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Rasch Model for Validation a User Acceptance Instrument for Evaluating E-learning System

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***Abstract*—Advances in science and technology, especially Information and Communication Technology (ICT), has great impacts on the present education management. It allows the development of the e-learning system to facilitate the teaching and learning processes. As a result, many modern universities have developed and utilized the system. For that reason, there is a great need to develop an instrument in which the e-learning management system can be evaluated from various aspects such as the system performance, user acceptance, and utilization. The level of the user acceptance is the central focus of this study, known to be strongly related to the level of utilization, and is widely studied by using the famous framework of Davis' Technology Acceptance Model (TAM). The framework is also adopted in the current study and the required data to analyze quantitatively the model are selectively obtained from a sample of 73 respondents. The validity and reliability of the data are evaluated by using the Rasch model. The results suggest that the all 16 items in the questionnaire are valid and reliable to measure the acceptance of the e-learning system.**

***Index Terms*—Rasch Model, E-learning System, User Acceptance Model**

I. INTRODUCTION

ADVANCES in science and technology, especially Information and Communication Technology (ICT), has great impacts for the advancement of education today. The education system, formal and informal, can use the ICT to support the learning process. The offered advantages do not only lie on the speed and easiness in obtaining the information or learning materials, but also in the multimedia facilities, which make the learning process more interesting through the interactive visual. In this respect, the ICT has facilitated the development of the e-learning system.

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The use of e-learning system in the education institution is inevitable. The system offers many benefits such as a greater and flexible learning opportunity without being tied to the constraints of time and space. It provides access of learning to community with richer contents of the learning material. Moreover, it opens the learning process, improves the learning effectiveness, and facilitates independent learning [1].

The modern e-learning is commonly manifested as the internet-based learning. The technology provides media to create, store, update, distribute, and share learning materials [2]. Generally speaking, the term of e-learning is an education system that uses electronic applications to support the teaching and learning process with the Internet media, computer networks, and standalone computers [3].

In contrast, the traditional learning systems are characterized by meetings between students and teachers [4]. The method has been going on since long ago to fulfill the main goal of teaching and learning. However, currently, the concept is facing difficulties particularly due to the constraints in place and in time and the increasing number of the activities of students and teachers. The change of paradigm or shift in the learning system has emerged in the process of knowledge transfer. The learning process is now likely to emphasize more on the process of teaching and content-based.

Traditionally, the learning process emphasizes the teaching process, content-based, abstract, and is limited to small groups. Currently, the process shifts and emphasizes the learning process, problem-based, contextual, and is not limited to small groups [5]. The current learning process requires students to be more active utilizing all learning resources through the Internet.

Previously, we have reported the case study of measuring the level of readiness of an e-learning system by using the ELR (e-learning readiness) model [5]. The model had ten factors and the study showed that the evaluated system was not fully satisfactory in respect of the aspects: human resources, financial, infrastructure, innovation, and institution. It was not clear whether the system was well received or not. A number of questions was left unanswered such as how the users accepted the system and how the level of the system utilization was. To understand these issues, the level of acceptance of the system should be measured as the system utilization rate is largely determined by its reception [6, 7]. A high level of the utilization represents a successful system implementation [8]. These issues are addressed in the current study.

II. Research Method

In this study, the measurement of the user acceptance is conducted by using Technology Acceptance Model (TAM). For this purpose, the instrument that is used to obtain the required data should be validated. The test of the instrument is known to be crucial [9]. This study intends to validate the instrument and measure its reliability by using the Rasch model. By using the model, the constructs in TAM and their related assessment can be assessed in the terms of consistency, reliability, and accuracy. The validity and reliability tests are performed with the following steps: (i) test reliability index and the separation of the items and the respondent, (ii) detect the polarization of the items that measure the construct, and (iii) test the fitness of the item instruments[10].

The number of the respondents is 73 and they are selected by using purposive sampling method. Regarding the sample size for a pilot study, Ref. [11] suggested a number in between of 25 and 100. Meanwhile, Ref. [12] recommended 30 participants. In the current study, the respondents are the students of the computer science department of an university. They are in the second to the sixth semester. Then, the analysis of the Rasch model is performed by using Winstep software of the version 3.92.1 [13].

A. Validity and Reliability Using the Rasch Model

Validity is the extent to which research testing instruments measure what it should measure. Therefore, a good conclusion can be made of the study sample [14]. Meanwhile, the reliability is the extent to which research testing instruments can be expected to get a consistent result when it is repeated. Reliability can provide consistency validity [10]. Rasch model approach is undertaken to examine the validity and reliability of the instruments used. In recent years, the model Rasch is also referred to Theory of Item-Response (IRT) or Properties Latent Model. It has been providing an alternative framework for understanding the measurement and alternative strategies for assessing the quality of an instrument or questionnaire [15, 16]. Application of Rasch models can generate a reliable and valid instrument. Rasch measurement model can also prove that an instrument has high degree of validity and reliability. This is because the use of models Rasch is a solution to a problem which the validity of the Rasch models provide useful statistics and offers an exceptional opportunity to investigate the validity of instrument [17]. In addition, the Rasch model application in the study is able to facilitate and provide more efficient, reliable and valid measurement instrument. A study to identify the validity and reliability of the instrument is very important to maintain the accuracy of the instrument [18]. It is necessary to ensure that the instrument can measure what will be measured consistently and accurately.

The fundamental difficulty of measurement in the social sciences is how to do a quantitative weighting to the qualitative latent phenomenon. These various phenomena such as attitudes, character, personality, and so forth. Measurements in the study of psychology, 95% of which are still being developed by CTT approach [10]. CTT rested on the assumption that the score looks (X) are the sum of the scores pure (T) and error (E). This error refers to various situational conditions that can not be controlled, such as fatigue, environmental setting, and so forth.

In a measurement based on the CTT, the assessment of a construct is made by applying arithmetic operations on the score obtained from the items. This is less relevant because the resulting scores of an item are ordinal in nature and therefore can not be treated as integer [19]. Rasch models in the development of measurement tools of social science is a response to the weaknesses paradigm of CTT [20]. The fundamental difference compared CTT Rasch models, among others, lies on how to treat the raw scores in the analysis process. In CTT, raw scores in the form of ratings (rating scale) are directly analyzed and treated as data that seems to have the character of an integer. While in the Rasch model, the raw data can not be directly analyzed before being converted into a form of “odds ratio” for later transformation into a logarithm logit unit as a manifestation of the probability of respondents in response to an item.

Referring to this procedure, Ref. [20] mentions that Rasch models can be used as a method to restore data according to their natural condition. This refers to the natural conditions of the basic characteristics of quantitative data, which is a continuum. Classical

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measurement theory which uses the raw data results of a rating deemed the response has not been able to bring the original characteristics of the data quantitative continuum. Through the model of Rasch, a response that is ordinal can be transformed into a form that has a ratio higher accuracy rate with the reference to the principle of probability. Reference [21] outlines five essential part of the analysis using the Rasch models. They are calibration and estimation capabilities item, the item characteristic curve in the model parameters, the function information items and instruments, maps the interactions between the items and the respondent, as well as items and respondents who fit/misfit. It distinguishes between the Rasch model of CTT as described in Ref. [17] that in the data analysis of Rasch model, it adjusts the data models, whereas, in the CTT, the model is selected based on the data. Based on this, the use of Rasch models in the validation of this instrument will generate more holistic information about the instrument and meet the definition of measurement.

B. Technology Acceptance Model

Technology Acceptance Model (TAM) is a model used to measure the extent to which the level of user acceptance to a technology especially information technology. TAM model originally developed by Davis (1989) based on the model of Theory of Reasoned Action (TRA) to closer the gap that explains the factors that influence or encourage users to use the technology [6]. In his research, Ref. [6] proposes two key factors of user behavior or adoption of technology to the acceptance of these technologies. The second key factor is the ease of use and usefulness both of which are believed to predict behavior or attitude in using technology. In other words, these two factors together affect the willingness to use and then it will affect the use of the system or the technology. Based on the results of research conducted Ref. [6], both factors or variables significantly affect the user acceptance of the technology. This is also supported by various studies or other studies which empirically been proven valid [22–25]. In other words, TAM model has proven able to measure the acceptance of the technology based on its perception. TAM models form the basis of evaluation of user behavior in the use of technology that can be presented in Fig. 1.

Based on Fig. 1, it can be seen that the users of the technology will have an interest in using the technology (interest behavior) if they feel the system or the technology useful and easy to use. TAM believes that the use of technology can improve the performance of an individual or organization, and provide convenience for their users for completing the work [26]. In other words, the cause of the rejection by the users of the technology can be predicted from those factors.

In TAM model developed by Ref. [6], there are five constructs or variables: perceived ease of use, perceived usefulness, attitude towards the use, interest in the usage behavior, and use real-time system. Over time the TAM model is widely used and developed by other researchers. Reference [27] modified TAM model by combining the variable of behavior intention to use with the actual system use into user acceptance as presented in Fig. 2.

Therefore, in this study TAM model that will be reviewed is following Gahtani (2001). It is shown in Fig. 3.

III. Results and Discussions

The following steps are taken to test the validity and reliability using the Rasch model: (i) compute the test reliability index and the separation of items and the respondent, (ii) compute the polarization of items that measure the construct based on the value of PTMEA

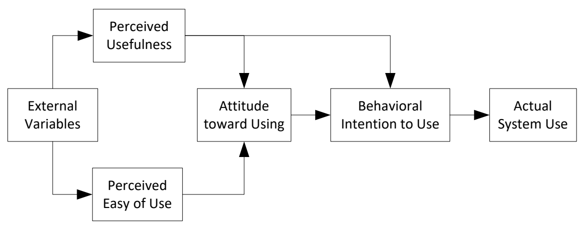

Fig. 1. The Technology Acceptance Model According to Ref. [7].

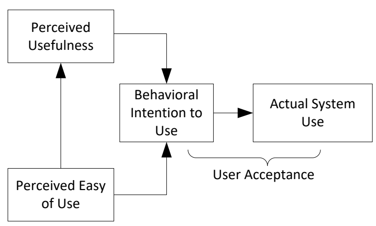

Fig. 2. The Modified Technology Acceptance Model According to Ref. [27].

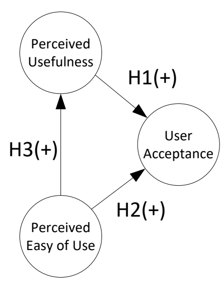

Fig. 3. The Conceptual Model of the Current Research.

CORR, and (iii) compute the fitness of the developed item instrument on the basis of on the MNSQ and ZSTD values [11]. The Rasch model considers the ability of the respondents to provide their responses to the questions as well as the difficulty level of the item itself. The analysis of the item suitability (item fit) evaluates whether the items in the instrument are able to measure what they are supposed to measure. If the item is not suitable or misfit, it should be revised or eliminated. The criteria for determining the validity and reliability of the instrument are presented in Table II.

Based on Table I, the instrument consists of three dimensions or variables with a total of 16 items. The dimension perception usefulness has six items, the perceived ease of use has six items, and the user acceptance has four items of measurement.

A. Reliability and Separation Item and Respondents

This section discusses the results of the statistical analysis in regard of the instrument reliability and separation item. Table III shows the Cronbach alpha values and the assumption of the reliability level. The proposed instrument has the Cronbach alpha value of 0.92 as shown in the results in Table IV.

According to Refs. [17, 20], an instrument is considered having high reliability if its Cronbach alpha value is greater than 0.7. With the value of 0.92, the current instrument is considered to be highly reliable.

Also in Table IV, it demonstrates reliability and separation index of items and the respondent obtaining reliability of item by item separation of 0.79 and 1.94. Based on Table III, the reliability of items of 0.79 is said to be included in both categories (good reliability) and acceptable [17, 20]. Meanwhile the separation item 1.94 is acceptable because the value is approaching or rounded to 2 where the items in the instrument can be divided into three levels based on the measurement of the degree of difficulty for respondents, it is approved. Based on Ref. [13], separation index is greater than 2, it can be assumed to have a good value.

Meanwhile, the reliability of the respondents produced are 0.89 and 2.84 of the separation respondents. Reliability testing results obtained also shows that the respondents have high reliability when referring to Table III. While the index for separation respondents of 2.84 is quite good because it meets the minimum requirements (> 2.0) in which respondents can be divided into four major groups.

B. Item Polarity based on PTMEA CORR

In this section, the validity of the items is measured with reference to the Point Correlation Measure (PTMEA CORR). It is the value of polarization item (item polarity). Examination of polarization item is intended to test whether the construct has been built to achieve its objectives. If the PTMEA CORR value is positive (> 0), it can be said that the item can measure what it should measure [17]. Conversely, if the value is negative (< 0), then it is said that the item is not developed to measure constructs that should be measured so that the item should be revised or

TABLE I
THE PROPOSED RESEARCH INSTRUMENT.

No	Variable	Item
1	Perceived Usefulness (X_1)	Work more quickly
		Improve job performance
		Increase productivity
		Effectiveness
		Make job easier
		Useful
2	Perceived Ease of Use (X_2)	Easy to learn
		Controllable
		Clean and understanable
		Flexible
		Easy to become skillful
		Easy to use
3	User Acceptance (X_3)	Actual use
		Usage frequency
		User satisfaction
		Motivate another user

TABLE II
THE CRITERIA OF VALIDITY AND RELIABILITY ACCORDING TO THE RASCH MODEL.

Criteria	Statistics Data	Minimum Requirement	Source
Item validity	Item polarity	PTMEA CORR > 0	[16][32]
Item	Item fit	Total Mean Square (MNSQ) infit and outfit of 0.6–1.4 for politomy data Z-standard (ZSTD) for -2 to 2	[16][20][32]
Item misfit	Separation Index (SE)	All items show ≥ 2	[16][30][33]
	Person reliability	Value > 0.8	[16][33][34]
	Item reliability	Value > 0.8	[16][34]
Reliability	Cronbach Alpha	Value > 0.7	[16][20]

TABLE III
THE VALUES OF CRONBACH ALPHA AND THEIR INTERPRETATION [17, 20].

Cronbach Alpha Value	Reliability Level
0.8–1.0	High
0.7–0.8	Good
0.6–0.7	Fair
0.0–0.6	Bad

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TABLE IV
STATISTICS SUMMARY OF INSTRUMENT: RELIABILITY OF ITEM AND RESPONDENT.

```
SUMMARY OF 73 MEASURED (EXTREME AND NON-EXTREME) Person
-------------------------------------------------------------------------------
           TOTAL                         MODEL         INFIT          OUTFIT
           SCORE     COUNT    MEASURE     S.E.     MNSQ   ZSTD    MNSQ   ZSTD
-------------------------------------------------------------------------------
MEAN        45.0      16.0        .90      .51
P.SD         7.8        .0       1.87      .28
S.SD         7.8        .0       1.89      .28
MAX.        64.0      16.0       7.20     1.84
MIN.        21.0      16.0      -3.63      .40
-------------------------------------------------------------------------------
 REAL RMSE   .62 TRUE SD  1.77 SEPARATION 2.84 Person RELIABILITY .89
MODEL RMSE    .58 TRUE SD 1.78 SEPARATION 3.07 Person RELIABILITY .90
S.E. OF Person MEAN = 0.22
-------------------------------------------------------------------------------
Person RAW SCORE-TO-MEASURE CORRELATION = .97
CRONBACH ALPHA (KR-20) Person RAW SCORE ''TEST'' RELIABILITY = .97 SEM = 2.26

SUMMARY OF 16 MEASURED (NON-EXTREME) Item
-------------------------------------------------------------------------------
           TOTAL                         MODEL         INFIT          OUTFIT
           SCORE     COUNT    MEASURE     S.E.     MNSQ   ZSTD    MNSQ   ZSTD
-------------------------------------------------------------------------------
MEAN       205.0      73.0        .00      .21      .99    -.1     .98    -.2
P.SD        10.7        .0        .49      .01      .25    1.4     .25    1.4
S.SD        11.0        .0        .50      .01      .26    1.4     .26    1.4
MAX.       223.0      73.0        .90      .22     1.71    3.5    1.65    3.2
MIN.       185.0      73.0       -.84      .21      .57   -2.9     .57   -2.9
-------------------------------------------------------------------------------
Item RAW SCORE-TO-MEASURE CORRELATION = -1.00
Global statistics:
UMEAN = .0000 USCALE = -1.0000
```

discarded. This is because the item is out of focus or hard to be answered by the respondents.

Based on Table V, it can be shown that for each item (v1–v16) has a positive value PTMEACORR. Thus there are no items in an instrument discarded because it has met the minimum requirements (PTMEA CORR > 0). In addition, in Table V, it can also see the value of log item measure, i.e., the item 9 (v9) with a value of $+0.90$ which indicates the item is the most difficult to be answered by respondents while item 14 (v14) is -0.84 indicating the easiest item to be approved by respondent. The results showed all the items have a high-value PTMEA CORR which indicates that the item can distinguish the ability of the respondent.

C. Item Fit (Conformity Item)

In this section, appropriateness or suitability of items (items fit) refers to the value Infit and Outfit Mean Square MNSQ, which can be shown in Table VI. The observations of MNSQ value is needed to determine whether the items are developed according to item (fit)

TABLE V
ITEM POLARITY BASED ON POINT MEASURE CORRELATION.

Entry Number	Total Score	Total Count	Measure	PTMEA CORR	Item
9	185	73	0.90	0.66	V9
5	188	73	0.77	0.67	V5
12	194	73	0.51	0.71	V12
8	197	73	0.38	0.64	V8
3	199	73	0.29	0.64	V3
4	202	73	0.16	0.53	V4
6	203	73	0.11	0.59	V6
15	204	73	0.07	0.73	V15
7	206	73	−0.03	0.68	V7
1	209	73	−0.16	0.67	V1
13	209	73	−0.16	0.59	V13
10	213	73	−0.35	0.67	V10
16	213	73	−0.35	0.67	V16
11	216	73	−0.50	0.63	V11
2	222	73	−0.79	0.69	V2
14	223	73	−0.84	0.60	V14

TABLE VI
ITEM FIT BASED ON MNSQ AND ZSTD VALUE.

Entry	INFIT		OUTFIT		Item
Number	MNSQ	ZSTD	MNSQ	ZSTD	
4	1.71	3.5	1.65	3.2	V4
14	1.27	1.5	1.25	1.4	V14
8	1.11	0.7	1.17	1.0	V8
3	1.05	0.3	1.15	0.9	V3
13	1.13	0.8	1.09	0.5	V13
6	1.08	0.5	1.03	0.2	V6
5	0.99	0.0	1.05	0.3	V5
9	0.99	0.0	0.97	−0.1	V9
7	0.97	−0.1	0.97	−0.1	V7
1	0.92	−0.4	0.90	−0.5	V1
16	0.89	−0.6	0.87	−0.7	V16
11	0.83	−1.0	0.84	−0.9	V11
15	0.82	−1.1	0.79	−1.2	V15
12	0.81	−1.2	0.76	−1.4	V12
10	0.72	−1.7	0.67	−2.0	V10
2	0.57	−2.9	0.57	−2.9	V14

in measuring the constructs (latent variables). Based on some of the literature to determine the suitability of the items that are built, the parameters Infit and Outfit MNSQ should be in the range between 0.6 and 1.4 for data polytomy and ranges between 0.7 to 1.3 for data dichotomy [17, 20]. Outfit MNSQ should be given more emphasis than the infit MNSQ in determining the harmony of items that measure the construct [28]. If the results show a value of more than 1.4, it means that the item is confusing. Whereas, if the results show logit value below 0.6, it means that the item is too easy for the respondents [13]. In addition, the value of Infit and Outfit ZSTD (z-Standard) received in the range of -2.0 to 2.0. But if the value of Infit and Outfit MNSQ is obtained, then the index ZSTD is negligible [17].

Table VI shows that there is only one item v4 which is effectiveness that are outside the range because it has exceeded the limit value of Infit MNSQ 1.71 (> 1.4) and MNSQ Outfit is equal to 1.65 (> 1.4). Likewise, Infit ZSTD value is obtained at 3.5 (> 2.0) and Outfit ZSTD 3.2 (> 2.0), so the item is considered to be revised or eliminated from the instrument. However, in this study, item v4 is maintained and revised for the objectives of research to measure user acceptance of e-learning system by user perspective. Thus the instrument has total 16 measurement items that are valid and reliable according to Rasch Model.

IV. CONCLUSIONS

The following conclusions are derived from the research.

1) The developed research instrument for evaluating the acceptance of a learning system using TAM model is highly reliable, marked by the value of the Cronbach alpha reliability coefficient of 0.92, which is much higher than that of the minimum requirement of 0.7. Similarly, the reliability of the items and their separation is also high.
2) The PTMEA CORR values, that measure the item polarity, for all items v1–v16 are within the range of 0.53 and 0.73. Thus, the whole items are valid and can measure what they should measure.
3) Only the item v4 has the values of Infit and Outfit MNSQ and ZSTD beyond the specified limits. It has Infit MNSQ of 1.71 and Outfit MNSQ of 1.60 where the limit is 1.4. Accordingly, the item is revised.
4) By using the Rasch model, the results of the current study suggest that the developed instrument is valid and reliable for measuring the level of the user acceptance of e-learning system within TAM framework.

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Appendix: Research Instrument (SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree).

No	Item (Statement)	Agreement Level			
		SD	D	A	SA
	Perceived Usefulness				
1	E-learning system helps me finishing my task more quickly.				
2	E-learning system improves my performance.				
3	E-learning system increases my productivity.				
4	E-learning system helps me finishing my task effectively.				
5	E-learning system helps doing my task easier.				
6	E-learning system is useful for my study.				
	Perceived Ease of Use				
7	E-learning system is easy to learn.				
8	E-learning system is easy to navigate.				
9	E-learning system is clear and easy to understand.				
10	E-learning system can be used flexibly.				
11	I become skillful in using e-learning system.				
12	E-learning system is easy to use.				
	User Acceptance				
13	It is certain that I will use e-learning system.				
14	It is certain that I will continue to increase the usage of e-learning system in the future.				
15	It is certain that I want to use e-learning system to support my study.				
16	I would recommend the use of e-learning system to my friends.				

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