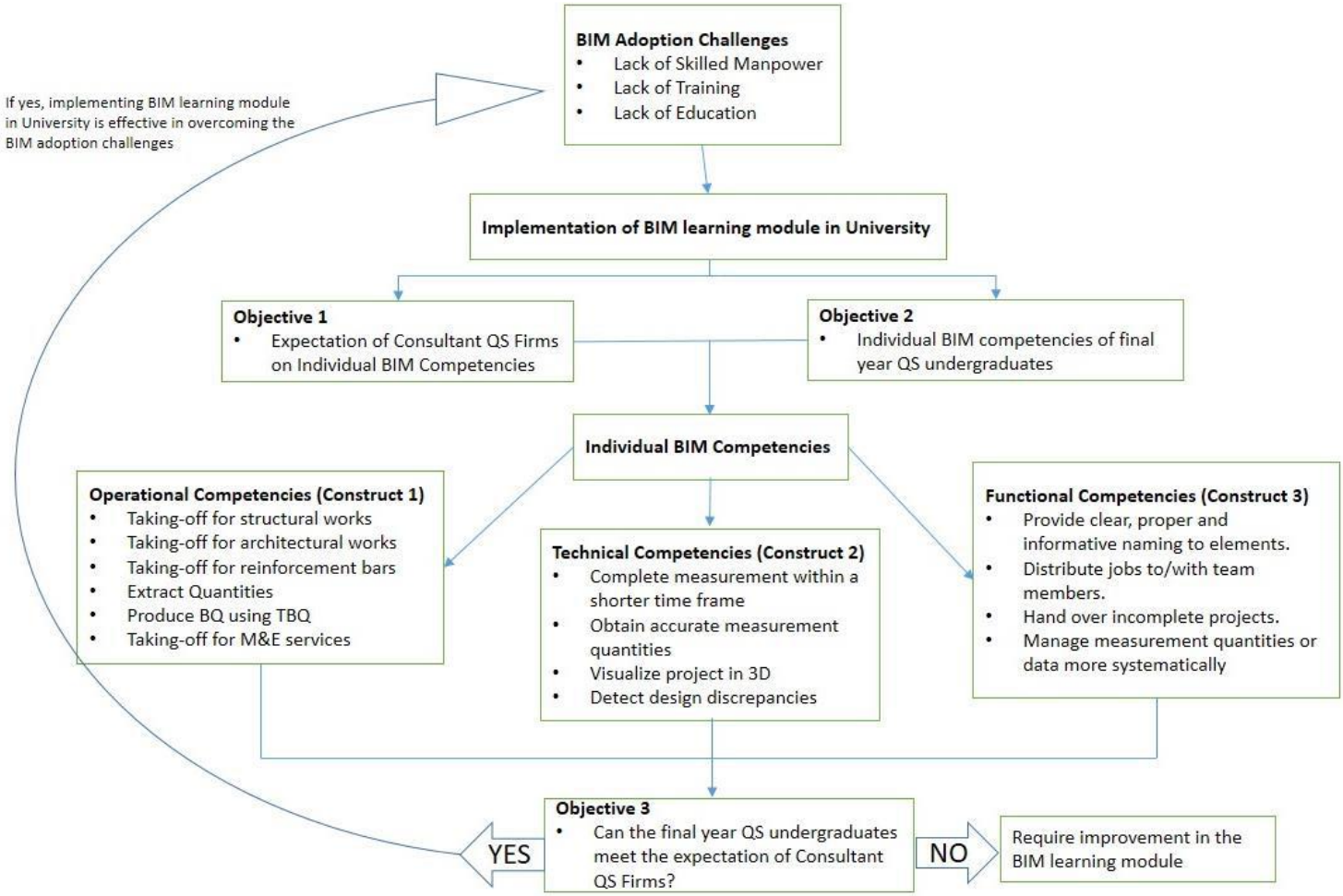

Figure 1: Conceptual Framework

4.2 Quantitative Research Method

This research study was approached using the quantitative research method. The reason is due to the sample size of this research study is large. The population cannot be represented by a small number of respondents. The research objective of this study seeks to obtain the expectations of the consultant QS firms and the individual BIM competencies of the final year QS undergraduates. The expectations and competencies of all the respondents vary. Hence, obtaining the data quantitatively is essential as the standard cannot be determined by a small number of people. The standard shall be set according to the data from the majority of the population. Therefore, qualitative research method is not applicable for this research study and quantitative research method is preferred.

The questionnaires of this research study only consist of close-ended question. Farrell (2016) stated that close-ended questions are suitable for quantitative research study because it limits the respondents' answers, allowing the answers to be analysed statistically. Besides that, the respondents can only select the answers stated in the questionnaires, removing the chance of getting irrelevant answer.

Sample size is used to determine the minimum required number of complete responses for quantitative research study. The sample size varies depending on the population size, desired confidence level and desired margin of error (SurveyMonkey, 2017). At 95% desired confidence level and 5% desired margin of error, the sample size of the Consultant QS Firms that uses Cubisoft is 92; while the sample size of the final year QS undergraduates of Taylor's University is 73.

4.3 Likert Scale

The Likert Scale used in this research is based on the Individual Competency Index (ICI) as described in 3.2.

4.4 Average Index

The Average Index Technique is a research technique that utilizes mean to analysis data (McCaffer, 1997). It is also used to classify the data in this research. The classification of the rating scale of Individual Competency Index by Succar (2013) was adopted into classification of Average Index by McCaffer (1997).

Table 3-Classification of the rating scale

Average Index	Classification of Level
0.00 ≤ Average Index < 0.50	None
0.50 ≤ Average Index < 1.50	Basic
1.50 ≤ Average Index < 2.50	Intermediate
2.50 ≤ Average Index < 3.00	Advanced

4.5 Independent Sample t-Test

The test of whether the individual BIM competencies of the final year QS undergraduates meet the expectation of the Consultant QS Firms was done using the independent sample t-test. The type of tailed test used was the left-tailed test. The value of the parameters used in this hypothesis test is 5% for significance level, 124 for degrees of freedom, and -1.657 for T critical value. The null hypothesis is rejected when the calculated test statistical value is less than -1.657, which means the individual BIM competencies of the final year QS undergraduates do not meet the expectations of the Consultant QS Firms.

5. FINDINGS

5.1 Expectations of Consultant QS Firms

Table 4: Expectations of Consultant QS Firms on Individual BIM Competencies of Fresh Graduates

Competencies		None	Basic	Intermediate	Advanced	Average Index	
		0	1	2	3	**AI**	**Levels**
1.0 Operational Skills		**%**	**%**	**%**	**%**		
1.1 Ability to do taking-off for Structural Works:							
a.	Foundation	6.5%	32.6%	34.8%	26.1%	1.804	Intermediate
b.	Column	4.3%	23.9%	37.0%	34.8%	2.022	Intermediate
c.	Beam	6.5%	23.9%	32.6%	37.0%	2.000	Intermediate
d.	Slab	6.5%	26.1%	30.4%	37.0%	1.978	Intermediate
e.	Wall & Partition	6.5%	26.1%	32.6%	34.8%	1.957	Intermediate
f.	Windows, Doors, Openings	6.5%	28.3%	37.0%	28.3%	1.870	Intermediate
g.	Roof	8.7%	37.0%	34.8%	19.6%	1.652	Intermediate
h.	Staircase	13.0%	39.1%	34.8%	13.0%	1.478	Basic
1.2 Ability to do taking-off for Architectural Works:							
a.	Floor Finishes	4.3%	21.7%	39.1%	34.8%	2.043	Intermediate
b.	Wall Finishes	4.3%	23.9%	39.1%	32.6%	2.000	Intermediate
c.	Skirting & Dado Finishes	8.7%	17.4%	50.0%	23.9%	1.891	Intermediate
d.	Ceiling & Suspended Ceiling Finishes	4.3%	19.6%	41.3%	34.8%	2.065	Intermediate
e.	Staircase Finishes	17.4%	37.0%	28.3%	17.4%	1.457	Basic
1.3 Ability to do taking-off for Reinforcement Bars:							
a.	Pile Cap	6.5%	39.1%	34.8%	19.6%	1.674	Intermediate
b.	Column	4.3%	37.0%	37.0%	21.7%	1.761	Intermediate
c.	Beam	6.5%	41.3%	28.3%	23.9%	1.696	Intermediate
d.	Floor Slab	6.5%	37.0%	32.6%	23.9%	1.739	Intermediate
e.	Wall	4.3%	37.0%	39.1%	19.6%	1.739	Intermediate
f.	Staircase	19.6%	45.7%	26.1%	8.7%	1.239	Basic
1.4	**Extract Quantities from BIM to BQ**	10.9%	37.0%	41.3%	10.9%	1.522	Intermediate
1.5	**Produce BQ using TBQ**	26.1%	54.3%	10.9%	8.7%	1.022	Basic
1.6	**Take off M&E Services using TME**	76.1%	19.6%	4.3%	0.0%	0.283	None
2.0 Technical Skills							
a.	Complete measurement	6.5%	30.4%	52.2%	10.9%	1.674	Intermediate

	within shorter time						
b.	Obtain accurate measurement quantities	4.3%	37.0%	41.3%	17.4%	1.717	Intermediate
c.	Visualize the project in 3D	4.3%	32.6%	43.5%	19.6%	1.783	Intermediate
d.	Detect design discrepancies of drawings	8.7%	32.6%	50.0%	8.7%	1.587	Intermediate
3.0 Functional Skills							
a.	Provide clear, proper, informative naming to the elements	6.5%	21.7%	56.5%	15.2%	1.804	Intermediate
b.	Distribute job to/with team members	13.0%	30.4%	54.3%	2.2%	1.457	Basic
c.	Hang over incomplete project to team members	10.9%	41.3%	43.5%	4.3%	1.413	Basic
d.	Manage measurement quantities and data systematically	6.5%	37.0%	52.2%	4.3%	1.543	Intermediate

Most of the individual BIM competencies of the BIM component the QS fresh graduates are expected to be are on average at intermediate level by the Consultant QS Firms with an exception of a few competencies. The average expectations on the competencies that do not meet the advanced level is considered fair as the expectations are on the QS fresh graduates.

The competencies expected to be at basic level on average by the Consultant QS Firms the ability to do taking-off for staircase, staircase finishes and reinforcement bars for staircase. In our opinion, taking-off for staircase using BIM can be complicated and certain consultant QS firms will just opt for manual measurement instead of BIM measurement for the staircase element due to the complicated operating procedure. Hence they only require the QS to achieve this competency at basic level. The ability to distribute jobs to/with team members based on BIM expertise and the ability to hand over incomplete projects to other team members are also only required at basic level of competencies.

The only competency which the Consultant QS Firms do not expect the QS to be competent is the ability to do taking-off for M&E services using TME. According to the demographic information from the respondents, only 5 out of 92 of the consultant QS firms are equipped with TME. Hence, majority of the firms do not have TME and therefore do not require the QS to be competent in using TME.

5.2 IBC of Final Year QS Undergraduates

Table 5: Individual BIM Competencies of Final Year QS Undergraduates of Taylor's University

Competencies		None	Basic	Intermediate	Advanced	Average Index	
		0	1	2	3	**AI**	
1.0 Operational Skills		**%**	**%**	**%**	**%**		**Levels**
1.1 Ability to do taking-off for Structural Works:							
a.	Foundation	5.0%	40.0%	30.0%	25.0%	1.750	Intermediate
b.	Column	0.0%	22.5%	37.5%	40.0%	2.175	Intermediate
c.	Beam	0.0%	23.8%	41.3%	35.0%	2.113	Intermediate
d.	Slab	3.8%	25.0%	35.0%	36.3%	2.038	Intermediate
e.	Wall & Partition	2.5%	28.8%	32.5%	36.3%	2.025	Intermediate
f.	Windows, Doors, Openings	8.8%	22.5%	36.3%	32.5%	1.925	Intermediate
g.	Roof	21.3%	38.8%	25.0%	15.0%	1.338	Basic
h.	Staircase	26.3%	25.0%	30.0%	18.8%	1.413	Basic
1.2 Ability to do taking-off for Architectural Works:							
a.	Floor Finishes	0.0%	28.8%	33.8%	37.7%	2.088	Intermediate
b.	Wall Finishes	0.0%	25.0%	41.3%	33.8%	2.088	Intermediate
c.	Skirting & Dado Finishes	6.3%	32.5%	28.8%	32.5%	1.875	Intermediate
d.	Ceiling & Suspended Ceiling Finishes	8.8%	33.8%	31.3%	26.3%	1.750	Intermediate
e.	Staircase Finishes	48.8%	37.5%	7.5%	6.3%	0.713	Basic
1.3 Ability to do taking-off for Reinforcement Bars:							
a.	Pile Cap	11.3%	26.3%	36.3%	26.3%	1.775	Intermediate
b.	Column	0.0%	22.5%	32.5%	45.0%	2.225	Intermediate

c.	Beam	1.3%	18.8%	31.3%	48.8%	2.275	Intermediate
d.	Floor Slab	1.3%	27.5%	33.8%	37.5%	2.075	Intermediate
e.	Wall	0.0%	41.3%	22.5%	36.3%	1.950	Intermediate
f.	Staircase	40.0%	41.3%	12.5%	6.3%	0.850	Basic
1.4	**Extract Quantities from BIM to BQ**	25.0%	22.5%	27.5%	25.0%	1.525	Intermediate
1.5	**Produce BQ using TBQ**	43.8%	22.5%	30.0%	3.8%	0.938	Basic
1.6	**Take off M&E Services using TME**	80.0%	12.5%	7.5%	0.0%	0.275	None
2.0 Technical Skills							
a.	Complete measurement within shorter time	0.0%	40.0%	21.3%	38.8%	1.988	Intermediate
b.	Obtain accurate measurement quantities	0.0%	35.0%	46.3%	18.8%	1.838	Intermediate
c.	Visualize the project in 3D	0.0%	33.8%	30.0%	36.3%	2.025	Intermediate
d.	Detect design discrepancies of drawings	3.8%	41.3%	32.5%	22.5%	1.738	Intermediate
3.0 Functional Skills							
	Provide clear, proper, informative naming to the elements	0.0%	27.5%	41.3%	31.3%	2.038	Intermediate
b.	Distribute job to/with team members	10.0%	25.0%	43.8%	21.3%	1.763	Intermediate
c.	Hang over incomplete project to team members	2.5%	45.0%	37.5%	15.0%	1.650	Intermediate
d.	Manage measurement quantities and data systematically	1.3%	26.3%	32.5%	40.0%	2.113	Intermediate

Almost all the individual BIM competencies of the final year QS undergraduates of Taylor's University are on average at **intermediate** level. The competencies that do not meet the level are the ability to do taking-off for roof, staircase, staircase finishes and reinforcement bars for staircase, produce Bill of Quantities using TBQ and the ability to do taking-off for M&E services using TME.

The ability to do taking-off for roof and elements of staircases are only at **basic** level. The measurement of roof and elements of staircases using BIM can be difficult depending on the design. The ability to produce Bill of Quantities using TBQ is also at basic level. There are around 44% of QS undergraduates who are not competent in using TBQ. This is due to Taylor's University does not include TBQ and TME in the BIM learning module.

Only a small number of the QS undergraduates are capable of utilizing TME. 80% of the QS undergraduates do not know how to use TME. In the practice of the construction industry of Malaysia, BQ for M&E services are often done by the M&E engineers. Therefore, the consultant QS firms do not value TME and did not purchase it. Hence, the amount of QS undergraduates that had the chance to use TME during internship is extremely low.

5.3 Comparing IBC of Final Year QS Undergraduates with the Expectations of Consultant QS Firms

The type of tailed test used in this research is the left-tailed test. The values of the parameters used in this hypothesis are 5% for significance level, 124 for degrees of freedom, and -1.675 for T critical value. The null hypothesis is rejected when the calculated test statistic value is lesser than -1.657 which means the individual BIM competencies of the final year QS undergraduates do not meet the expectations of the consultant QS firms.

Table 6: Competencies of the IBC of Final Year Undergraduates with the Expectations of Consultant QS Firms

Competencies		CQS		Student		t-Test	Null Hypothesis Accepted / Rejected
1.0 Operational Skills		TR	Mean	TR	Mean	t-value	
1.1 Ability to do taking-off for Structural Works							
a.	Foundation	46	1.804	80	1.750	-0.325	Accepted
b.	Column	46	2.022	80	2.175	1.014	Accepted
c.	Beam	46	2.000	80	2.113	0.733	Accepted
d.	Slab	46	1.978	80	2.038	0.358	Accepted
e.	Wall & Partition	46	1.957	80	2.025	0.410	Accepted

f.	Windows, Doors, Openings	46	1.870	80	1.925	0.317	Accepted
g.	Roof	46	1.652	80	1.338	-1.783	**Rejected**
h.	Staircase	46	1.478	80	1.413	-0.347	Accepted
1.2 Ability to do taking-off for Architectural Works:							
a.	Floor Finishes	46	2.043	80	2.088	0.292	Accepted
b.	Wall Finishes	46	2.000	80	2.088	0.591	Accepted
c.	Skirting & Dado Finishes	46	1.891	80	1.875	-0.094	Accepted
d.	Ceiling & Suspended Ceiling Finishes	46	2.065	80	1.750	-1.861	Rejected
e.	Staircase Finishes	46	1.457	80	0.713	-4.438	Rejected
1.3 Ability to do taking-off for Reinforcement Bars:							
a.	Pile Cap	46	1.674	80	1.775	0.585	Accepted
b.	Column	46	1.761	80	2.225	3.078	Accepted
c.	Beam	46	1.696	80	2.275	3.679	Accepted
d.	Floor Slab	46	1.739	80	2.075	2.103	Accepted
e.	Wall	46	1.739	80	1.950	1.319	Accepted
f.	Staircase	46	1.239	80	0.850	-2.407	**Rejected**
1.4	Extract Quantities from BIM to BQ	46	1.522	80	1.525	0.016	Accepted
1.5	Produce BQ using TBQ	46	1.022	80	0.938	-0.496	Accepted
1.6	Take off M&E Services using TME	46	0.283	80	0.275	-0.075	Accepted
2.0 Technical Skills							
a.	Complete measurement within shorter time	46	1.674	80	1.988	2.002	Accepted
b.	Obtain accurate measurement quantities	46	1.717	80	1.838	0.869	Accepted
c.	Visualize the project in 3D	46	1.783	80	2.025	1.572	Accepted
d.	Detect design discrepancies of drawings	46	1.587	80	1.738	0.988	Accepted
3.0 Functional Skills							
a.	Provide clear, proper, informative naming to the elements	46	1.804	80	2.038	1.636	Accepted
b.	Distribute job to/with team members	46	1.457	80	1.763	1.942	Accepted
c.	Hang over incomplete project to team members	46	1.413	80	1.650	1.688	Accepted
d.	Manage measurement quantities and data systematically	46	1.543	80	2.113	3.899	Accepted

Table 6 shows the summarized result on whether the Individual BIM competencies of the final year QS undergraduates of Taylor's University meet the expectations of the Consultant QS Firms. The null hypothesis in this t-test is that the final year QS undergraduates meet the expectations of the consultant QS firms. Only 4 out of the 30 of the null hypothesis are rejected, representing only 13.3% of the individual BIM competencies of the QS undergraduates do not meet the expectations of the firms. The 4 competencies that do not meet the expectations are the ability to do taking-off for roof, ceiling & suspended ceiling finishes, staircase finishes and reinforcement bars for staircase. The remaining null hypotheses are accepted, indicating that the remaining BIM competencies (86.7%) of the final year QS undergraduates of Taylor's University are able to meet the standard of expectations of the consultant QS firms.

6. LIMITATION OF THE STUDY

The scope of the study is only targeted on the Cubicost users and final year undergraduates of Taylor's University. The scope is chosen due to the ease of access of data which enabled the researchers to increase the relevance of the research result. Since the scope is very specific, the findings of this research study are not applicable for other BIM software besides Cubicost and the undergraduates of other universities. Furthermore only 3 types of individual BIM competencies are included in this research

study. There are other competencies which are not included in this research study. BIM is also utilized by other professions in the construction field. However, this research study is mainly focusing on QSs and does not consider the other professions of the construction field.

7. RECOMMENDATION FOR FURTHER STUDIES

Further research on a wider scope can be conducted to include other BIM software which is available in the construction market and students of other universities. The further studies can be carried out based on the research framework of this research as shown in Figure 1. Researchers can also carry out further studies on other professions in the construction field because this study is only focusing on the QSs. The conceptual framework can still be used with a slight modification on the competencies to suit the role and job scope of the professions.

8. CONCLUSION

The majority of the individual BIM competencies of the final year QS undergraduates of Taylor's University are able to meet the expectations of the consultant QS firms even though there are a few individual BIM competencies which are required to be strengthened. The implementation of BIM learning module in the university is to produce more BIM competent QSs. The BIM competent QSs are able to contribute in overcoming the BIM adoption barrier caused by the lack of skilled staffs and lack of education or training. Besides that, the BIM competent QS undergraduates of Taylor's University are equipped with the extra skill sets for future employers to look into which can potentially increase their employment chance.

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