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An Analysis of BIM Employability Skills Among Polytechnic Architecture Graduates

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Abstract: *Building Information Modelling (BIM) has become a crucial topic of discussion among the construction players in the construction industry. The needs of professionals' talent in the BIM skills aspect are required to ensure the BIM implementation can be carried out smoothly. However, most of the studies carried out found that industry lack BIM expertise and BIM knowledge. There is also a lack of studies emphasis the aspect of the need for semi-skilled workers in BIM-related skills. This paper aims to determine the employability skills in BIM-related acquired among architecture graduates from polytechnics as semi-skilled workers in the construction industry and the differences level of skills between genders. Quantitative methods through survey questionnaires were used to obtain data to answer the research questions. A sample survey of 169 (male and female) architecture diploma graduates from Malaysian polytechnics was selected to answer the survey. Data collected and analysed using Statistical Package for the Social Science (SPSS). Descriptive analysis was performed and an independent t-test to identify differences in acquired skills between men and women for working as semi-skilled workers. Cronbach's Alpha values over 0.85 are high-level categories based on the validity and reliability analysed made. The results showed significant differences between male and female graduates in the skills acquired to work as semi-skilled workers in the construction industry. The level of skills among the graduates in nontechnical skills is higher than technical skills and BIM knowledge. The research findings are helpful in identifying architecture graduates' skills level in order to enhance students' ability in the future to meet industry's needs.*

Keywords: *Employability Skills, Technical skills, Nontechnical Skills, Semi-skilled Workers, BIM Knowledge, Building Information Modelling*

1.0 INTRODUCTION

The human capital aspect plays an important role in a developing country. Based on the 2015-2020 strategic plan, there are four focus outcomes in the national higher education system: ensuring that graduates are of quality and meet market demand, quality Technical and Vocational Education and Training (TVET), ensuring lifelong learning in the community, holistic graduates, and ensuring graduate talent. To achieve the target, the government needs to improve quality higher education to support developing skills, innovation, and knowledge to ensure improvement in technical and professional skills.

The use of BIM in Malaysia is currently a topic of discussion due to demand from the government to implement the use of BIM comprehensively starting in Q4 of 2020 on projects that meet the conditions and criteria set according to the Construction Information Technology Plan 2016-2020 (CITP).

Construction Industry Development Board (CIDB) Malaysia CIDB (2021) defines Building Information Modelling (BIM) as preparing, using, and sharing 3D models through digital technology that contains a variety of information that can be used by all parties involved in the project to achieve objectives throughout the implementation phase of a project. The benefit of BIM use in the construction project is that it can improve the quality, reduce cost, and speed up the construction process to meet the completion time. However, based on the report conducted by CIDB Malaysia, there is still a low BIM adoption usage in the companies in the Malaysian construction industry due to a lack of BIM professional skills talent in the industry (CIDB, 2016).

There is a high demand for an employee who has the skills, knowledge, and expertise in BIM to work in the construction industry. However, many graduates from higher education institutions do not have the skills appropriate to the construction industry involving BIM. Ahmad Jamal et al. (2019) found that the cause of BIM implementation in the industry is the lack of skilled workforce and BIM knowledge required by employers. With the demand for BIM technology increasing dramatically, the lack of BIM skills has become a major constraint, which slows down and delays BIM implementation (Sacks & Barak, 2010). Providing early education of BIM knowledge and skills during the tertiary level will lead to graduates' BIM skills expertise which assists in a smoother implementation of BIM. Employers can expect graduates who are proficient in BIM upon graduation during employment.

In order to meet the industry demands in this sector, educational programs should collaborate with industry to determine the extent to which students should be exposed to BIM technology and the amount of BIM skills, knowledge, and experience that students must learn in order to complete their careers (Lee & Yun, 2015). Findings from Zhao et al. (2015) have identified that BIM skills will be a fundamental competency required for construction workers in the future. Therefore, to increase their chances of getting a job in the industry, graduates must have technical and employability skills (Hanapi et al., 2018; Shekhawat, 2020). BIM skills are key skills that employers expect to hire new employees and benefit the company. Moreover, as the construction industry involving BIM is growing. Graduates having basic skills foundation in support of other technical skills gives graduates the opportunity to be employed. For a better future, there is a need for the education and industry sectors to be streamlined to ensure that future generations of graduates are equipped with BIM skills.

Overall, this study aims to determine the employability skills in BIM-related acquired among architecture graduates from polytechnics as semi-skilled workers in the construction industry and the differences level of skills between gender. Specifically, this study aims to:

I. To identify the level of BIM employability skills among architecture graduates from polytechnic
II. To determine the difference of BIM level skills among architecture graduates according to gender

2.0 LITERATURE REVIEW

In today's global economic competition, an individual's success to get a job depends on the knowledge, skills, and competencies possessed by that individual. Similarly, most employers prefer employees who have technical, non-technical skills and knowledge in BIM to be employed in the BIM construction industry. Graduates equipped with the BIM skills and knowledge will prepare them for career success (Ku & Taiebat, 2011). Most construction players find out that preparing BIM skilled talent with BIM training is costly; it will become a barrier for BIM adoption in the industry. Therefore, graduates equipped with the skills at the tertiary level become beneficial to the Architecture, Engineering and Construction (AEC) industry as it reduces the cost of BIM adoption and provides career opportunities for graduates (Wu & Issa, 2014). There is still debate whether technical, non-technical skills or BIM conceptual knowledge are more important for the AEC industry and education. However, despite these conflicting arguments among the scholars, technical and non-technical skills and BIM knowledge are more recommended to equip by graduates (Coates et al., 2018).

2.1 BIM Technical Skills

Technical is also known as hard skills. Technical skills are usually associated with specific technical expertise and practical knowledge required to perform a BIM job function. Most of the graduates from polytechnics are known for their excellent technical skills. Osmin (2017) empirical study found out that most employers are satisfied with polytechnic graduates' skills. However, future graduates should not take it lightly as the number of unemployed graduates is increasing due to the demands from industry being different from the skills supplied by the graduates.

Three major factors that employers focus looking on a graduate who is good academic performance, strong technical skills in related fields, and employability skills (Rasul et al., 2013). However, having good academic backgrounds and skills no longer differentiates them from other candidates with current jobs. The current industry demands that graduates be more proactive in providing related skills following industry demands. Graduates need to be competent in specific technical skills because of the demands of employers in certain jobs.

A new era of the construction industry has been introduced to local construction players with the introduction of Building Information Modelling (BIM) in Malaysia. CIDB also introduced the Construction Industry Transformation Plan 2016-2020 to ensure that local construction implements BIM in the industry by 2020 for the selected project (CIDB, 2019). This program demands the construction employers have BIM expertise such as skills and knowledge in BIM to ensure BIM implementation in the Malaysian construction industry. However, one of the major barriers to implementing BIM is the lack of BIM competent staff in operating BIM software and the unaware of the technology required (Memon et al., 2014).

Competencies for BIM jobs are require graduates to have BIM skills and various types of skills, knowledge, and activities (Uhm et al., 2017). Early introduction of BIM skills and knowledge during the tertiary level of education to graduates is essential to ensure graduates are prepared in job hunting as well as prepare professional skills for the current and future demand. Findings from Ooi and Ting (2015) highlight that graduates must have relevant technical skills for a target job. Graduates who have specific technical skills will be advantageous and their opportunity to get the job.

2.2 Nontechnical Skills

Nontechnical skills are also known in terms of soft skills, general skills, generic skills, employability skills, transferable skills, and key competencies. The terms depend on the purpose of the study done by the scholars. Apart from technical skills, most scholars point out that employers also demand nontechnical skills from graduates. Both technical and nontechnical skills are essential for all semi-skilled workers to increase their productivity in the workplace (Md Nasir et al., 2011). Therefore, it is part of the skills that need to be emphasized in education and training.

Based on the Malaysian Qualification Agency (MQA) (2017), five learning domains are outlined in the Malaysian Qualification Framework (MQF). The five learning domain clusters are knowledge and understanding, cognitive skills, functional work skills, and a focus on (practical skills, interpersonal skills, communication skills, digital skills, numeracy skills and leadership, autonomy, and responsibility), personal and entrepreneurial skills, and ethics and professionalism. Based on the MQF, graduates need to possess these skills to ensure that they will meet the demands of work and challenges in daily tasks (Rasul et al., 2012).

Most previous scholars found that employers demand engineering graduates be excellent in nontechnical skills and academic (Mohd Kamaruzaman et al., 2019; Zaharim et al., 2009). Graduates must possess these skills to embark on their careers as these are the most necessary skills to work. Gokuladas (2010) found out that nontechnical skill is the stronger predictor for employability than other technical knowledge for engineering graduates. Graduates with good nontechnical skills can adequately deliver the technical skills.

Most employers believe that the cost of developing a new trainee is increasing in line with demand in the market. Employing an employee with the required skills is beneficial to the company. It is advantage to the graduates with the skills in getting the jobs in the industry. Educational institutions such as polytechnics must produce graduates with technical skills and need technical skills to cater to the labour demand in the market (Husain et al., 2010). The required skills must be part of the skills in training and education so that graduates can facilitate the skills to get a job.

There are various skills in nontechnical skills as studies by different scholars. Studies indicate that employees who master the non-technical skills can achieve greater success and job satisfaction than those who only acquire the technical skills (Haron et al., 2019). Graduates should have both technical and nontechnical for acquire the job. In the BIM scope, nontechnical skills are also required from the graduates. There are nontechnical skills prioritize in the BIM, such as communication skills, teamwork skills, problem-solving skills (Rahman & Ayer, 2017). Even though most of the architecture involved technical skills, there is also a need for good communication, ethical skills, and interpersonal skills in BIM. An empirical study by Raiola (2016) identified that nontechnical are ranked as very high demands in BIM as the nature of BIM involved a collaboration. The focus of this study was nontechnical skills currently demanded by employers to work in the BIM construction industry.

2.3 BIM Knowledge

BIM education becomes vital to upskilled the knowledge and skills not in construction practitioners but also the education system. Education and training at the tertiary level are important to ensure that the graduates' BIM skills have knowledge, skills, and comprehensive training to succeed and enable work in the BIM construction industry environment (Kugbeadjor et al., 2015). Currently, most institutions have prioritized the BIM skills and knowledge to ensure graduates' readiness to embrace the industry technology's demand. The education and training function essential to empower the BIM skilled talent for future BIM expertise (Ibrahim et al., 2019).

BIM knowledge will benefit graduates in searching for a job. Most employers consider employing graduates with BIM knowledge compare who lacked it (Panuwatwanich et al., 2013). Employers also expect, upon graduation, most of the graduates to have basic BIM knowledge. As BIM currently demands in the construction industry, graduates with the skills have an advantage and more opportunity to be employed. An empirical finding from Mojtaba and Ku (2010) found out that employers are looking for employees who have deep conceptual knowledge in BIM rather than those who have skills in operating the software only. This shows the importance of BIM education in higher education institutions.

3.0 METHODOLOGY

For this study, a quantitative method approach was used to determine the skills acquired by architecture graduates. A survey questionnaire was conducted using a Google Form to obtain the data to achieve the research objective. The study population focused on six polytechnics in Malaysia that offered Diploma Architecture programs: Politeknik Ungku Omar (PUO), Politeknik Sultan Haji Ahmad Shah (POLISAS), Politeknik Sultan Abdul Halim Mu'adzam Shah (POLIMAS), Politeknik Port Dickson (PPD), Politeknik Merlimau Melaka (PMM), and Politeknik Sultan Idris Shah (PSIS). This study's population is 228 diploma architecture graduates in 2019 who completed their Diploma. A simple random sampling technique was applied to select the sample for the research study. The sample size was determined by referring to the sampling table by Krejcie and Morgan (1970), which come out 169 total of sample size required for the current population. A total of 169 questionnaires were distributed to a randomly selected sample using email and Telegram application.

The survey questionnaire was adapted from the previous scholar. There are two sections in the questionnaire instruments which Section A is on respondent demographic profiles and Section B is on employability skills. The 5-point Likert scale was used to measure the items from scale 1 "Disagree" to scale 5 "Very agree".

Two experts have been referred to the instrument validation procedure from the higher institution. The items on the instruments have been conducted reliability tests to identify the reliability of the items. The Cronbach's Alpha item has a high-reliability level with a value of more than 0.90 for the skills (Nunnally, 1978). The descriptive analysis was conducted to determine the employability skills level of graduates in BIM-related skills. This study uses five levels of interpretive mean scores, as shown in Table 1.

Table 1: Mean Score Interpretations

Mean score	Interpretation
1.00 to 2.33	Low
2.34 to 3.67	Moderate
3.68 to 5.00	High

4.0 RESULTS AND DISCUSSION

4.1 Respondents' Profiles

The total of the respondent is 169 of respondents who are responding to the survey carried out. Out of 169 respondents, 85 (50.3%) are male, and the other 84 (49.7%) of the respondents are female from the six polytechnics. The majority race of graduates from polytechnic is Malay were 156 (92.3%), followed by Chinese (n=5, 3.0%), Indian (n=4, 2.4%), Siamese (n=3, 1.8%) and Indian Muslim (n=1, 0.6%). In term of employment status, there were 77 (45.6%) of the graduates are full-time job status, followed by 46 (27.2%) are a contract worker, 20 (11.8%) of the has further studies, 26 (15.4%) are still looking for a job. In term of CGPA, 86 (50.9%) got 3.00–3.49, while 65 (38.5%) CGPA is 2.50-2.99, followed by 16(9.5%) got CGPA 3.50-4.00 and remaining of 2(1.2%) got CGPA 2.00-2.49. The majority (n=97, 57.4%) of the graduates have BIM training in Autodesk Revit for Architecture. There were 58(34.3%) who has no BIM

training, 13(7.7%) of them have BIM training in Autodesk AutoCAD, and the remaining 1(0.6%) of them have Autodesk 3Ds Max training. Table 2 display the respondent's profile.

Table 2: Respondent's profile

Measure	Gender	Frequency	Percent%
Gender	Male	85	50.3
	Female	84	49.7
Race	Malay	156	92.3
	Chinese	5	3.0
	Indian	4	2.4
	Siamese	3	1.8
	Indian Muslim	1	0.6
Employment Status	Full-time job	77	45.6
	Contract worker	46	27.2
	Further study	20	11.8
	Still looking for a job	26	15.4
CGPA	2.00 – 2.49	2	1.2
	2.50 – 2.99	65	38.5
	3.00 – 3.49	86	50.9
	3.50 – 4.00	16	9.5
BIM Training	Autodesk Revit for Architecture	97	57.4
	Autodesk AutoCAD	13	7.7
	Autodesk 3Ds Max	1	0.6
	No	58	34.3
	Total	169	100

4.2 Graduates Level of BIM Technical Skills

Descriptive analysis was used to determine the level of technical skills in BIM-related among architecture graduates as semi-skilled workers. The results of technical skills in BIM-related show graduates' overall level of skills are moderate (M=3.44). Design skills (M=3.69, SD=.74356) are the highest skills score level among the graduates. In contrast, other technical skills such as modelling skills (M=3.51, SD=.89016),

virtual modelling skills (M=3.45, SD=.74443), construction drawing skills (M=3.39, SD=.71837) and computer application skills (M=3.17, SD=1.04455) score a moderate level of skills. This indicates graduates feel confident with three years doing design as a core subject for their Diploma. The skills score moderate level indicate that BIM will take more time to explore. Table 3 displays the overall technical skills in BIM-related mean and standard deviation.

Table 3: Level of Technical Skills in BIM-related

Technical Skills	Mean	Sd	Level	Rank	Overall Mean
					Moderate
Design Skills	3.69	.74356	High	1	3.44
Modelling Skills	3.51	.89016	Moderate	2	
Virtual Modelling Skills	3.45	.74443	Moderate	3	
Construction Drawing Skills	3.39	.71837	Moderate	4	
Computer Application Skills	3.17	1.04455	Moderate	5	

4.3 Graduates Level of BIM Nontechnical Skills

Descriptive statistical analysis is used to determine the level of nontechnical skills of architecture graduates as semi-skilled workers. The overall level for nontechnical skills is high level with an overall mean is 3.73. Most of the nontechnical skills of graduates' level are high except for creative skills (M=3.53, SD=.86364) show a moderate level. The top rank of nontechnical architecture graduates is teamwork skills (M=3.92, SD=.76691) and then communication skills (M=3.76, SD=.82045), willingness to learn (M=3.75, SD=.86926), and problem-solving skills (M=3.69, SD=.80878). Table 4 displays the nontechnical skills mean and standard deviation.

Table 4: Level of Nontechnical skills in BIM-related

Nontechnical Skills	Mean	Sd	Level	Rank	Overall Mean
					Moderate
Teamwork Skills	3.92	.76691	High	1	3.73
Communication Skills	3.76	.82045	High	2	
Willingness to Learn	3.75	.86926	High	3	

Problem-Solving Skills	3.69	.80878	High	4
Creative Skills	3.53	.86364	Moderate	5

4.4 Graduates Level of BIM Knowledge

Descriptive analysis is used to determine the skills level of architecture graduates in the BIM knowledge. The result shows that graduates' level of knowledge in BIM is moderate with mean score is 3.35. The highest mean score for BIM knowledge is the ease of using BIM software (M=3.86, SD=.78979), and the lowest is knowledge in BIM software (M=3.34, SD=.84568). This indicates that graduates acknowledge the ease of using BIM software but still lack the knowledge in BIM software applicable as demand in the market. Table 5 displays the BIM knowledge mean and standard deviation.

Table 5: BIM Knowledge

BIM Knowledge	Mean	Sd	Level	Rank	Overall Mean
					Moderate
Ease of Use	3.86	.78979	High	1	3.35
BIM Diploma Knowledge	3.34	.84568	Moderate	2	
BIM Software Knowledge	2.86	.46517	Moderate	3	

4.4 Level of Skills According to Gender

Table 6 shows the independent t-test based on male graduates' and female graduates' skills to fulfil the job. After the statistical analysis of the independent t-test, Levene's test showed a significant ($p< 0.05$). There were statistically significant slightly differences in the level of skills between gender for male (M=3.56, SD=0.671) and female (M=3.33, SD=0.665) with score differences of [$t (167) = 2.256$, $p=0.025$; $p<0.05$). Since the significant value is small than 0.05, so the null hypotheses are rejected, and alternative hypotheses are accepted. The result indicates slight differences in level skills between males and females, in which male graduates are more skilled in working in the BIM construction industry.

Table 6: Independent T-Test for the level of skills among gender

Element	Gender	Mean	Std. Deviation	Independent T-Test			
				Significant Value	F	t	df
Skills	Male	3.56	0.671	0.025	0.048	2.256	167
	Female	3.33	0.665				

5.0 DISCUSSION

The study determined the level of technical skills in BIM-related among architecture graduates from Malaysia Polytechnic. The study found out the level of technical skills in BIM-related among architectural graduates was moderate. The finding explained that graduates' technical skills in BIM-related still new to adapt thoroughly in this study. They were likely to need more actual working experience to adapt skillfully. Most of the skills were acquired during study maybe is not the same as the actual practice on the site.

Results show that design skills are the higher skill in the technical skills category. The result affected due to most of the graduates is major in architecture which involved a lot of design work. Followed by it is are modelling skills and virtual modelling skills. The lowest skills in technical are construction drawing skills and computer application skills. It shows that graduates have not seriously considered working in the BIM construction industry after graduation. Most of the graduates not well-prepared in technical skills in BIM-related. They are not fully aware of the advantages of skills for job hunting.

Meanwhile, results display graduates' skills level in BIM knowledge is also moderate. The finding explains that the BIM knowledge during higher education is still moderate. Graduates mostly need more exposure in actual practice in order to enhance their knowledge in BIM. Most fresh graduates lack knowledge and skills in BIM related because they are not being exposed to the working situation in BIM. However, to work in the BIM construction industry, graduates must possess the technical skills on BIM-related and has knowledge on BIM to be employed. It is important and beneficial to the graduates to have the skills and knowledge within the tertiary level to become a developing country by 2020 (Hj Kamarazaly et al., 2018). Frequent training during higher education will enhance their skills and knowledge in BIM. A finding by Elijah and Oluwasuji (2019) emphasise that adequate BIM training will enhance the knowledge and skills of using BIM applications. With the experience in the actual practice, graduates can enhance their technical skills and knowledge in BIM.

On the other hand, the study found out that graduates' level of nontechnical in BIM-related is high compare to technical skills and BIM knowledge. The finding explains that most architecture graduates from polytechnic have a high nontechnical due to the MQA framework domain of outcome learning that focuses on generic student skills. This aligns with the finding from Raiola (2016), highlighting that although BIM skills are studied, the major finding is that the need for nontechnical in BIM is required. Zaharim et al. (2009) agree that nontechnical skills significantly impact the new graduates to get a job. Overall, finding shows that level of architecture graduates to work as semi-skilled workers in the BIM construction industry is moderate. Also, there are slight differences between males and females in terms of BIM technical skills level.

5.0 CONCLUSION

The study has achieved the research objective to determine the level of BIM employability skills architecture graduates and different of BIM employability skills between males and females as semi-skilled workers in the construction industry. The result shows overall graduates' skills level as moderate. The research finding shows a gap in the level of skills between gender as skills preparation for employability. Hence, a moderate level of skills shows inadequate skills to ensure they can perform well in the industry. Therefore, each of the graduates should acquire all the industry demands to have more employment opportunities. Thus, the number of architectures graduates skilled in BIM employability skills remains low due to the low market of job opportunities in the BIM sector. Most of the company involved in the BIM construction industry is located in the city with big project involved. Not all architecture firms in Malaysia are fully implementing the BIM due to costs, maintenance, and training.

However, this study is tested among respondents from the Polytechnic graduates' session dec 2019 only. This study is not representative of all architecture graduates offering architecture programs in Malaysian institution. A further study needs to be done to see to what extent the skills acquired among architecture graduates affected the employability of graduates as a whole architecture program.

Thus, initiatives by lecturers and institutions are being taken to ensure that polytechnic graduates, particularly architecture, are highly competent and fulfil the expectations of employers in the building and construction industry. Collaboration among institutions and industry will aid in determining needed

capabilities and providing early education in BIM skills and knowledge to develop semi-skilled workforce to fulfil the expectations of construction employers. Furthermore, it is critical for students to contribute to the diversification of skills and knowledge so that employers may anticipate graduates to be proficient in BIM technical and nontechnical abilities upon graduation.

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