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QUANTITATIVE ANALYSIS ON THE LEVEL OF IBS ACCEPTANCE IN THE MALAYSIAN CONSTRUCTION INDUSTRY

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Abstract

This IBS Survey report continues a practice that began in 2003. The first report was published in 2003 followed by in 2005 and in 2008. It records recent trends in selected areas that reflect Malaysia's achievement on the IBS usage in building construction industry. Due to the dynamic economic and technological changes, IBS usage reports have been increasingly important. The design of the quantitative survey in IBS acceptance questionnaire is based on the Technology Acceptance Model (TAM). The comparison was done between the class of contractors G7 and the combined groups of G6, G5, and G4. The *t*-test analysis shows that all the class of contractors (G7, G6, G5 and G4) have a common agreement on the awareness of IBS and IBS actual use (the benefits of using IBS in construction) but have a significant difference in opinion on IBS actual use (the problems faced in using IBS and promotion of IBS by the government through CIDB), perceived ease of IBS use and perceived IBS usefulness. However, there are items in the variable that show significant difference between the comparison groups.

Keywords: Malaysia, Industrialized building system (IBS), Technology acceptance model (TAM), *t*-test analysis.

1. Introduction

The industrialized building system (IBS) was introduced by the Housing and Local Government in 1964 based on several European countries IBS models. The IBS method in the European countries gives good quality control on the production and effective mass production. IBS is a construction technique in which components are

Nomenclatures

p-value	A measure of probability that a difference between groups during an experiment happened by chance
t-test	Statistical test

Greek Symbols

α	Cronbach's alpha

Abbreviations

CIDB	Construction industry development board
CIMP	Construction industry master plan
IBS	Industrialized building system
MC	Modular coordination
MMC	Modern method construction
TAM	Technology acceptance model
OSCT	Off-site construction technology
OSM	Off-site manufacturing

and assembled into a structure with minimal additional site work [1-5]. The government carried out two pilot projects in 1966. The first project was the 17-storey Tunku Abdul Rahman Flats located in Kuala Lumpur consisting of residential 3000 units. The project adopted the Danish System using large prefabricated industrialized panels. The second project was the Rifle Range Road Flats located in Penang comprised of 3699 residential units and 66 shop lots along the Rifle Range Road [6, 7]. The previous Seventh Malaysia Plan (1996-2000) has targeted 800,000 units of houses; however, only 20% was achieved [8].

The construction industry development board (CIDB) has been actively promoting the use of IBS in the local construction industry since 1998. The concept of CIDB is to educate the contractors to function as "assemblers of components" instead of "builders". The commitment of the government in encouraging the use of this approach can be seen with the development of the Roadmap IBS 2003-2010 [1]. This IBS Roadmap was approved by the Cabinet Ministers in October 2003 with the aims of providing guidelines towards the establishment of an industrialized construction sector as well as achieving an open construction system by the year 2010. The development of this roadmap was based on the 5M strategy (machinery, manpower, material, measurement, and method) and will be implemented gradually within government projects [1]. This IBS guideline targets as much as 70% of the government projects to be in the category of buildings using the IBS approach in Malaysia by 2008 [9]. However, the level of success and effectiveness of implementing IBS at construction sites towards achieving the Construction Industry Master Plan (CIMP) 2006-2015 should be reviewed and tested in more detailed manner. The plan is a comprehensive plan charting the strategic position and future direction of the Malaysian construction industry over the next 10 years. The CIMP is also intended to ensure that the construction industry is well positioned to support the nation's overall economic growth and in meeting various challenges, such as the need to enhance productivity and quality along the entire construction industry value chain [3]. It is already a requirement for government projects to use IBS (from 30% in 2004 to 70% in 2008). CIDB Malaysia as a statutory body under The

Ministry of Works has been promoting the industrialization of construction sector through IBS road map 2003-2010.

Previous IBS surveys were conducted in 2003 and 2005; apparently the objectives of IBS Roadmap 2003-2010 have nearly met the target deadline. As such, this paper aims to highlight the IBS survey 2008 report in the 3rd review of the IBS awareness in Malaysia. This paper reports a survey conducted on the contractor construction companies in Malaysia. The main objective of the survey is to investigate the level of IBS acceptance in the Malaysian construction industry in year 2008.

2. Research Methodology

In this IBS usage survey, the most suitable survey instruments are determined to be used as the basis for data gathering, analysis and subsequent action planning. It also provides details about the type of data that are used in IBS survey 2008 report. This will help to clarify not only definitions and sources of data but their limitations as well. The methodology IBS survey 2008 is similar to Chen [10] and Dulaimi et al. [11] comprising of questionnaire design; a questionnaire survey; interview with the contractors, IBS manufacturers and the government agency; and statistical analysis of the survey data. The selected projects in this survey are mainly building construction projects and this paper focuses on questionnaire design and a quantitative questionnaire survey.

2.1. Research structure and key milestones

In order to have a good understanding of the survey results on IBS usage, the appropriate research structure was constructed. This research structure is to make IBS survey activities manageable. This research structure provides a basis for analyzing existing IBS survey and form a basis for the creation of useful results as shown in Fig. 1 [12].

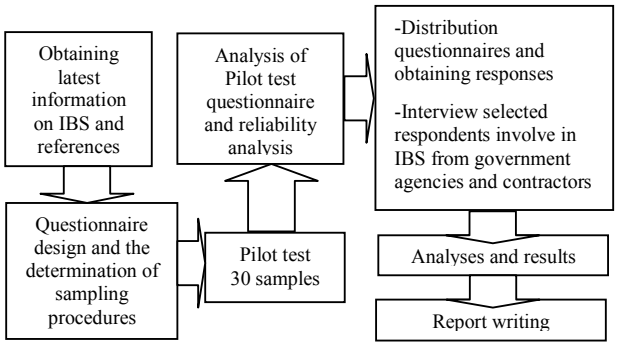

Fig. 1. IBS Research Structure [12].

2.2. Data collection based on questionnaire

Data for IBS awareness, actual use, true acceptance, and IBS project costs were obtained from the questionnaire. The IBS acceptance and usage questionnaire was created based on a technology acceptance model (TAM) as shown in Fig. 2. The

TAM is an information systems theory that models how users come to accept and use a technology [13, 14]. The model suggests that when users are presented with a new technology, a number of factors influence their decision about how and when they will use it. The output of TAM is as the indicator level of IBS acceptance however this paper will focus on the result of the *t*- test analysis.

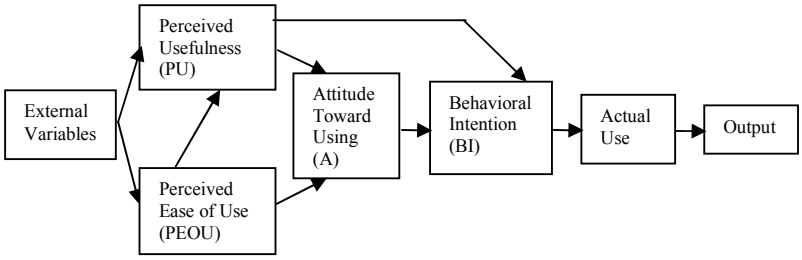

Fig. 2. The IBS Acceptance and Usage Questionnaire based on an original Technology Acceptance Model [14].

A total of 23 questions were developed to determine the usage of IBS and its relevant information. The questionnaire contains seven parts. Part 1 to 5 was developed to measure the IBS concerns. The details of the content of the questionnaire are presented in Table 1. The questionnaires were posted to the survey respondents (G4 to G7 represent building contractors in Malaysia) to gauge their perceived IBS awareness, knowledge and usage.

Table 1. The Design of IBS Questionnaire based on TAM [12].

Part	The IBS Design Questionnaire	No. of Items	TAM
1	IBS Awareness	6 statements	Perceived Usefulness
2	IBS Actual Use Information:		
	2.1 IBS in building projects	5 statements	
	2.2 IBS projects from 2004 to 2008	Subjective	Actual Use
	2.3 IBS benefits	8 statements	
	2.4 IBS problems	8 statements	
	2.5 Suggestions for improvement	5 statements	
3	Perceived Ease of IBS Use	5 statements	Perceived Ease of Use
4	Perceived IBS Usefulness	7 statements	Behavior Intention
5	Attitude toward Using IBS	4 types	Attitude Toward Using
6	Background Information	3 types	-
7	Comments/Views on IBS	Subjective	-

3. Results and Analysis of IBS Survey 2008

3.1. Background information

A total of 6886 questionnaires were sent through mails and 454 responses were obtained for this study. The response rate of this survey is 6.8%. Companies with G7 CIDB registration grades have given very good response to the IBS survey for

all regions. This is followed by G5 companies. Table 2 shows the CIDB contractor grade and the tender capacity.

Table 2. CIDB Contractor Grade and Tender Capacity.

Grade	Tender Capacity (RM)	Paid-up Capital (RM)
G7	No limit	750,000.00
G6	Not more than 10 millions	500,000.00
G5	Not more than 5 millions	250,000.00
G4	Not more than 3 millions	100,000.00

The reliability of the items has also been investigated. Cronbach (1951) quantified this reliability by proposing a coefficient (namely Cronbach's alpha) α which theoretically ranges from 0 to 1 [15]. If α is near 0 then the quantified answers are not reliable at all, and if it is close to 1 the answers are very reliable. As a rule of thumb, if $\alpha \geq 0.8$ then the answers are reliable [15]. Table 3 shows that the mean value for α-Cronbach is 0.787 and change the result into one decimal point will be approximately 0.8 which meet the result requirement of Leontitsis and Pagge [15]. The result is generated by using SPSS software.

Table 3. Mean Value of α-Cronbach IBS Questionnaire [12].

Part	IBS Questionnaire Design	α-Cronbach
1	IBS Awareness	0.861
2	IBS Actual Use Information:	
	2.1 IBS in building projects	0.858
	2.2 IBS projects from 2004 to 2008	0.723
	2.3 IBS benefits	0.681
	2.4 IBS problems	Nil
	2.5 Suggestions for improvement	Nil
3	Perceived Ease of IBS Use	0.744
4	Perceived IBS Usefulness	0.853
5	Attitude toward Using IBS	Nil
	Mean	0.787

3.2. *t*-Test analysis

The *t*- test was performed to determine the statistical significance of the IBS acceptance from the contractors and the result showed that there is no significant difference in the awareness on IBS (*p*-value = 0.071), problems faced in using IBS (*p*-value = 0.259) and promotion of IBS by the government through CIDB (*p*-value = 0.949). However there is a significant difference in IBS actual use (the benefit of using IBS in construction), perceived ease of IBS usage and perceived IBS usefulness as shown by the result of *p*-value 0.029, 0.001 and <0.001 respectively. In order to further measure the detail items of acceptance of IBS among the contractors in Malaysia, the *t*- test analysis was based on two groups; the first group consists of G7 and the second group consists of G6, G5 and G4. The *t*- test assesses whether the mean of the two groups are statistically different from each other. This analysis is appropriate to compare the mean of the two

groups, and especially appropriate for comparison of two groups. The *t*- test items focus on the awareness of IBS, IBS actual use, perceived ease of IBS use, and perceived IBS usefulness.

3.2.1. Awareness on IBS

Table 4 shows the result of the overall items awareness on IBS via the *t*-test analysis. The overall mean score is 3.01. G4-G7 has similar agreement on the P1Q1, P1Q3, P1Q4 and P1Q5 but they have disagreement on P1Q2. G7 is more familiar on the term of Industrialized Building System than other contractors (*p*-value = 0.050). G7 has more expert capability in the IBS system than the other contractors. G7 have the technological advantages that associated with possessing formidable construction technologies; sophisticated management systems for scheduling, material tracking, organized sub-contractors; and financing that enables the company to arrange financing for IBS project.

Table 4. The Awareness on IBS.

Code	Item	Group	N	Mean Score	*p*-value
P1Q1	The awareness of the government enforcement of using IBS	G7	281	3.83	0.080
		G6,G5,G4	131	3.66	
P1Q2	The familiarity of the term Industrialized Building System	G7	281	3.72	0.050*
		G6,G5,G4	131	3.40	
P1Q3	The awareness of MS1064	G7	280	2.73	0.277
		G6,G5,G4	130	2.62	
P1Q4	The familiarity of MS1064	G7	276	2.49	0.487
		G6,G5,G4	130	2.42	
P1Q5	The awareness in year 2006, where the government required applied the MS1064 in IBS to increase standardization IBS components	G7	278	2.68	0.509
		G6,G5,G4	130	2.61	

* Indicates the difference of *p*-value 0.05 between G7 and G6, G5, G4.

3.2.2. IBS actual use

Tables 5, 6 and 7 show the items IBS actual usage which has three sets of questionnaire. Table 5 shows the benefits of using IBS in construction, Table 6 shows the problems faced in using IBS and Table 7 shows promotion of IBS by the government through CIDB.

Table 5 shows that all contractors have the similar view on P2Q9C, P2Q9D, P2Q9E, P2Q9F, P2Q9G and P2Q9H. The G7 manage to minimize the site labor as compare to other contractor (*p*-value = 0.028). With the problem of labor shortage and especially with the lack of skilled workers, the IBS system provides vast opportunities to be competitive and profitable. Kadir [6] has the same agreement with studies carried out by Peer and Warszawski [16] which indicated that with the use of IBS, labor can be saved up to 70 percent in Israel, 50 percent in Singapore [17] and Japan [18]. But it is insignificant in Malaysia where

Kadir [6] studies found that the difference in actual labor productivity between conventional and IBS was mainly contributed by the cycle time (difference of 76 percent) rather than the crew size (difference of 18 percent). At same time G7 is able to minimize wastage (p-value = 0.012) more than the other contractors where able to undergoing the paradigm shift from using conventional technology to a more systematic and mechanized system that utilizes the latest information and communication technology.

Table 5. The Actual Use of IBS (the Benefits of Using IBS in Construction).

Code	Item	Group	N	Mean Score	p-value
P2Q9A	Reduction of site labor	G7	269	4.08	0.028*
		G6,G5,G4	121	3.91	
P2Q9B	Minimal wastage	G7	270	4.21	0.012*
		G6,G5,G4	119	4.03	
P2Q9C	Less site materials	G7	271	4.09	0.154
		G6,G5,G4	120	3.98	
P2Q9D	Cleaner environment	G7	271	4.14	0.087
		G6,G5,G4	121	4.02	
P2Q9E	Controlled quality	G7	271	4.00	0.240
		G6,G5,G4	120	3.91	
P2Q9F	Neater and safer construction sites	G7	271	3.90	0.055
		G6,G5,G4	119	3.75	
P2Q9G	Faster project completion	G7	270	3.96	0.470
		G6,G5,G4	120	3.90	
P2Q9H	Lower total construction costs	G7	269	3.07	0.523
		G6,G5,G4	121	3.02	

* Indicates the difference of p-value 0.05 between G7 and G6, G5, G4.

Table 6 shows that all contractor have the same view except for P2Q10G regarding the lack of standardization and repetition when applying the IBS system for the construction project. G6, G5 and G4 agree significant with mean value 3.70 compare with G7 which is 3.44 that would result in lack of standardization and repetition (p-value = 0.007). Prefabrication, like Lego blocks, share a similar concept of producing standardized shapes in unlimited designs using the principles of Modular Coordination (MC). Standardized components such as wall panels, window walls, floor panels, beams, columns and entire building components are usually produced in large units in the IBS manufacturing plants. They are ready-made, ready to be assembled on the building site. Currently IBS component is still expensive and requires high volume to minimize the cost of the project which required high repetitive usage of the IBS component. That is why the government introduced the Malaysian Standard MS 1064 which requires architects, suppliers, and contractors to follow the standard specification set for the size of basic modular units [7]. The advantages of prefabrication include the cost savings of mass production and the technique permits the speedy erection of very large structures.

Table 6. The Actual Use of IBS (the Problems faced in using IBS).

Code	Item	Group	N	Mean Score	*p*-value
P2Q10A	Higher cost compared to the conventional methods	G7	255	3.51	0.933
		G6,G5,G4	111	3.52	
P2Q10B	Complaint on leakage at joints by clients	G7	252	3.41	0.931
		G6,G5,G4	109	3.40	
P2Q10C	Lack of expertise in implementation and installation	G7	253	3.66	0.890
		G6,G5,G4	110	3.63	
P2Q10D	Non acceptance by client	G7	255	2.85	0.854
		G6,G5,G4	108	2.87	
P2Q10E	Problems in design alteration during or after construction	G7	256	3.59	0.829
		G6,G5,G4	110	3.56	
P2Q10F	Limited suppliers of prefabricated elements	G7	254	3.75	0.217
		G6,G5,G4	113	3.87	
P2Q10G	Lack of standardization and repetition	G7	255	3.44	0.007*
		G6,G5,G4	109	3.70	
P2Q10H	Preference of conventional type of construction method	G7	256	3.39	0.190
		G6,G5,G4	111	3.51	

* Indicates the difference of *p*-value 0.05 between G7 and G6, G5, G4.

Table 7 shows that all the contractors agree on the actual use of IBS and on the Government's role in promoting the use of IBS in the construction industry. This finding is also in agreement with the study done by Froese et al. [19] in Canada and Dulaimi [11] in Singapore. Both studies have suggested the important role of the government to educate and build up the awareness of using the information technology in developing the construction industry and providing financial assistance and support to companies seeking to expand overseas.

Table 7. The Actual Use of IBS (promotion of IBS by the Government through CIDB).

Code	Item	Group	N	Mean Score	*p*-value
P2Q11A	Government offer more incentive	G7	281	4.18	0.951
		G6,G5,G4	127	4.17	
P2Q11B	Compulsory attendance of IBS training	G7	282	3.46	0.789
		G6,G5,G4	126	3.44	
P2Q11C	Compulsory use of IBS through building	G7	282	3.07	0.860
		G6,G5,G4	127	3.05	
P2Q11D	Include IBS in the university syllabus	G7	280	3.96	0.206
		G6,G5,G4	127	3.87	
P2Q11E	Increase levy for employing unskilled labor	G7	281	2.89	0.417
		G6,G5,G4	124	2.98	

* Indicates the difference of *p*-value 0.05 between G7 and G6, G5, G4.

In today's environment, the markets have expanded involving international players and more demanding customers. Customers are demanding more variety, better quality service and faster delivery. Globalization also brings foreign

competition into the markets that were traditionally local. Therefore IBS plays an important role in assisting the construction industry to compete and meet the market standard demand. The main function of the IBS is to create synergy, by generating partners in the industry to assist in training, giving exposure on use of IBS techniques, encouraging the setting up of new IBS factories locally, updating on the latest technology, and tackling current issues on IBS at the local state and international level [1].

3.2.3. Perceived ease of IBS Usage

Table 8 gives the response on the items perceived ease of IBS usage. All contractors have the same agreement in P3Q13 and P3Q14. G7 can easily obtain information on the use of IBS compared to the other contractors which have limited information on the use of IBS (p-value < 0.001). G7 agreed the most that the installation of IBS components will require fewer workforce compare to the other contractor (p-value = 0.007). G7 have more capital to buy the technology to suit to the local condition. The other contractor will take time to adjust the human resource requirement and to adjust to the system to meet the IBS requirement. G7 is more adaptable to become skilful at using IBS compare to other contractors (p-value = 0.019).

Table 8. The Perceived Ease of IBS Usage.

Code	Item	Group	N	Mean Score	p-value
P3Q12	Learning the concept of IBS is easy for the company	G7	279	3.65	<0.001*
		G6,G5,G4	126	3.36	
P3Q13	It is easy for company to get info on IBS	G7	279	3.33	0.228
		G6,G5,G4	126	3.22	
P3Q14	The transportation & storage of IBS component to be manageable	G7	279	3.43	0.230
		G6,G5,G4	126	3.32	
P3Q15	The installation of IBS components will required fewer workforce	G7	279	3.76	0.007*
		G6,G5,G4	126	3.53	
P3Q16	It is easy for the company to become skillful at using IBS	G7	279	3.54	0.019*
		G6,G5,G4	125	3.34	

* Indicates the difference of p-value 0.05 between G7 and G6, G5, G4.

3.2.4. Perceived IBS usefulness

Table 9 gives the response on the items perceived IBS usefulness. Item P4Q19, P4Q21 and P4Q23 have the same agreement statement of all contractors. G7 has strong agreement in using IBS would quickly accomplish the construction works (p-value = 0.026) and able to improve the project performance (p-value < 0.001); and IBS is a usefulness in construction projects than other contractors (p-value < 0.001). This is because of the G7 have better logistical practice and manage to deliver the products at the right place, at the right time and at the right price has become a new challenge for companies, rather than producing only high quality products. While the other contractor still in the process of collaboration and management within Malaysia IBS construction industry are at present associated

with an inappropriate traditional culture and the unique features of the organizational structure.

Table 9. The Perceived IBS Usefulness.

Code	Item	Group	N	Mean Score	*p*-value
P4Q17	Using IBS in a project would enable the company to accomplish construction works more quickly	G7	280	3.86	0.026*
		G6,G5,G4	128	3.68	
P4Q18	Using IBS would improve project performance	G7	279	3.85	<0.001*
		G6,G5,G4	128	3.58	
P4Q19	Using IBS in the project is the way to move forward and be more competitive in the construction industry	G7	279	3.82	0.115
		G6,G5,G4	128	3.68	
P4Q20	Using IBS would enhance project efficiency	G7	279	3.85	0.001*
		G6,G5,G4	128	3.60	
P4Q21	Using IBS would make it easier to complete a project	G7	279	3.65	0.055
		G6,G5,G4	128	3.50	
P4Q22	IBS is useful in construction projects	G7	279	3.87	<0.001*
		G6,G5,G4	128	3.59	
P4Q23	Aware that the residential constructions using 50% or more of can obtain exemption on levy by CIDB since February 2005	G7	277	3.29	0.076
		G6,G5,G4	127	3.12	

* Indicates the difference of *p*-value 0.05 between G7 and G6, G5, G4.

4. Conclusions

The study on the percentage of IBS usage in Malaysia was successfully carried out from June 2008 to December 2008. The acceptance of IBS was measured using the TAM that covered four aspects including (a) the awareness on the IBS system IBS (b) the actual usage of IBS (c) the perception on the ease of IBS usage and (d) perception on the usefulness of IBS. The *t*-test of the average percentage difference shows that all the respondents consisting of class contractors (G7, G6, G5 and G4) have strong agreement on the IBS actual use (problems faced in using IBS), the awareness on IBS and the IBS actual use (promotion of IBS by the government through CIDB) with 0.63%, 3.98% and 4.06% respectively. But there are disagreement in perceived IBS usefulness, the perceived ease of IBS usage and the actual use of IBS (the benefits of using IBS in construction) vis-à-vis 12.74%, 10.06% and 6.54%. This shows that all the contractors are facing the common problems in using IBS. However, they are highly aware of the importance of IBS in the construction industry as well as the need to overcome the problems in using IBS. They appreciate the role of CIDB to promote IBS in the Malaysian construction industry. In contrast, there is doubt on IBS actual use in the context of benefit, perceived ease of IBS use and perceived IBS usefulness from the all the correspondents consisting of contractors, where the *t*-test on items shows that G7 have strong agreement on the usage of IBS with their acceptance of the IBS system

as compared to other class of contractors (G6, G5, G4). Thus the *t*-test on items shows that G7 and G6, G5, G4 have significant difference in each independent variable except for the actual use of IBS (Table 7). G7 and G6, G5, G4 are in agreement on the important role of CIDB in educating the construction industry to apply the IBS extensively. The study shows most of the contractors believed that the IBS system can help to generate a better quality building system and assist in reducing the dependence on foreign workers. The building industry is now ready and with the Treasury Circular Letter No. 7/2008 by the ministry of Finance Malaysia, the percentage of IBS components in every government project may reach up to 70% as proposed in the Roadmap 2003 -2010.

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