PERSPECTIVE ON THE EFFICACY OF INDUSTRIALIZED BUILDING SYSTEM IN CIVIL ENGINEERING CURRICULUM

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ABSTRACT
Objective: Industrialized Building System (IBS) refers to a technique of constructing and manufacturing components in a controlled environment, onsite/offsite. In Malaysia, IBS is strongly supported by government at due to its versatilities in various ways and techniques. However, the application of IBS still faces challenges in lack of technical expertise or professional workers. Based on the new IBS roadmap 2030, one of the new pillars is needed to have a ready pool of components for IBS professionals and workers throughout the entire project lifecycle. Therefore, students related to construction and engineering need an early exposure to the application of IBS in Malaysia to provide a platform for readiness of IBS application in construction industry. This study aims to identify the effectiveness of IBS curriculum in Civil Engineering courses; thus, the investigation seeks the agreement of Civil Engineering student on the curriculum offers and later comparison study is made on the effectiveness of IBS curriculum within the research, technical and polytechnic Higher Learning Institutions (HLI's).
Research Method: For this research, a questionnaire survey was employed amongst three HLI's involving final year students. The data was analyzed using frequency analysis and average index.
Findings: The studies and findings shows deficit of IBS curriculum in HLI's.
Originality: This study will help in improving the strategies and action plans in higher education institution curriculum based on technical knowledge and skill in IBS.
Keywords: IBS, Civil Engineering Curriculum, Construction System, Effectiveness of IBS.

1. INTRODUCTION

Innovative trends and technique has emerged as a new synchronically groundbreaking engineering (Khan, Zakaria, Shamsudin, et al., 2019). Thus, Industrialized Building Systems (IBS) is a construction method that produces engineered building components manufactured in a factory. As a developing country, Malaysia needs to move towards a sustainable industrial growth. Prime minister of Malaysia said that the construction industry is expected to maintain a double-digit growth and has surpassed the performance of other economic sectors in the country (Ahmad, 2018; Fischer, 2010; Khan, Zakaria, Aminudin, et al., 2019). However, to make the expectation becomes reality, construction industry needs to deal with a crisis related to many problems in construction industry such as increasing of using foreign workers, waste of building materials, uncontrolled quality of building materials, unsafe construction site and delay of construction period.

In view to such problems, the Construction Industry Development Board Malaysia (CIDB) (CIDB, 2016) has identified the importance of increasing the level of knowledge within the construction community; promote the modern method of construction and to expedite the implementation of the IBS Roadmap and Construction Industry Transformation Plan (CITP) 2021-2025 (CIDB, 2016; Martin et al., 2019). The shortage of IBS professional may affect the effective adoption which offers benefits in term of cost and time certainty, attaining better construction quality and productivity, reducing risk related to occupational safety and health, and skilled workers (Shealy, 2016). In applying IBS, the workers need to know the careful design process and several controlling processes before the construction phase to ensure that there is no mistake and minimize the chance of any changes after the design phase (Saad et al., 2021). The lack of knowledge and exposure to IBS technology is one of the factors that contributes to poor structural analysis and design of prefabricated components and lead to improper assembly due to difficulties during installation (Chukov & Brost, 2014). IBS requires high construction precision and needs a higher skill level of workers. In comparison to the conventional construction method, the skill level of IBS workers is more demanding (Miah et al., 2017). Therefore, the contractor must be prepared technologically with IBS knowledge and skills. It is generally perceived that the number of skilled IBS installers in Malaysia is still low even though the system has been implemented for a long time. The Ministry of Education 2015-2025 accentuates the balance between knowledge and skills for students to adapt and thrive in an ever-changing world by enhancing curriculum (Russell, 2015).

This research presents a study which aims to investigate the effectiveness of IBS curriculum implementation in HLI's to make ready skilled and knowledgeable civil engineers of IBS. The following objectives were outlined to achieve the aim of study, to investigate the level of acceptance of Civil engineering students on the IBS curriculum offered by HLI curriculum. Also, to determine the level of effectiveness of adoption and understanding of student in learning IBS for construction projects. The study focuses on IBS construction and the IBS curriculum in Civil Engineering courses.

The survey was conducted within 4th year civil engineering students. Three HLI's were selected in data collection which including; Civil Engineering students of Universiti Teknologi Malaysia (UTM) as Research University; Civil Engineering students from Politeknik Ungku Omar (PUO); Civil Engineering students from Universiti Tun Hussein Onn Malaysia (UTHM) as technical university.

2. LITERATURE REVIEW

Industrialized Building System (IBS) is a term used in Malaysia to represent the prefabrication and construction of industrialized concepts. Lessing et al. 2005 defined IBS as an integrated manufacturing and construction process with well-planned organization for efficient management, preparation and control over resources, activities and results supported by highly developed components.

Furthermore, according to (Rooshdi et al., 2014) The fabricated components are manufactured mechanically by using the machine or formworks in factory. Accordingly (Shiel et al., 2016) MMC includes techniques such as thin-joint block work and tunnel in the form of construction. MMC includes floor or roof cassettes, pre-cast concrete foundation components, pre-formed wiring looms, mechanical engineering composite materials, and modern construction methods. MMC offers production of components on construction site prior to installation, thus it gives advantages for a remote location and off-site construction.

Since 2003, IBS roadmap has suggested on IBS curriculum in universities but the syllabus is yet not fully implemented to all universities (Saad et al., 2021). This is because it is still complicated to include IBS in existing engineering curriculum as it appears that teaching the know-how of industrialized building systems is not at the top of educational institution's priority list.

CITP 2021-2025

The Ministry of Works (2016) remarked concerned on collaborating with its agencies and, following to the attention the Construction Industry Development Board (CIDB) have drafted the CITP (CIDB, 2016; Misnan et al., 2010; Salim et al., 2018). The objective is to empower and strengthen the construction industry as espoused in the thrusts of the Eleventh Malaysia Plan (RMK11).

The importance of CITP in order to bring Malaysia's construction industry to the next level, aims to transform the construction industry encompassing four strategic thrusts:

1. Productivity: Raising the overall productivity level of the industry.
2. Internationalization: Focusing on improving competitiveness in the capability and capacity of our industry players to foray internationally.
3. Quality, Safety and Professionalism: Improving the overall quality, safety and professionalism of the industry.
4. Environmental Sustainability: Environmental sustainability being incorporated in the design, construction, and subsequent maintenance of our building and infrastructure.

IBS Curriculum

Curriculum development in Malaysian education is an ever-changing process which is strongly affected by current trends and issues happening locally and globally. The need of professional workers and sustainable construction method is highly demanded. Students are the upholstery of professional construction workers so they need to be exposed about new construction methods. Researcherw proposed that there is a natural tendency among practitioners to choose conventional methods perhaps with occasional utilization of single prefabricated elements (Wuni et al., 2020).In Malaysia polytechnic, the IBS education implementation is since diploma level up to the degree level. Polytechnic education is more to skill than technical knowledge. This is the reason there are expose to IBS curricular more than university. University education is more to technical knowledge rather than skill. Therefore, university education should include more intensive IBS knowledge and skills in their syllabus in direction for more IBS professionals to be supplied.

To effectively manage quality in projects, Juran's 1988 study highlights the importance of quality planning, assurance, and control. QA and QC are very important in the construction industry because they guarantee that quality standards are followed and that the total project performance is assessed, which reduces risks and improves project outcomes. Working drawings, specifications, and tender documents are essential for construction project quality control. Ensuring quality at the pre-tender stage is essential. According to (Chew et al., 2017), maintaining quality control is crucial for the success and durability of a project from the beginning of design through the end of construction and into the maintenance phase.

3. METHODOLOGY

This study employed quantitative survey to gain opinion from 4th/final year student of Civil Engineering courses. Total 238 copies of questionnaires were distributed to the respondents to three HLI's includes UTM, UTHM and PUO students. Respondents for the questionnaire in this research consist of students from faculty of civil engineering. Handing out questionnaires directly in class was used to identify the effectiveness of IBS curriculum in civil engineering courses. It is designed to gather and verify the information from literature review. The questionnaire consisted of four parts.

1. General information of respondent.

2. A survey on their level of acceptance of the respondent on the curriculum offers.
3. Their experience and readiness of adapting IBS in construction projects.
4. Ways to enhance implementation of IBS in civil engineering curriculum.

Frequency analysis and Average Index Method were applied in analysis of this study. The average index was calculated based on formula adapted from Ismail et al. (2013) and Memon et al. (2011) as follow:

$$\text{Average index} = \sum \alpha i xi / \sum xi \quad (2)$$

Where, αi = weighting given to each factor by frequency of respondents, xi = number of respondents for $i = 1, 2, 3, 4, 5$.

There are five categories of scale ratings that represent the feedback of the respondents. For instance, the application rating scale of average index in questionnaire is listed in table 1.

Table 1 Average index rating scale (Source: Abd Majid and Mc Caffer, 1997)

Rating Scale	Average Index	Category of Agreement
1	$1.00 \leq a \leq 1.50$	Strongly Disagree
2	$1.50 < a \leq 2.50$	Disagree
3	$2.50 < a \leq 3.50$	Moderately Agree
4	$3.50 < a \leq 4.50$	Agree
5	$4.50 < a \leq 5.00$	Strongly Agree

All the objectives are measured based on the Average Index of likert scale. The value greater than (3.5) is considered as the factors or criteria that showed significant results and effectiveness of the students ready towards IBS.

4. RESULTS AND DISCUSSIONS

After participation of 238 final year civil engineering students out of which 90 students were from UTM, 100 students from UTHM and 48 students from PUO. The number of respondents is represented 30% of the final year civil engineering students in the selected university. For UTM students, there is 48.9% male and 51.1% female. At UTHM, there are more male students than female students, with 57% male and 43% female. PUO students same as UTM students as there are 47.9% male and 52.1% female which is almost balance the percentage between male and female students. From the figure 1, UTM students has a lowest ranking for the level of acceptance of students on IBS Curriculum offers with Average Index scale below (3.5).

This means that the level of acceptance of UTM students on IBS curriculum offer is fair. The highest average index for UTM is only (3.39) while the lowest is (2.86). For UTHM students, with average index is (3.96), it is shown that they agreed that there is IBS curriculum in the civil engineering course of their university. They also agreed that there is technical knowledge of IBS learned in the curriculum (3.86) and they do agree that they think the IBS technical knowledge that they've learned during their degree is effective (3.53). The awareness of UTHM students about the IBS knowledge and its practices will uphold their IBS expert and professionalism of modular design in construction execution are at (scale 4) with an average index of (3.61). UTHM students agreed that IBS curriculum offered during their degree is significant (3.50).

However, other questions are at scale 3 which is for the IBS technical skills applied in the curriculum offers (3.44), IBS technical skills they've learned during their degree is sufficient for them to utilize when practiced in construction industry (3.13) and they can enhances their level of confident in practicing IBS in real project experience with the use of all IBS technical knowledge and skills (3.48).

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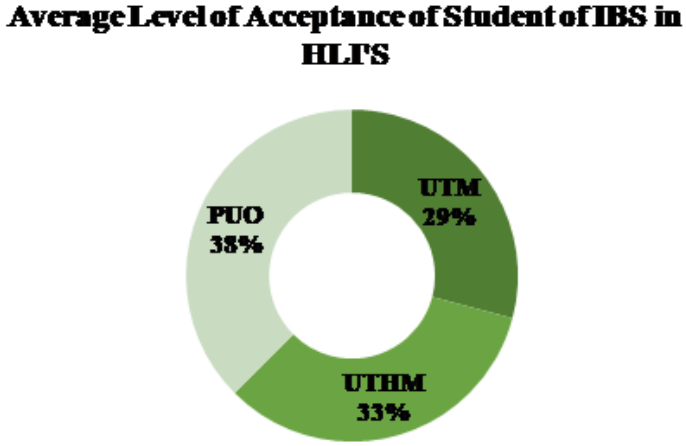

Figure 1 Average Level of Acceptance of IBS in HLIS'

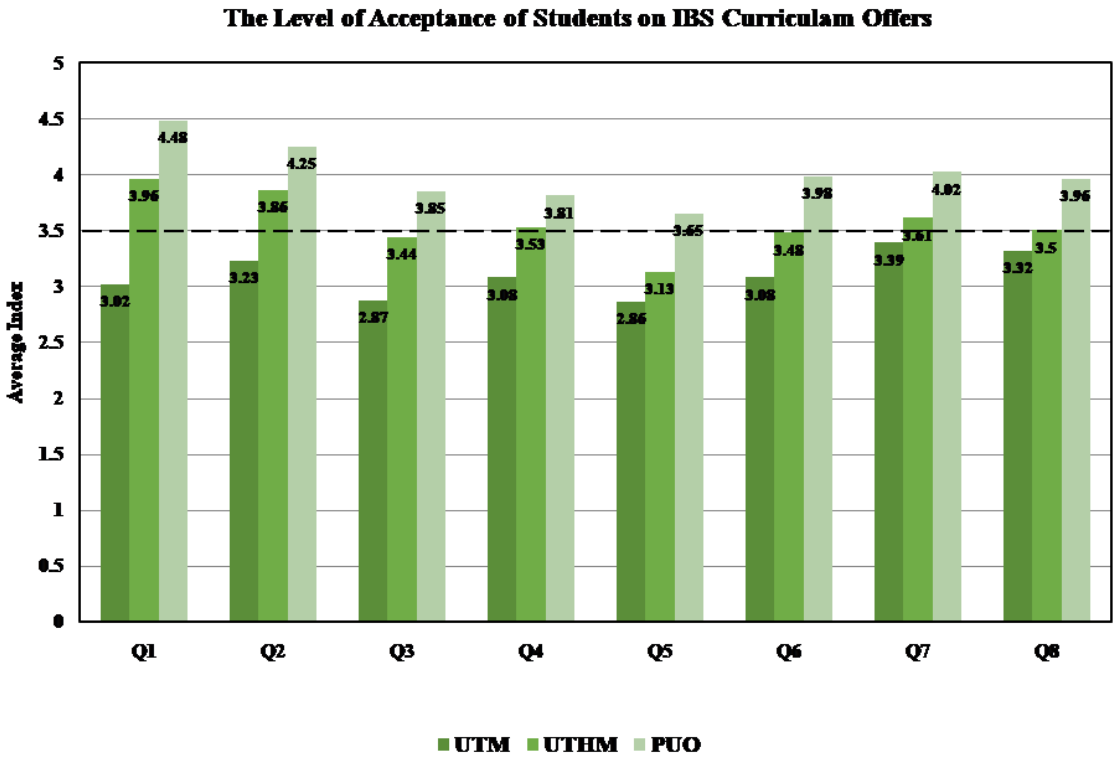

Figure 2. The Level of Acceptance of Students

The research revealed that with respect to objective, the figure 1 and 2 shows that the level of acceptance of UTM students on IBS curriculum offers are lower because

the average index of UTM students for all the questions are lower than (3.5. The level of acceptance of UTHM students at average because 4 of the questions are above (3.5) and the other 4 questions are below (3.5) which means UTHM students level of acceptance on IBS curriculum offers are between UTM and PUO. PUO students have the highest average index of the level of acceptance on IBS curriculum offers which is above (3.5) and all are at scale of (4) which is agree. From this it can be concluded that UTM students have lower level of acceptance on IBS curriculum offers compared to UTHM and PUO students while PUO students has the high level of acceptance on IBS curriculum offers. The adoption of IBS in the curriculum offers were rated in percentage by the students which they only tick the related subjects include in their civil engineering curriculum.

However; with respect to second objectives the table 2 shows that the most of the subjects stated by UTM students are at lowers scale which is 21-40%. There are 5 subjects that the UTM students had given the percentage of 21-40%. In UTM, construction technology is the only subject that has 61-80% of IBS has been embedded because there is basic knowledge of IBS in this subject and the other subjects are 41-60%. For UTHM students, most of the subjects have 41-60% of IBS has been embedded. Steel and timber design and elective subject are the only highest percentage of IBS has been embedded which is 61-80%. This is because in UTHM, there is an elective subject such as IBS, pre-stressed concrete and structural design so some of the students take one of them as the elective subject.

Table 2. The Percentage of IBS has been embedded in Civil Engineering courses

No	Questions	UTM		UTHM		PUO	
		Average Index	Percentage (%)	Average Index	Percentage (%)	Average Index	Percentage (%)
1	Structural Analysis	2.44	21 - 40	2.78	41 - 60	3.29	41 - 60
2	Reinforced Concrete Design	2.82	41 - 60	3.22	41 - 60	3.65	61 - 80
3	Steel and Timber Design	2.67	41 - 60	2.89	41 - 60	3.54	61 - 80
4	Technical Drawing(Autocad)	2.46	21 - 40	2.72	41 - 60	3.54	61 - 80
5	Construction Technology	3.02	41 - 60	3.03	41 - 60	4.06	61 - 80
6	Civil Engineering Lab.	2.37	21 - 40	2.53	41 - 60	3.23	41 - 60
7	Construction Management	2.71	41 - 60	3.20	41 - 60	3.79	61 - 80
8	Integrated Design Project	2.62	41 - 60	3.28	41 - 60	3.71	61 - 80
9	Elective Subject	2.72	41 - 60	2.80	41 - 60	3.17	41 - 60
10	Industrialised Building System	1.03	0 - 20	1.03	0 - 20	4.79	81 - 100

Indeed, in PUO the students have learned IBS more because almost all the subjects have 61-100% of IBS embedded, where as IBS subject is compulsory for the students. There are 7 subjects that have the average index more than (3.5) which is reinforced concrete design (3.65), steel and timber design (3.54), technical drawing (3.54), construction technology (4.05), construction management (3.79), integrated design project (3.71) and industrialized building system (4.79).These 7 subjects are from PUO.

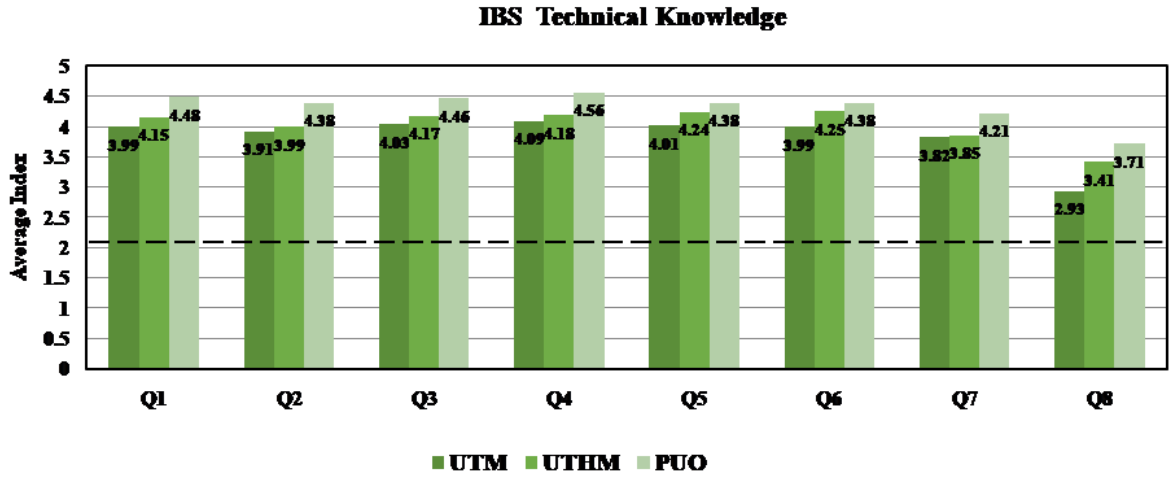

Figure 3. IBS Technical Knowledge

Meanwhile this study resulted in PUO students have more IBS knowledge compared to UTM and UTHM students as PUO students are the only that have average index higher than 3.5 given in figure 3. But, only on technical skills part because UTM, UTHM and PUO students have the same level of understanding on IBS technical knowledge as shown in figure 4. They all have average index higher than (3.5) for all the 8 questions. This shows that all of them have good understanding on IBS technical knowledge based on the results from questionnaires. Figure 4 below portray the level of agreement to technical skills among the respondents.

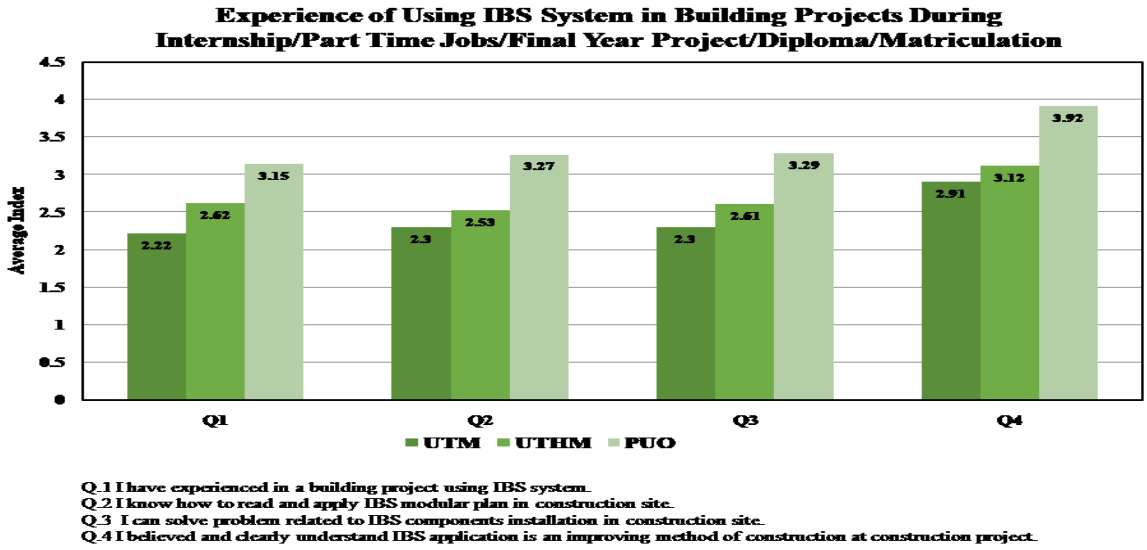

Figure 4. Experience of Using IBS System in Building Projects during Internship/Part Time Jobs/Final Year Project/Diploma/Matriculation

In figure 4 it is proven that PUO students exposed to more technical skills than UTM and UTHM because PUO students have the highest average index about experience of using IBS. It is followed by UTHM with average index between PUO and UTM. UTM students have the lowest average index amongst them. This means UTM and UTHM students' needs more focus on adoption and understanding of IBS for construction projects.

5. CONCLUSIONS

The global construction industry has shown significant interest in prefabrication due to the significant obstacles posed by the high demand for construction, increasing cost pressures, and pressing environmental concerns (Imran et al. 2019). This led the practitioners adopt new philosophical developments such as IBS. From the results and discussion, there are several conclusions that can be made:

1- UTM students has lower level of acceptance on IBS curriculum offered compared to UTHM and PUO students while PUO students has the high level of acceptance on IBS curriculum offers.
2- PUO has most of the subjects with the percentage of IBS that have been embedded in civil engineering curriculum offered comparative to UTM and UTHM.
3- UTM, UTHM and PUO students have the same level of IBS technical knowledge. However, PUO students have more experience on IBS construction and IBS technical skills than UTM and UTHM.

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