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Validity Testing of Technology Acceptance Model Based on Factor Analysis Approach

Darmawan Napitupulu[1,2], Jimmy Abdel Kadar[1], Rahmi Kartika Jati[1]
[1]Research Center of Quality System and Testing Technology Pengujian, Indonesian Institute of Sciences
[2]Computer Science Faculty, University of Borobudur, Indonesia
Corresponding author, e-mail: darwan.na70@gmail.com, jimmy.ak3@gmail.com; rahmikj@gmail.com

Abstract

Successful implementation of Information Technology can be judged or predicted from the user acceptance. Technology acceptance model (TAM) is a model that is built to analyze and understand the factors that influence the acceptance of the use of technologies based on the user's perspective. In other words, TAM offers a powerful explanation related to acceptance of the technology and its behavior. TAM model has been applied widely to evaluate various information systems or information technology (IS/IT), but it is the lack of research related to the evaluation of the TAM model itself. This study aims to determine whether the model used TAM is still relevant today considering rapid development of information & communication technology (ICT). In other words, this study would like to test whether the TAM measurement indicators are valid and can represent each dimension of the model. The method used is quantitative method with factor analysis approach. The results showed that all indicators valid and can represent each dimension of TAM, those are perceived usefulness, perceived ease of use and behavioral intention to use. Thus the TAM model is still relevant used to measure the user acceptance of technology.

Keywords*: TAM, Model, Testing, Validity, Factor Analysis*

1. Introduction

Technology acceptance model (TAM) studies have been used widely in the field of information systems or information technology (IS/IT) in order to obtain a more comprehensive perspective and a better explanation of the process of acceptance of technology on individuals [1]. TAM concept developed by Davis (1989) offers a simple yet powerful explanation related to technology acceptance and usage behavior [2]. In other words, TAM is a model that is built to analyze and understand the factors that influence the acceptance of the use of technologies based on the user's perspective. TAM model actually adopted from the model theory of reasoned action (TRA), namely the theory of reasoned action with the premise that a person's reaction and perception to something will determine the attitude and behavior of the person. Reactions and perceptions of users of information technology (IT) will affect his attitude in the acceptance of these technologies. TRA models adapted by Davis [2] to predict behavior and user acceptance of the technology and explain the factors that encourage the user.

One of the factors that can influence it is the user's perception of the usefulness and ease of use of IT as an act that is reasonable in the context of technology users, so the reason someone in to see the benefits and ease of use of IT to make the action/behavior of people such as the benchmark in the reception a technology. In other words, IT usage behavior preceded by their perceptions of the benefits (perceived usefulness) and perceptions of the ease of use (perceived ease of use). Both of these components when associated with TRA are part of faith. Based on Davis [2], the level of IT utilization by the user will be largely determined by the level of user acceptance, while acceptance of the users themselves can be predicted from the perception of the benefits or "how beneficial the technology (to increase of productivity)" and perceived ease of use, or "how easily these technologies can used (less effort to use)". Both of these variables could explain the behavioral aspects of users of the technology. Thus through TAM, it can be seen why a technology that has been developed can be accepted or not by the user. Additionally TAM can answer questions from the many technology or systems failed in implementation. Measurement of user satisfaction is usually used in research where the use of information technology is mandatory or directed (must be).

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The end user does not have a choice or alternative to the use of these technologies. In researching the use of information technology such as voluntary, the measure of success is usually based on user acceptance. In the environment of use is voluntary, the end user has full freedom whether the user will use or leave the technology [3-4].

TAM model has been applied widely to evaluate various information systems or information technology [5-8], but there is still a lack of empirical research related TAM model evaluation itself. TAM has been used to measure technology acceptance based on user perspective in many areas such as e-learning, e-library, e-government, e-commerce, etc. As performed by Alharbi & Drew (2014) which utilizes TAM to explain the interest in user behavior using the learning management system (LMS) in the context of e-learning [9]. In the field of e-library, Thong [10] examined the factors that influence the reception of digital libraries. According to Thong [10], acceptance of one's digital library technology affects the level of utilization in the future. Similar to the study conducted by Thong [10], Kim [11] applies TAM to examine the factors that influence user acceptance of the online database of electronic journals provided library. Also in the field of e-Government, Putra (2008) examines the behavior of interest in city government officials in using e-government system with TAM approach [12]. Putra [12] mentions that the TAM model can be used in the context of e-Government considering that e-Government is also part of the information system. So also in the field of e-Commerce, TAM model has also been used extensively. One of these studies conducted by Devi & Suartana [13] who conducted an analysis of TAM on the use of information systems at the Nusa Dua Beach Hotel. User acceptance of information systems is influenced by two main factors, namely TAM perceived ease of use (perceived ease of use), and perceptions of benefits (perceived usefulness). Eventhough TAM was used extensively since it has been proposed in 1989 [2], TAM model itself was never tested empirically in particular whether the dimensions and attributes is fit and still relevant today. In other words, this study aims to determine whether the model TAM which has been widely used is still relevant in view of the rapid development of Information & Communication Technology (ICT) nowadays. Therefore, through this study the validity of TAM models especially the fit between the dimensions and attributes contained will be tested empirically. Thus this study would like to demonstrate that the attributes or indicators of TAM could really explain or represent the existing dimension of model. The proposed solution based on previous works [9-14] is to establish empirical evidence through testing the validity of TAM model with quantative approach such as survey and factor analysis. As mentioned earlier that most existing studies only measures user acceptace of certain technology. In other words, there was rare study to measure the validity of TAM epecially the fit between dimensions and indicators of model as a novel aspect of this research.

2. Research Method

As mentioned previously that the user acceptance of the technology is determined by two main factors, namely the perceived ease of use and perceived usefulness. But TAM model refer to Davis (1989) was originally known as 5 (five) variables or constructs [2], they are the perceived ease of use, perceived usefulness, attitude toward using, behavioral intention to use and actual system use. In nowadays, model of TAM [2] has been developed and modified by other researcher such as Venkatesh [15] integrating TAM model by including intrinsic and extrinsic factors as external variables that affect the use of the system. Intrinsic factor is a factor derived from the individual users while extrinsic factors are factors beyond the individual user who pushed for the use of technology [16].

Besides other researchers are Gahtani [17] also modified TAM model by combining a variable intensity or interest in the usage behavior and the use of the actual system into a variable reception as shown in Figure 1. This means that the user acceptance is directly influenced by the ease of use and usefulness factors.

Meanwhile Sanjaya [18] simplified model of TAM into 3 variables or dimensions, two independent variables are perceived usefulness and perceived ease of use and behavioral intention to use) as dependent variable. Sanjaya Model [18] will be used as a research model in this study.

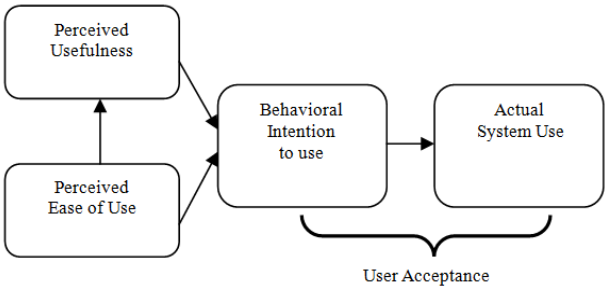

Figure 1. Modification of TAM [17]

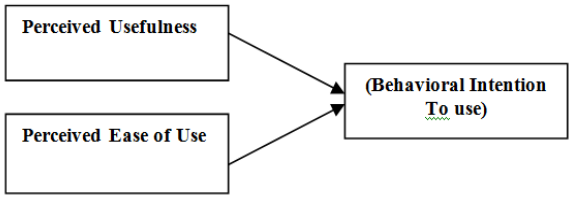

Figure 2. TAM research model [18]

Based on Figure 2 above, it can be seen that behavioral intention to use technology is determined by the perceived usefulness and perceived ease of use where the variable perceived usefulness consisted of six indicators, perceived ease of use also have six indicators, while behavioral intention to use consists of 3 items / indicators as shown in Table 1 [2]:

Table 1. Variable & indicator of TAM

No	Dimension	Item/Indikator
1.	Perceived Usefulness (X1)	Work more quickly ($X1._1$)
		Improve job performance ($X1._2$)
		Increase productivity ($X1._3$)
		Efectiveness ($X1._4$)
		Make job easier ($X1._5$)
		Useful ($X1._6$)
2.	Perceived Ease of Use (X2)	Easy to learn ($X2._1$)
		Controllable ($X2._2$)
		Clear & understandable ($X2._3$)
		Flexible ($X2._4$)
		Easy to become skillful ($X2._5$)
		Easy to use ($X2._6$)
3.	Behavioral Intention To Use (Y1)	Motivasi of usage ($Y1._1$)
		The addition of supported equipment on IT ($Y1._2$)
		Motivating other users ($Y1._3$)

The methodology used in this study is a survey by factor analysis approach. The survey conducted to gauge user acceptance of the technology in the form of expert system application to diagnose the type of plant pests and diseases of potatoes and control solutions. This questionnaire-based survey conducted in several locus of research by purposive sampling. The locus or research object selected as the center of the potato crop in Indonesia, they are Garut district, sub-district Pengalengan, Wonosobo distric, city of Batu Malang, Jambi Kerinci district, Berastagi city, district Enrekang and sub-distric Malino South Sulawesi. Based on 8 (eight) locus, questionnaires was distributed to the all object of research, namely farmers and extension workers in the field with total respondent is 234 people as respondent. Farmers and technicians are potential users requiring the technology the application of expert system to support the cultivation of potatoes. However, from 234 respondents the questionnaire data that can be processed and analyzed further as there are only 215 because some data were

incomplete. The questionnaire was designed using a Likert scale of 1 to 5, where 1="strongly disagree" (lowest scale) and 5="strongly agree" (highest scale). Respondents give their agreement level to each statement as an indicator of research.

Factor analysis approach was used to analyze or test whether the TAM model is still relevant for use gauge or measure user acceptance of technology. This is consistent with the purpose or usef of factor analysis approach to find a connection (interrelationship) between the large number of variables (constructs) that are independent from one another so that it can be made one or more sets of variables or dimensions (factors) that are fewer in number than initial variables which is known as data reduction [19-20]. With factor analysis, it can be constructed a hypothesis or theory based on dimensions built between latent constructs and variables. Factor analysis also provides empirical evidence of the constructs that form latent variables (construct validity) based on the results of measurements in order to test a hypothesis or theory (theoretical construct) in research [19-20]. In other words, a factor analysis approach used can be determined the validity of the model TAM.

3. Results and Discussion

The amount of data to be processed and analyzed by factor analysis approach is 215 samples of measurement results. Guilford [21] recommended a minimum number of samples required to perform factor analysis is 200. Cattel [22] also suggested the number of samples that good and acceptable is minimal 200. Likewise, according to Comrey [23], the number or size of the sample 200 can also be acceptable (fair). Therefore, the amount of the sample size in this study is considered adequate and meets the requirements (> 200). After the number of samples is considered adequate, the next step is to test the feasibility of variables. But earlier, reliability coefficient was measured based on Cronbach Alpha which is obtained 0.885 as presented in Table 2.

Table 2. Reliability coefficient

Cronbach's Alpha	N of Items
.885	15

It shows the instruments used reliable for meeting the requirements which is above 0.80 [24]. Testing the feasibility of the variables used by the value of KMO (Kaiser-Meyer-Olkin) as follows:

1. KMO value ranges from 0 to 1 that indicates whether the data is appropriate or not to be analyzed further. If the value of KMO equal to or greater than 0.5 and with significant values (sig) or probability (p) is less than 0.05 then it means the data already eligible for further analysis in the factor analysis.
2. Hypothesis for significance, namely:
   Ho=Data not adequate for further analysis
   H1=Data has been adequate for further analysis
3. Criteria with a view of probability:
   Probability sig> 0.05 then Ho is accepted
   Probability sig <0.05 then Ho is rejected

3.1. Perceived Usefulness Dimension

The results of testing the feasibility of a variable for the dimension of perceived usefulness can be demonstrated as Table 3.

Table 3. KMO and bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.815
Bartlett's Test of Sphericity	Approx. Chi-Square	291.795
	df	15
	Sig.	.000

Based on Table 3, it can be seen that the value of KMO and Bartlett's Test obtained is 0.815 with a significance of 0.000. This implies Ho rejected, which means that the data has been eligible for further analysis in the factor analysis because it has met the requirements of KMO greater than 0.5 (>0.5) and significance under 0.05 (<0.05). Once the data has met the requirements then the next step is to look at total variance that indicates the number of factors that are formed based on eigen values as shown in Table 4.

Table 4. Total variance explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	2.882	48.025	48.025
2	.878	14.632	62.657
3	.729	12.158	74.815
4	.566	9.438	84.253
5	.493	8.221	92.474
6	.452	7.526	100.000

Number of factors formed can explain the variability of all variables used with a number of criteria Eigen values smaller than 1 are not used in calculating the number of factors that are formed. Based on Table 4 can be seen form factor is only one factor (component) because it has Eigen values above 1 that is 2.822. While other factors have a number of Eigen values below 1 (<1). It is also shown at this stage there are grouping a number of variables to specific factors for their resemblance or similarity of the characteristics of certain variables. Thus one factor that is formed is the most optimal number of factors which could explain the variability of 48.025% of all variable. This proves that all 6 items / variables used to assess it is appropriate to explain one factor that is perceived usefulness.

Table 5. Component matrix[a]

Item/Variable	Component 1
Work more quickly ($X1._1$)	.671
Improve job performance ($X1._2$)	.601
Increase productivity ($X1._3$)	.762
Efectiveness ($X1._4$)	.681
Make job easier ($X1._5$)	.706
Useful ($X1._6$)	.726

Furthermore, the correlation the variables that exist with that form factor that is based on the value of factor loading. Based on Costello & Osborne that structural factors have a pure or fit if the loading factor greater than 0.3 which shows the loading factor has a quite high value and indicates that variable has strong correlation with factors formed (convergent validity). Similarly Hair suggests that the factor loading of the item>0.3 were considered significant, factor loading item>0.4 is more important and factor loading item>0.5 is considered very significant. In this study used a cut-off factor loading of 0.5 in order to obtain a high loading factor (strong factor loading). Based on Table 5, it can be seen all over the item/measurement variable has a value of loading factor greater than 0.5 (0.5), which means all the items/variables have a strong and significant correlation to factors formed perceived usefulness. In other words, it can be said that all the item/variable considered valid for measuring the dimension of perceived usefulness.

3.2. Perceived Ease of Use Dimension

In Table 6 below, it shows that the value of KMO and Bartlett's Test obtained is 0.784 with the significance 0.000. This implies Ho is rejected or H1 accepted, which means that the data has been feasible or sufficient for further analysis in the factor analysis for the value of KMO is greater 0.5 (>0.5) and the significance 0.000 (>0.05) because it has met the requirements. Next step is a look at a number of factors which are formed by the analysis of the total variance explained based on the numbers of Eigen values.

Table 6. KMO and bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.784
Bartlett's Test of Sphericity	Approx. Chi-Square	349.383
	df	15
	Sig.	.000

Table 7. Total variance explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	2.941	49.010	49.010
2	.989	16.477	65.488
3	.727	12.121	77.608
4	.571	9.508	87.117
5	.455	7.579	94.696
6	.318	5.304	100.000

From Table 7 above, it can be seen that the form factor is also only one factor (component) because these factors have eigen values above 1 that is 2.941 while 5 (fice) other factors values have eigen numbers below 1. The formed factor can explain the variability of 49.010% of the overall measurement variable. This means proving that all 6 items/variable used is appropriate or valid to explain one factor that is perceived ease of use.

Table 8. Component matrix[a]

Item/Variable	Component 1
Easy to learn ($X2_{.1}$)	.574
Controllable ($X2_{.2}$)	.710
Clear & understandable ($X2_{.3}$)	.579
Flexible ($X2_{.4}$)	.798
Easy to become skillful ($X2_{.5}$)	.809
Easy to use ($X2_{.6}$)	.694

According to the Table 8 above, it can be seen that the entire item/measurement variables also have factor loading values above 0.5 (>0.5) with a range 0.574 to 0.809. This means that all variables have a strong correlation and significant to the form factor is the perceived ease of use. In other words it can be said that all the items/variables represent valid for measuring perceived ease of use dimension.

3.3. Behavioral Intention to Use Dimension

Results of testing the feasibility of a variable based on the value of KMO (Kaiser-Meyer-Olkin) and Bartlett's Test of dimensions of interest behavior can be explained in Table 9 as follows:

Table 9. KMO and bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.680
Bartlett's Test of Sphericity	Approx. Chi-Square	135.062
	df	3
	Sig.	.000

KMO value in Table 9 shows the numbers 0680, which means the value is greater than 0.5 (>0.5) with signfikansi to Bartlett's Test is 0.000 under 0.05 (<0.05). This indicates that the data is deemed appropriate to proceed in the next stage of factor analysis.

Table 10. Total variance explaine

Component	Initial Eigenvalues Total	% of Variance	Cumulative %
1	1.976	65.879	65.879
2	.570	19.005	84.884
3	.453	15.116	100.000

Based on Table 10, it can be seen that the number of factors that one is 1 factor with Eigen values of 1.976 which established the factors that could explain the variability of 65.879% of the variable. This means proving that the all item / variable used as valid to explain one factor that is behavior intention to use.

Table 11. Component matrix[a]

Item/Variable	Component 1
Motivasi of usage ($Y1._1$)	.823
The addition of supported equipment on IT ($Y1._2$)	.833
Motivating other users ($Y1._3$)	.778

Based on Table 11, it can be shown that all the measurement variables also have value of loading factor above 0.5 (>0.5) with a range of 0.778 to 0.833. This means that all the items/variables have a strong and significant correlation to factors formed that is behavioral intention to use. In other words, all the items/variables is valid to measure or represent the dimension of behavioral intention to use. Correspondence between the items/variables and dimension of behavior intention to use has been empirically proven.

Based on result gained from the analysis, the validity of the model has been demonstrated through statistical approach in this study. It is said that each item or indicator is proven to be valid and reliable because they had met the minimum requirements specified such as KMO value, reliability coefficient and loading factors. Therefore, the items or indicators could explain or represent the dimension of TAM model. Most of previous research as said only applicate TAM model in measuring user acceptance of technology [9-13]. The result is also about the correlation among dimensions, instead of correlation between dimensions and indicators of TAM model. But the proposed solution in this research was also conducted in another research in order to test the vadility of PeGI model in e-government area [14].

Besides, result of study showed that the number of factor formed also in accordance with the dimensions of TAM model based on Eigen value. The dimension of perceived usefulness could explain the varians of 48.025% of all items or indicator, the dimension of perceived ease of use could explain the varians of 49.010% of all items while the dimension of behavioral intention to use could explain the varians of 65.879% of all items. The result give significant contribution since it has proven the fit between dimension and attributes of TAM model. Thus it can be said that the TAM model is still relevant to be used nowadays.

4. Conclusion

Based on the research that has been done, a number of conclusions with quantitative approach especially factor analysis shows that for each dimension of TAM: perceived usefulness, perceived ease of use and the behavioral intention intention to use told have all item/variable valid based on the high value of loading factor (>0.5). Factors or dimensions formed are suitable according to TAM model, where only one factor for each dimension. Thus the entire item/ variable (as an indicator) measured can explain or represent each dimension of TAM model. This study contributes to demonstrate empirically for validity of the TAM model. This means that the dimensions and indicators of TAM is still relevant used today for measuring user acceptance of technology. Suggestions for further research are to do more testing validity of TAM model widely on different domains.

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