Available online www.ejaet.com

European Journal of Advances in Engineering and Technology, 2015, 2(12): 11-20

Research Article ISSN: 2394 - 658X

Unlocking the Potential Value of BIM Implementation in Malaysia: A Pilot Study

Afifuddin Husairi Hussain[1], Mohd Khairi Abu Husain[1], Adi Irfan Che Ani[2], Noor Irza binti Mohd Zaki[1] and Zarina Mohd Ali[3]

[1]RAZAK School of Engineering and Advance Technology, Universiti Teknologi Malaysia
[2]Faculty Built Environment, Universiti Kebangsaan Malaysia
[3]Centre for Modern Languages and Human Sciences,Universiti Malaysia Pahang
afifuddinhusairi@gmail.com

ABSTRACT

Previous research has consistently shown that the implementation of BIM has brought tremendous benefits to clients. A number of countries around the world especially among the developed nations have realized the vast opportunities that BIM brings and have thus been investing to develop their own capability. In Malaysia, BIM is still in the infancy stage as it currently stands. As such, the implementation of BIM is likely to face a number of challenges in its adoption. Therefore, the aim of this research is to measure the potential of value of BIM implementation from the perspective of client organisation. A 25-item questionnaire was piloted and randomly distributed to 500 private clients organisations in Malaysia, which yielded 13% response rate. Rasch measurement model was employed in the analysis of responses from 65 clients' organisations using WINSTEPS version 3.73. Preliminary results showed that clients' organisations were divided into five groups according to separation strata namely: innovators (n=2); late adopters (n=9); early majority (n=23); late majority (n=9); and laggards (n=7). The most competent group had logit score of P_{max} *= +6.17 while the logit score for the least competent group,* P_{min} *= -6.00. Preliminary findings suggest that Malaysia is on the right track to implement BIM like in other developed countries.*

Key words: Building Information Modeling, Rasch Measurement Model, Construction Industry, Construction Management, Construction Business

INTRODUCTION

The findings of previous research have consistently shown that clients are among the parties that obtain great values from the BIM implementation [1-4]. For clients, current fragmented nature of the AEC industry indicates the need for enhancement of coordination and collaboration process [5-7]. Extensive clients' involvement with BIM will accelerate an exciting pace at which it is growing around the globe [8-10]. Many construction clients are expecting that BIM will transform their business operation [11-14]. Applying BIM in business has positive effects on collaboration [15-17], coordination of multiple disciplines [18-20], sustainable design as well as competency and reputation of organisation [21-24]. With BIM implementation, the proposed design and engineering solutions can be reliably measured based on the client's requirements [25]. Moreover, the implement of BIM will enhance the delivery and value of their core expertise [28-29], streamline their workflow [26-27], improve communication with clients, consultants, and contractors [30-31] broaden the services they offer to clients [32] and ideally, increase net revenue [33]. Therefore, BIM can be an innovative guiding beacon for clients to directing their business process towards enhancement of organisational development and growth.

This research is concerned with the implementation of BIM from the perspective of client in the Malaysian AEC industry. Clients who are owners of a construction project are potentially the major drivers for BIM in the Industry. However, recent studies have tended to constantly focus on the needs of consultant and contractor [34-37], instead of the needs of the clients. Thus, the present study aimed to study the potential implementation of BIM from the clients' perspective. As this study viewed the potential implementation of BIM from the clients' perspective, its scope covered the decision making process for BIM throughout the project/asset life cycle. The main objective of this research was to analyse the potential of value of BIM implementation from the perspective of client organisations. It is anticipated that the findings of this research will contribute to filling the void the relevant literature and knowledge regarding the implementation of BIM at a strategic level particularly concerning client organisations

RESEARCH METHODOLOGY

A quantitative method was adopted, appropriate to the exploratory aims of the research, which was to unlock the potential value of BIM implementation in Malaysia. Mail questionnaire was employed in this research. A pilot study was conducted to assess the feasibility of twenty-five items of BIM uses in measuring the potential value of BIM implementation in a full-scale study. By conducting a pilot study, problems encountered by the respondents with the item statements could be identified and improvement could be made before data collection for the main or actual study began. The period of data collection for the pilot study was between March 2014 and June 2014. During that period, it was reported that no Government agencies has mandated the usage of BIM and that there had been no national scale reports or surveys on BIM usage – an indication of the scarcity of research on BIM in Malaysia [38].

Twenty-five items were tested in a questionnaire that was mailed to 500 housing and property developer organisations in Malaysia. The instrument was adapted from BIM survey for organizations by [39]. A 5-point Likert rating was used (1=Unimportant; 2=Less important; 3=moderately important; 4=Important; 5=Very important). Prior to the pilot study, the instrument had been reviewed by two groups of experts comprising two academicians and four industry practitioners for content validity process. All the reviewers had agreed that the items in instrument were relevant to the respondents with some advice and suggestions for changes. Furthermore, to validate the instrument, the pilot study followed the precise procedure of determining the goodness of fit of data. This involved a series of tests such as Item calibration, Reliability and validity tests, Item-Person Fit, Unidimensionality test and Differential Item Functioning (DIF), Local Dependence and Item-Person Fit.

After the goodness of fit of data was determined, then only the main analysis was conducted. Data were first sorted, coded and entered in *Microsoft Excel 2010* and then saved in *.csv* format before being transferred into *WINSTEPS Version 3.73* to perform Rasch Analysis [40-41]. Before the first and second tests were performed, the overall demographic profile was tabulated.

DATA ANALYSIS

Response Rate

The response rate for the survey was 13%. It had been anticipated that response rate from mail survey was not high as reported in other studies which had used similar data collection method. It had taken four months to receive feedback from 13% (64 questionnaires) of the respondents before researchers decided to proceed with the analysis. Of these responses, valid responses were 69% (44 respondents), 39 % (38 respondents) partial response and 11% (11 respondents) invalid as respondents had refused to answer. Such response rate was consistent with previous research on BIM such as [42-44] with response rates of 11.8%, 18.7% and 8% respectively. The low response rate for this study was probably because the respondents were not familiar with BIM implementation and their organisations did not implement BIM and therefore had chosen not to respond to the mail survey. Another reason was probably because of the method chosen being mail survey.

Demographic Data

Slightly more than half of the respondents (66%) were of the age of 40 years and above. Further analysis on the highest tertiary education showed that majority of respondents (52%) had at least Degree qualification, followed by 20% of respondents who had professional qualification. For the working experience in industry, majority (75%) of the respondents had more than 10 years of experience. Additional information collected about the respondents indicated their level of knowledge on BIM. It was found that 66% of the respondents had knowledge of BIM. It showed that while BIM was still relatively new and had yet to be fully implemented in the country, there was already awareness of BIM implementation. However, majority of them (92%) did not have working experience with BIM at all. Based on respondents' demographic information (age, highest tertiary education and working experience in industry) it can be concluded that most of respondents were competent to respond to the items in this questionnaire. Therefore, this pilot study had sampled the right group of respondents.

For demography of organisations, 75% of the organisations which the respondents represented had been established for more than 10 years. Further investigation on the practice of sending their employees for training or seminar on BIM implementation by organisations also showed that, slightly more than half of the respondents (52%) admitted that their organisation had been sending their employees for training. In terms of level of implementation of BIM in their respective organisations, only 14% of the respondents indicated that their organisations were not interested to implement BIM. The rest of the organisations were found to be exploring the possibilities of implementing BIM (30%) while 27% of the organisations already had a structured plan to implement BIM. Only 5% of the respondents indicated that their organisations were already using BIM. Nevertheless, 59% of the respondents admitted that the projected period for their organisations to start using BIM was within 5-year period with nearly half of them within 1 year. Overall, although BIM had not yet been implemented in clients' organisations, there was a relatively high level of awareness of BIM among the target group. This was consistent with the results of a study published in the UK NBS National BIM Report 2014 which found that 93% of those who knew about BIM believed they would be using it in three years' time [45]. It was also reported in the findings of the same study that 54% were aware of and already using BIM in the UK.

GOODNESS OF FIT OF DATA

Decisions to retain the items in the questionnaire based on analysis from the pilot study were made according to goodness of fit of data, determined by a series of tests on item calibration, unidimensionality, reliability and validity, Differential Item Functioning (DIF), Local Dependence and Item-Person Fit.

A. Item Calibration Test

In Rasch Measurement Model, the validity of the scale eventually affects the measurement of responses according to response categories. Therefore, adequate data in each category is required for the consistency of measurement. Analysis of data as shown in Figure 1 indicates that the Observed Average increases consistently from -0.95 to 1.14 logits. This suggests consistency in response pattern; persons with higher ability endorsed the higher categories, and those with lower ability endorsed the lower categories.

[46] suggest that that the difference in threshold should be within 1.4 logits to 5.0 logits. Table 1 further reveals that the separation between rating 2 and rating 4 needed to be collapsed since the separation was less than 1.4. The purpose of collapsing is to improve the functioning categories and clarification to the data. The collapsing of categories should be done few times based on trial and error, until it produced an ideal and consistent increase-efficacy in observed averaged, ordered thresholds, higher person separation and the difference between categories would be of more than 1.4 [47].

Table 2 displays that categorization 011155 yields produced higher person separation. Thus, categorization 011155 was proposed; the lowest response categories were combined giving score 0 for category "Totally disagree", score 1 for "Somewhat Agree" and score 2 for "Strongly Agree". By using these three categories, the data were re-arranged and rename for actual questionnaire survey in the main study. After collapsing, 5-point rating became 3-point rating (1=Unimportant; 2=moderately important; 3=Very important), there was a consistency in the response (see Table 3). What was being measured is a culturally acceptable response to the particular item where there exists ordered form of observed average measure, structure calibration, and category measure, indicating the well-functioning three-category (two-threshold) rating scale.

Table -1 Summary of Category Structure

CATEGORY		Observe Count		Observe Average	Structure Calibration	Category Measure
LABEL	Score	Count	%			
Unimportant	1	228	21	-0.95	None	-2.70
Less Important	2	141	13	-0.56	-1.28	-1.22
Moderately Important	3	291	26	0.15	-0.85	-0.07
Important	4	248	23	0.86	0.57	1.19
Very Important	5	192	17	1.14	1.56	2.87

Table -2 Comparison of 6 Categorisation

Category	Average Measure	Person Separation	Diff in cat measure (Min)	Diff in cat measure (Max)
012345	Disordered	3.59	<1.4	>5.0
000445	Ordered	1.85	>1.4	<5.0
011155	**Ordered**	**4.77**	**>1.4**	**<5.0**
011223	Ordered	4	>1.4	<5.0
011444	Ordered	4.62	>1.4	<5.0

B. Unidimensionality Test

In Rasch Measurement Model, unidimensionality is based on the value of Raw Variance Explained by Measures and Unexplained Variance in first contrast that produced by Principle Component Analysis (PCA) [48-50]. The unit analysis is Eigenvalue. To satisfy unidimensionality, the items in the instrument must measure the same composite of abilities the potential value of BIM implementation.

The PCA of the residuals in Rasch measurement model show that the Raw Variance Explained by Measures was 66.40%, which closely matched the expected target of 66.50% (see Table 4). Raw variance explained by measures consisted of 38.90% of raw variance explained by items and another 27.50% of raw variance explained by persons. Rasch analysis requires at least a minimum of 40% raw variance explained by measures as proposed by Fisher. The unexplained variance in the first contrast was 8.20%, which was fair according to Fisher [51].

Table -3 Final Category Structure

CATEGORY		Observe Count		Observe	Structure	Category
LABEL	**Score**	**Count**	**%**	**Average**	**Calibration**	**Measure**
Unimportant	0	89	8	-3.05	None	-3.67
Moderately Important	1	542	49	0.42	-2.57	-0.23
		0	0		Null	1.31
Very Important	2	469	43	1.78	2.57	2.26

Table -4 Standardized Residual variance (in Eigenvalue units)

		Empirical			Modeled
Total raw variance in observations	=	74.4	100.00%		100.00%
Raw variance explained by measures	=	49.4	66.40%		66.50%
Raw variance explained by persons	=	20.5	27.50%		27.60%
Raw Variance explained by items	=	29	38.90%		39.00%
Raw unexplained variance (total)	=	25	33.60%	100.00%	33.50%
Unexplained variance in 1st contrast	=	6.1	8.20%	24.50%	

C. Reliability and Validity Tests

Table 5 shows the summary statistics for 44 measured Organisations and 25 measured Items. The overall mean on the Organisation ability was $Mean_{Person}$ 0.30 logit. The infit of mean square (MNSQ) was 0.98 and z-standard (ZSTD) was 0.50, indicating that there was goodness of fit of the instrument in measuring what was supposed to be measured since the value was close to 1 and 0 respectively. Besides, the separation index (3.13) indicated that instrument managed to separate the respondents into five distinctive groups along a continuum. This means that the instrument was capable of separating the anticipation for BIM implementation of clients' organisations into five strata or profiles, namely Innovators, Early Adopters, Early Majority, Late Majority and Laggards. This endorses that the demographic information was reflective of the formation of five categories of client organisations.

Item Reliability of 0.91 suggests that the instrument was 'very good' [51]. The high item reliability also indicated that if the study was to be replicated using the same instrument that had these items and distributed to another sample of respondents from the targeted group, it would likely yield similar results [52-55]. The high-test reliability might be due to the adequacy of item difficulty, which resulted in sufficient useful information for parameter estimation. As for the item mean, it was set at 0.00 logit to ensure that each organisation has a 50:50 chance of success in responding to the item that matches their ability. The instrument had a good measurement model error of ± 0.14 logit [51]. The separation statistic for items was 3.23, indicating the 25 items were generally separated into five level of difficulties, ranging from very easy to very difficult.

In general, the organisations' ability to implement BIM was found to be high at the mean logit of 0.30 logits. This indicates that there were many items, which were easy to be endorsed. The maximum item measure was +1.04 logits while person ability was at a high +6.17 logits. Despite the very good reliability, however, more items needed to be introduced for that large gap of 5.13 logits. Nevertheless, there were sufficient items (a gap of 3.95 logits) for the easy task where the minimum item measure was at -2.05 logits.

D. Differential Item Functioning (DIF)

Differential item functioning (DIF) analysis is a procedure conducted to determine that an item is fair and apt in assessment and measurement. It is based on the assumption that the individuals participating in the measurement activity have similar ability and should perform in similar ways regardless of their groups (gender, ethnicity etc.). A good item shall have invariant estimates across sub-groups of persons [39]. An item with large Differential Item Functioning measures of DIF size greater than ± 0.5 and DIF t greater than ± 2.0 are said to be biased in measuring the respondents' ability [56-59]. Figure 1 and 2 shows the DIFF Size between groups in terms of staff attendance in any seminar, training or seminar on implementation of BIM. Effect size values of the t-test and correlations results were calculated to identify the magnitude of the effect of the variables. As can be seen, the differences were obvious for some items and the gap in the agreeability level was big. Although the items were well discriminated, they did not fall outside the predefined range, thus indicating no item bias [53, 57-59].

Overall, DIF analyses for training attendance indicated that the instrument was generally working the same for both groups. However, for the three items showing minor discriminating, additional research would be useful to try to understand why they were functioning differently, or should be either rewritten or selected for removal.

E. Local Dependence

The effect of local dependence is assessed in the following manner. If the Largest Standardized Residual Correlations (LSRCs) were between 0.70 and 0.58, this indicated that no pairs of items shared more than around 80% of their random variance. As shown in Table 5, correlated residue of the items SiteUP and BSA was still less than the maximum allowable limit of 0.80. Hence, all the items listed were retained for the purpose of further measurement.

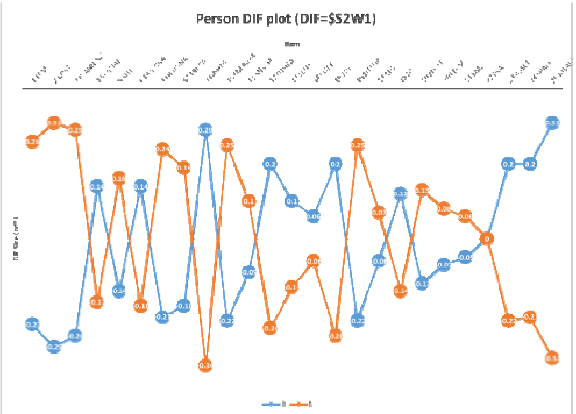

Fig. 1 DIFF Size

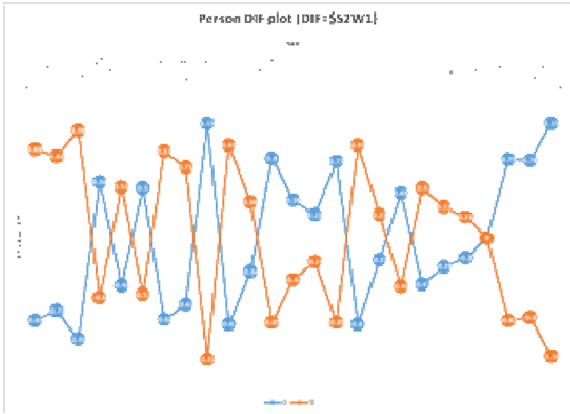

Fig. 2 DIFF t-value

Table -5 Summary Statistics

	Organization	Item
Cronbach Alpha (α)	0.97	
Reliability Index	0.91	0.91
Separation Index	3.13	3.23
Mean	0.30	0.00
S.D	2.66	0.69
Max	6.17	1.04
Min	-6.00	-2.05

Table -6 Largest Standardized Residual Correlation

Correlation	Entry Number	Item	Entry Number
0.70	16	SiteUP	22 BSA
0.63	9	LightA	11 MechA
0.58	3	Planning	7 DesignA
-0.65	8	StrucA	20 RecM
-0.64	5	Site	22 BSA
-0.62	12	OthEA	19 3D_CP
-0.62	14	Code	22 BSA
-0.61	13	LEED	20 RecM
-0.61	18	DF	19 3D_CP
-0.59	1	ECM	20 RecM

F. Person and Item Fit Analysis

The fit statistics were examined to determine how well the empirical data met the requirements of Rasch Model. Item fit statistics were used to identify misfitting items that may not be contributing to a unidimensional construct being measured and needed to be examined and either revised or eliminated (Smith et al., 2002). The acceptance range of the infit mean square statistics for each item in this study followed suggestions from [60-62] in which three criteria were considered in examining the outfit data. The person and item were considered to be misfit with the model if the point measure correlation (PtMea Corr) is larger than 0.4 and less than 0.85 (0.4 <PtMea Corr < 0.85), the outfit mean square (MNSQ) is larger than 0.5 and less than 1.5 (0.5<MNSQ<1.5) and the outfit Z-standard (ZSTD) is larger than -2 and less than +2. The three criteria must be fulfilled or otherwise the person or the item would be considered as the outfit or outliers in the data.

Based on the criteria suggested by [60-62], none of the items were identified as misfit items as shown in table 7. None of the items fulfilled the three stipulated criteria for misfit indicators. This shows that in general, all items fitted the Rasch Measurement Model, except for two items. These two items (MechA and DF) were considered as minor misfits. Since this study was at pilot stage, further precaution factors need to consider overseeing these two items for real study.

According to Table 8, nine organisations (20%) were identified to be misfits by the indicators of MNSQ, ZSTD, and Pt.Mea Corr. Therefore, it was decided that these nine respondents were discarded in order to raise the value of person- and item reliability as misfit respondents representing one of the factors affecting the reliability value index. This analysis demonstrated issues on targeting respondents. Some respondents were exhibited as misfit persons. Further qualitative and technical clarifications are needed to scrutinise this issue. The factors that led to this scenario could be because respondents were not familiar enough with the items, thus their responses were distorted. Since this was at the pilot stage, it is recommended that structured interview should be employed to further investigate these issues.

Table -7 Item Fit Order

Item	TOTAL Score	MEASURE	MODEL S.E	Outfit		Point Measure Correlation
				MNSQ	ZSTD	
MechA	131	0.12	0.19	1.86	3.2	A .65
DF	146	-0.42	0.19	1.58	2.3	B .71
LightA	127	0.26	0.18	1.42	1.8	C .68
Disaster	104	1.04	0.19	1.17	0.8	D .65
3D_CP	130	0.16	0.19	1.17	0.8	E .72
ECM	152	-0.65	0.2	1.19	0.9	F .77
RecM	120	0.5	0.18	1.07	0.4	G .70
OthEA	130	0.16	0.19	1.08	0.4	H .73
Spatial	124	0.36	0.18	1.08	0.4	I .73
SiteA	160	-0.99	0.21	1.07	0.4	J .82
Code	122	0.43	0.18	0.95	-0.2	K .74
BMS	115	0.66	0.18	0.93	-0.2	L .72
Space	107	0.93	0.19	0.92	-0.3	M .70
3DC	150	-0.57	0.2	0.91	-0.3	l .80
Cost	179	-2.05	0.27	0.91	-0.2	k .85
StrucA	138	-0.12	0.19	0.88	-0.5	j .79
LEED	151	-0.61	0.2	0.84	-0.7	i .81
DesignA	135	-0.02	0.19	0.87	-0.5	h .78
Programming	132	0.09	0.19	0.83	-0.7	g .78
BSA	113	0.73	0.18	0.74	-1.2	f .73
DesignR	159	-0.94	0.21	0.7	-1.4	e .85
Asset	111	0.8	0.18	0.67	-1.6	d .74
EnergyA	127	0.26	0.18	0.67	-1.6	c .82
CDS	145	-0.38	0.19	0.56	-2.3	b .85
SiteUP	127	0.26	0.18	0.43	-3.2	a .83

Table -8: Organisation Fit Order

ENTRY Number	TOTAL Score	Measure	MODEL S.E	OUTFIT		PMC	Remarks
4	98	1.16	0.25	2.21	3.3	0.44	Misfit
35	82	0.3	0.22	2.11	3.3	0.53	Misfit
3	80	0.2	0.22	2.02	3.1	0.65	Misfit
44	101	1.34	0.25	2.01	2.8	-0.07	Misfit
9	71	-0.23	0.22	21.84	0.7	0.37	Misfit
15	97	1.1	0.24	1.73	2.2	-0.02	Misfit
--- consolidation---							
7	99	1.22	0.25	0.44	-2.4	0.29	Misfit
--- consolidation---							
31	100	1.28	0.25	0.39	-2.7	0	Misfit
41	100	1.28	0.25	0.39	-2.7	0	Misfit

G. Overall Goodness of Fit of Data

The preliminary findings from the pilot study have shown that the 25-item instrument used was capable of measuring the value of the BIM implementation in Malaysia. This was achieved after six goodness of fit of data tests (item calibration test, unidimensionality test, reliability and validity tests, Differential Item Functioning (DIF), Local Dependence and Item-Person Fit), were conducted. The instrument demonstrated that it was fit in measuring the value of the BIM implementation in Malaysia. With the exception of person fit test, the entire tests demonstrated its normality. This revealed that all the items were well functioning, although there were slight issues in targeting the suitable respondents representing the appropriate organisations.

DISCUSSION

As illustrated in Figure 3, the organisations were divided into 5 groups according to separation strata namely as innovators (n=2), late adopters (n=9), early majority (n=23), late majority (n=9) and laggards (n=7). The most competent group is P_{max} is at +6.17 logit and the least competent group; P_{min} is at -6.00 logit.

A quick glance of the Figure 3 is that about 5% from total respondents are located at the upper map and therefore was categorized as innovators. Both of these organisations shared same logit ($ß_{max}$ = +6.17) and identify as maximum extreme score. Other than that, both organisations in this group shared the same demographic characteristics of having been implementing BIM. This group would be referred to as trendsetters for BIM implementation. They had score to all items in measuring values of BIM implementation. Indeed, they were among organisations that had embraced BIM and were experimenting BIM application.

The second group that represented 20% from total organisations was the late adopters for BIM implementation. The maximum logit for this group is $ß_{max}$ = +1.34 logit and the minimum logit is $ß_{min}$ = +1.04 logit with the +0.30logit

length. By character, the late adopters had special interest in BIM implementation and diligently paid attention to what the innovators discovered and found a practical use of BIM. This group played a very important role by influencing the attitude in BIM implementation and changing the behaviour of the late adopters to embrace BIM.
The third group that represented 52% from total organisations was the early majority for BIM implementation. All of the organisations in this group were located ranging from $ß_{max}$ = +0.92 logit to $ß_{min}$ = -0.52 logit. This group had carefully observed the early adopters, but waited to adopt innovative products until they were sure that they would get value from them. This early majority would only implement BIM if they were sure the BIM would be useful to their organisations and not be a waste of their time and money for if implemented.

The map reveals that the fourth group which represented 7% from total organisations was late majority for BIM implementation. The organisations in this group were located ranging from ßmax = -0.61 logit to ßmin = -0.86 logit. This group was a little sceptical and would rather wait until BIM had been successfully implemented by a majority of consumers and the cost of BIM implementation would drop first before they would be willing and ready to adopt BIM. The late majority would adopt BIM if they discovered that all organisations were either implementing it or decided to implement it.

The last group that represented 7% from total organisations was laggards for BIM implementation. The organisations in this group were located ranging from ßmax = -2.05 logit to ßmin = -6.00 logit. Moreover, six organisations in this group belong to minimum extreme score. They scored 0 for all item in measuring value for BIM implementation. This reveals that these organisations rejected the BIM implementation in their organisations. This group known as the traditionalist and was the very last group to implement BIM. Laggards were contented with what they had, and they might adopt BIM but unenthusiastically and only because they felt it was something that they had to do.

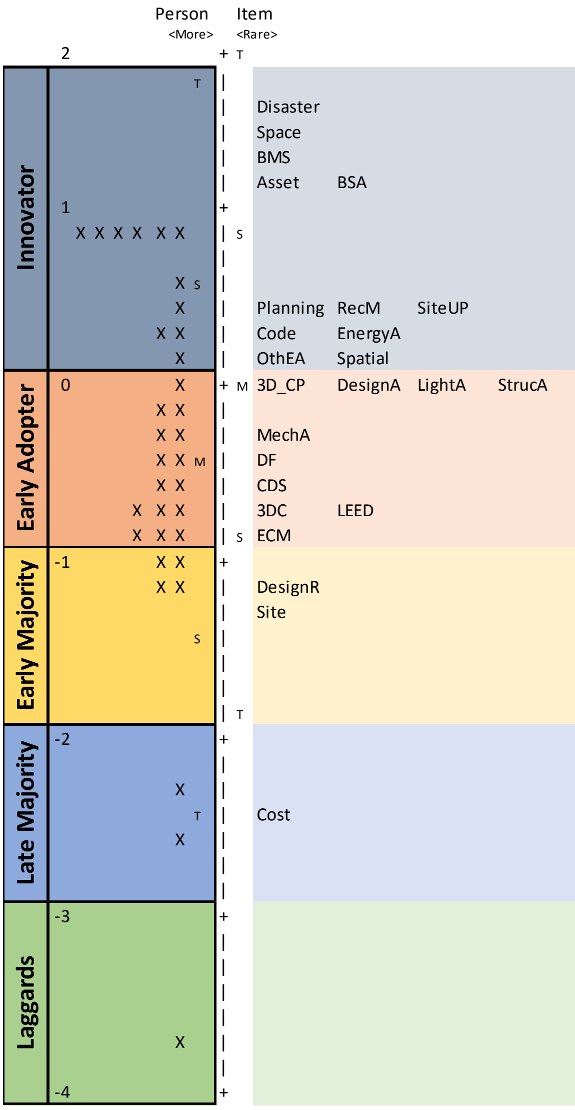

Fig. 3 Organisation-Item Distribution Map

The map further reveals that all items (items Cost, DesignR, SiteA, 3DC, ECM, LEED, DF, CDS, StructureA, DesignA, MechA, OtherEA, 3D_CP and Spatial) were located below the line of μ_{person}. This was an indication that majority of the organisation relatively had no difficulty in performing these items. The easiest item to be endorsed by organisations was Cost with $\delta_{item\ =}$ -2.05. There was a huge gap (1.06 *logit*) between Costs to the nearest item (Site). This showed that organisations really wanted to implement BIM if they could manage the cost as value for BIM implementation.

Eleven items are located above the $\mu_{person.}$ The items are SiteUP, EnergyA, LightA, Planning, Code, RecM, BMS, BSA, Asset, Space and Disaster. These items were relatively difficult to endorse by majority of respondents. The minimum measure for this group was $\delta_{item\ =}$ 0.26 *logit* which belonged to SiteUP and the highest measure was δ_{item} = 1.04 *logit*.

CONCLUSION

Previous research revealed that BIM in Malaysia was still at infant stage. The preliminary findings presented here indicated although implementation of BIM was still minimal, Malaysia was on the right track to implement BIM like in other countries. Although majority of organisation had not yet implemented BIM, this research revealed that most of the clients' organisations were aware of BIM implementation. Indeed, respondents who represented their organisations were positive to the certain values offered by implementing BIM in their respective organisations. The main outcome from this research is to profile the the clients' organisations towards value of BIM into five categories namely as innovators, late adopters, early majority, late majority and laggards. The findings of this research would also be significant in suggesting further strategies to enhance the implementation of BIM. More importantly, the findings of this study have contributed to awareness, understanding and implementation of BIM in Malaysia thus unlocking its potential value. Further research is therefore needed to investigate the value of BIM implementation in Malaysia.

REFERENCES

[1] OA Olatunji, Modelling the Cost of Corporate Implementation of Building Information, *Journal of Financial Management of Property and Construction*, **2010**,163, 211–231.
[2] KTC Tse, AKD Wong and FKW Wong, Modeling Objects and Interfaces in Building Information Modelling, In Computing in Civil Engineering VA: *American Society of Civil Engineers*, Reston, **2005**, 1–8.
[3] B McAdam, Building Information Modelling: the UK Legal Context, *International Journal of Law in the Built Environment*, **2010**, 23, 246–259.
[4] A Ahankoob, SM Khoshnava, R Rostami, R, C Preece and A Technology, BIM Perspectives on Construction Waste Reduction, *Management in Construction Research Association*, **2012**, 195–199.
[5] H Xu, J Feng and S Li, Users-Orientated Evaluation of Building Information Model in the Chinese Construction Industry, *Automation in Construction*, **2014**, 39, 32–46.
[6] NH Ibrahim and U Kingdom, Reviewing the Evidence: Use of Digital Collaboration Technologies in Major Building and Infrastructure Projects, *Journal of Information Technology in Construction*, **2013**, 40–63.
[7] GP Luth, A Schorer and Y Turkan, Lessons from Using BIM to Increase Design-Construction Integration, *Practice Periodical on Structural Design and Construction*, **2014**, 191, 103–110.
[8] McGraw Hill, *The Business Value of BIM for Owners*, **2014**.
[9] DK Smith and M Tardif, *Building Information Modelling - A Strategic Implementation Guide*, Hoboken: John Wiley and Sons, Inc, **2009**.
[10] J Taylor and P Bernstein, Paradigm Trajectories of Building Information Modelling Practice in Project Networks, *J. Manag. Eng.*, **2009**, 25 (2), 69–76.
[11] PCM Eastman, G Tech, GA Ga and C Eastman, Information Delivery Manuals to Integrate Building Product Information into Design, *Ole Berard Jan Karlshoej*, **2011**, 17, 64–74.
[12] Brad Hardin, BIM and Construction Management: Proven Tools, Methods, and Workflows, *Indianapolis, Wiley Pub*, **2009**, 3 (28-31), 193-197.
[13] B Succar and M Kassem, Automation in Construction Macro-BIM Adoption: Conceptual Structures, *Automation in Construction*, **2015**, 57, 64–79.
[14] AKD Wong, FKW Wong and A Nadeem, Government roles in implementing building information modelling systems: Comparison between Hong Kong and the United States, *Construction Innovation: Information, Process, Management*, **2011**, 111, 61–76.
[15] C Dossick, G Neff and H Homayouni, The Realities of Building Information Modeling for Collaboration in the AEC Industry, *Construction Research Congress*, **2009**, 396–405.
[16] V Singh, N Gu and X Wang, A Theoretical Framework of a BIM-Based Multi-Disciplinary Collaboration Platform, *Automation in Construction*, **2011**, 202, 134–144.
[17] W Lu, D Zhang and S Rowlinson, BIM Collaboration: A Conceptual Model and Its Characteristics, *Proceeding of 29th Annual Association of Researchers in Construction Management Conference*, UK, **2013**, 25-34.

[18] M Hooper and A Ekholm, A Pilot Study: Towards BIM Integration - An Analysis of Design Information Exchange and Coordination, *Proceedings of the CIB W78 2010: 27th International Conference*, Cairo, Egypt, **2010**, 16–18.
[19] M De Blois, B Herazo-cueto, I Latunova and G Lizarralde, Relationships between Construction Clients and Participants of the Building Industry: Structures and Mechanisms of Coordination and Communication, *Architectural Engineering and Design Management*, **2011**, 7, 3–23.
[20] M Trebbe, T Hartmann and A Dorée, 4D CAD Models to Support the Coordination of Construction Activities between Contractors, *Automation in Construction*, **2015**, 49, 83–91.
[21] B Succar, W Sher and A Williams, An Integrated Approach to BIM Competency Assessment, Acquisition and Application, *Automation in Construction*, **2013**, 35, 174–189.
[22] SK Lee, KR Kim and JH Yu, BIM and Ontology-Based Approach for Building Cost Estimation, *Automation in Construction*, **2014**, 41, 96–105.
[23] R Solnosky, Current Status of BIM Benefits, Challenges, and the Future Potential for the Structural Discipline, *In Structures Congress*, **2013**, 768–780.
[24] K Wong and Q Fan, Building Information Modelling BIM for Sustainable Building Design, Facilities, **2013**, 313, 138–157.
[25] R Sebastian, Integrated Design and Engineering using Building Information Modelling: A Pilot Project of Small-Scale Housing Development in The Netherlands, *Architectural Engineering and Design Management*, **2010**, 62, 103–110.
[26] M Kassem, N Iqbal and N Dawood, A Practice Oriented BIM Framework and Workflows, *Computing in Civil Engineering*, **2013**, 524–532.
[27] S Root and AD Chasey, Achieving Sustainability through Building Information Modelling Workflow, *ICSDC*, **2011**, 344–351.
[28] PC Suermann, Evaluating Industry Perceptions of Building Information Modelling BIM Impact on Construction, *Journal of Information Technology in Construction*, **2009**, Vol (14), 574–594.
[29] K Newton and N Chileshe, Awareness, Usage and Benefits of Building Information Modelling BIM Adoption – The Case of the South Australian Construction Organisations, *Proceedings of 28th Annual Association of Researchers in Construction Management Conference*, Edinburgh, UK, **2012**, 3–12.
[30] X Wang and PE Love, BIM + AR: Onsite Information Sharing and Communication via Advanced Visualization, *IEEE 16th International Conference on Computer Supported Cooperative Work in Design*, **2012**, 850–855.
[31] W Shen, Q Shen and Q Sun, Building Information Modelling-Based User Activity Simulation and Evaluation Method for Improving Designer–User Communications, Automation in Construction, **2012**, 21, 148–160.
[32] AKD Wong, FKW Wong and A Nadeem, Attributes of Building Information Modelling Implementations in Various Countries, *Architectural Engineering and Design Management*, **2010**, 574-594
[33] L Simonian and T Korman, Building Information Modelling For Electrical Contractors: Current Practice and Recommendations, AEI, **2011**, 456–463.
[34] U Eicker and R Weeks, Building Information Modelling as an Information Management Tool: A South African Perspective for Contractors Who Take on Design Responsibility, *Proceedings of PICMET '14: Infrastructure and Service Integration*, **2014**, 1770–1776.
[35] M Abubakar, YM Ibrahim, D Kado and K Bala, Contractors Perception of the Factors Affecting Building Information Modelling (BIM) Adoption in the Nigerian Construction Industry, *Computing in Civil and Building Engineering*, **2014**. 167–179.
[36] A Aibinu and S Venkatesh, Status of BIM Adoption and the BIM Experience of Cost Consultants in Australia, *Journal of Professional Issues in Engineering Education and Practice*, **2013**, 1–10.
[37] N Thurairajah and D Goucher, Advantages and Challenges of Using BIM: a Cost Consultant's Perspective, 49th *ASC Annual International Conference Proceedings*, **2013.**
[38] MF Mohd-Nor and MP Grant, Building Information Modelling BIM in the Malaysian Architecture Industry, *WSEAS Transactions on Environment and Development*, **2014**, 10, 264–273.
[39] R Kreider, J Messner and C Dubler, Determining the Frequency and Impact of Applying BIM for Different Purposes on Projects, *Proceedings of the 6th International Conference on Innovation in Architecture, Engineering and Construction*, **2010**, 1–10.
[40] JM Linacre, Rasch Measures and Unidimensionality, *Rasch Measurement Transactions*, **2011**, 24 (4), 1310.
[41] G Rasch, *Probabilistic Models for Some Intelligence and Attainment Tests*, Chicago: The University of Chicago Press, Copenhagen, Danish Institute for Educational Research, **1960**.
[42] W Wu and R Issa, BIM-Enabled Building Commissioning and Handover, *Computing in Civil Engineering*, **2012**, 237, 237–244.
[43] P Bynum, R Issa and S Olbina, Building Information Modelling in Support of Sustainable Design and Construction, *Journal of Construction Engineering and Management*, **2013**, 139, 24–34.

[44] J Boktor, A Hanna, M Asce, CC Menassa and AM Asce, State of Practice of Building Information Modeling in the Mechanical Construction Industry, *Journal of Management in Engineering*, **2014**, 78–85.
[45] RIBA, *NBS National BIM Report*, 12, **2014**.
[46] TG Bond and CM Fox, *Applying the Rasch Model: Fundamental Measurement in the Human Sciences*, Lawrence Erlbaum Associates Publishers, New Jersey, **2007**.
[47] JM Linacre, Optimizing Rating Scale Category Effectiveness, *Journal of Applied Measurement*, **2002**, 31 (3), 85–106.
[48] R Debelak and M Arendasy, An Algorithm for Testing Unidimensionality and Clustering Items in Rasch Measurement, *Educational and Psychological Measurement*, **2012**, 72(3), 375–387.
[49] E Brentari and S Golia, Unidimensionality in the Rasch Model: How to Detect and Interpret, *Statistica*, **2007**, 3, 253–261.
[50] D Beglar, *A Rasch-Based Validation of the Vocabulary Size Test. Language Testing*, **2010**, 27(1), 101–118.
[51] Fisher, Reliability, Separation, Strata Statistics, *Rasch Measurement Transactions*, **1992**, 6(3), 328.
[52] A Aziz and A Salleh, Construct Validity: A Rasch Measurement Model Approaches, *Journal of Applied Science and Agriculture*, **2014**, 9(12), 7–12.
[53] TG Bond, Validity and Assessment: A Rasch Measurement Perspective, *Metodologia de Las Ciencias Del Comportamiento*, **2003**, 5(2), 179–194.
[54] JM Linacre, Predicting Responses from RASCH Measures, *Journal of Applied Measurement*, **2010**, 11(1), 1-10.
[55] R Mohd, S Mohamad and N Nor, Understanding Financial Behaviour of Gen Y via Financial Intelligence Logit Ruler : A Preliminary Study, *Proceedings of 11th International Business and Social Science Research Conference*, **2015.**
[56] I Paek and M Wilson, Formulating the Rasch Differential Item Functioning Model Under the Marginal Maximum Likelihood Estimation Context and Its Comparison With Mantel-Haenszel Procedure in Short Test and Small Sample Conditions, Educational and Psychological Measurement, **2011**, 71(6), 1023–1046.
[57] C Strobl, J Kopf and Zeileis, Rasch Trees: A New Method for Detecting Differential Item Functioning in the Rasch Model, Psychometrika, **2013**.
[58] Bechger, T. M., and Maris, G., A Statistical Test for Differential Item Pair Functioning. Psychometrika, **2014**, Doi:10.1007/s11336-014-9408-y
[59] D Andrich and C Hagquist, Real and Artificial Differential Item Functioning in Polytomous Items, *Journal of Educational and Behavioral Statistics*, **2012**, 37(3), 387–416.
[60] A Abdulaziz, A Mohamed, N Arshad, S Zakaria and M Masodi, Appraisal of Course Learning Outcomes using Rasch Measurement: A Case Study, *International Journal of Systems Applications, Engineering and Development*, **2007**, 1(4).
[61] AA Azrilah, M Azlinah, A Noorhabibah, Z Sohaimi, Z Azami, AG Hamza, M Mohd Saidfuddin, Application of Rasch Model in Validating the Constructs of Measurement Instrument, *International Journal of Education and Information Technologies*, **2008**, 2 (2), 105-112.
[62] GB Trevor and MF Christine, *Applying the Rasch Model Fundamental Measurement in the Human Sciences* (2nd Ed.), Lawrence Erlbaum Associates, Publishers, Mahwah, New Jersey, London, **2007**.