The Use of Modified Theory of Acceptance and Use of Technology 2 to Predict Smart Metering Acceptance of Residential Consumers

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Abstract —In Indonesia, the use of Machine to Machine (M2M) solutions continue to grow in various sectors of industry which was supported by the increasing of mobile technology usage. The number of electricity customers in Indonesia especially household customer was 92.81% and became the highest electricity customer compared to other customer groups. Since the market potential of household customer group was quite high, the implementation of Smart Metering services provided an opportunity business for the Telco companies in Indonesia. In order to increase the adoption of Smart Metering, it is important to identify the key factors influenced behavior intention of household customer to start using Smart Metering. This study identified and predicted the key factors influenced the behavior intention of prospective users of Smart Metering by using a Modified Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) model. The result shows that there were six factors in Modified UTAUT2 which significantly and positively influenced the behavior intention of Smart Metering. Since the most influential factor was the Price Value, so the provider of Smart Metering should be able to deliver the product in accordance with the service level guarantee and always have the up to date feature in order to make the household customer do not mind spending a reasonable cost for using the Smart Metering.

Index Terms—Smart Metering, Modified UTAUT2, Intention, Adoption, Indonesia

I. INTRODUCTION

The population growth and economic levels in a country would be an impetus for change in the level of energy consumption, especially electricity. Since the electrical energy is one of the main factors to drive the wheels of the economy and is one of the indispensable necessities in today's society [1]. With the growing human population in Indonesia, which also lead to an increase in the amount of electrical energy consumption, it was necessary to regulate the balance between electricity supply and demand of public consumption [2]. To manage the availability of supply and demand of electricity consumption easily, it is needed a technology that able to control devices automatically from a distance. The technology should be a combination between electricity and telecommunications infrastructure. Telco companies in Indonesia were ready to offer solutions machine to machine (M2M) to meet this challenges with Smart Metering Services.

M2M is a solution that makes the hardware can communicate with each other without the help of humans. In Indonesia, the use of Machine to Machine (M2M) solution continues to grow in various sectors of industry which was supported by the increasing of mobile technology usage. Results of a study conducted by AnalysysMason estimates that by 2020 there would be 2.1 billion connected M2M devices globally, and also indicated that the utility sector - electricity, water and gas especially for commercial and residential user became the largest sector of industry connected with M2M [3].

From the statistical data issued by electrical state owned company, in short in Indonesia called PLN in 2013, the household customer was the highest electricity customer compared to the others customer groups [4]. The market potential was quite high from household customers, so the implementation of Smart Metering services could provide an opportunity business for Telco companies in Indonesia to achieve revenues from customers through alerts and notifications as well as through service top up of electric pulses.

Due to the opportunity of Smart Metering, Telco companies in Indonesia had already done pilot project to implement M2M for household customer since 2013. So far it had not been known the rate of acceptance toward this M2M. So this study identified and predicted the tendency of people who are active actors in consumption and energy management in the household to use the Smart Metering

II. PROBLEM STATEMENTS AND PURPOSE OF THE STUDY

Smart Metering will provide benefits for utility companies as well as for their customers. Currently, in Indonesia Smart Metering had just implemented in the utility companies and would be developed for their customer especially for household customer. Acceptance of the customer would be indispensable for the successful

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implementation of Smart Metering in household customers. In other countries, several studies had been done to examine the factors that are considered important by the customer when they want to use the Smart Metering, but this study did not find the similar studies that had been done in Indonesia.

Related with the problem statements, this research focused on predicting prospective user's acceptance of Smart Metering by using Modified Unified Theory of Acceptance and Use of Technology2 (UTAUT2) model. The objectives of the study were to examine the factors in Modified UTAUT 2 model that would influenced the adoption of Smart Metering in household customers and if the differences on ageand income had impacts on the relationship of the factors.

This study was conducted in five regions with the highest electricity consumption of households in Indonesia that were West Java, East Java, Jakarta, Central Java and Batam [4].

III. LITERATURE REVIEW AND CONCEPTUAL MODEL

Smart Metering is a technology that combines electricity and telecommunications infrastructure to integrate and connect all users in order to streamline the balance of consumption and production of electricity. Smart Metering can be controlled remotely via telecommunications facilities (laptop, smart phone or other gadget) with the agreed payment system, . Smart Metering will provide benefits for utility companies as well as for their customers. For utility companies, it can perform real-time monitoring for all the devices used in the company, make the information transparent, describe the energy load profile to control the expenses for electricity consumption. The benefits for household customers was customer can access the information of KWH, status information and notifications charging token (electric pulses), monitoring power consumption status, setting the threshold (lower limit) quota of electricity consumption as well as charging tokens on line. All of these features can be accessed through the gadget, laptop or smart phone.

Technology adoption model which was suitable as a base of theoretical framework of this study was Modified Unified Theory of Acceptance and Use of Technology 2 (UTAUT 2). Due to its ability to explain the acceptance of the technology in the context of consumer use [5]. The variables of UTAUT2 consist of Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Condition and Price Value while dependent variable is Behavioral Intention, and Age became the only moderating variable in this study.

Based on, the results of discussion with the product owner of the Smart Meter in Telco companies and other research journal literature, the UTAUT model 2 in this study had been modified by adding Perceived of Security and Risk variable to make the model fit with the object of the study. Result from the discussions with the team of Telkom Smart Metering project, it can be concluded that Smart Metering should have the security system in order to prevent fraud from the loss of control in monitoring the electricity consumption. From the literature review, a research was conducted by Il, Yongbeom and Han (2007) in order to determine the influence of perceived risk and the type of technology on the trend of customer adoption of the technology, it showed that the variables of perceived risk, technology type, user experience and gender influence the behavioral intention [5].

Besides adding Perceived of Security and Risk variable, the study also eliminated variable Habit and Hedonic Motivation. The Habit variable was eliminated, since the object in this study was potential users who had never use Smart Metering. The Hedonic Motivation variable was eliminated because it was not applicable with the object of the study. The propose model as shown in Fig. 1.

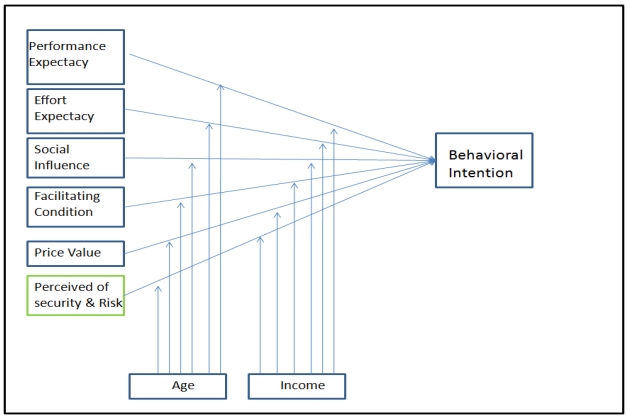

Fig. 1,Proposed Modified UTAUT2

As it can be seen from Fig. 1, this study had six independent variables, one dependent variable and two moderator variables. The independent variables consist of Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Condition (FC), Price Value (PV) and Perceived of security & Risk (PSR). While dependent variable was Behavior Intention (BI) and the moderator variables were Age and Income.

The definition of variables and items used to measure the variables in this study adopted from several previous literature [6], [7], [8], [9]. The operationalization of variables was shown in Table 1.

IV. HYPOTHESIS AND MEASUREMENT

Based on the proposed modified UTAUT2 as the research model, the hypotheses of this study wereshown in Table 2.

V. DATA COLLECTION, ANALYSIS AND RESULT

Data were collected from respondents through online questionnaires by using GoogleForms and through paper based distributed directly by three research assistants. It took 17 days for data collection from April 13th 2015 until April 30th 2015. Data were obtained from 425 respondents and 394 data were valid. The valid data came from respondents who knew about Smart Metering,

answered the screening question correctly, and answered all the item in questionnaire.

The valid data were analyzed by using Partial Least Square (PLS) which has two stages, namely assessment of the measurement model and testing of structural models. The aim of assessment on a measurement model was to make sure that the items used have the ability to measure the variables with reliable and valid. The tests carried out using Cronbach's Alpha (CA) as a reliability indicator with the reference value of 0.7, Composite Reliability (CR) with a reference value of 0.7 and Average Variance Extracted (AVE) with the reference value of 0.5 [10]. The valid data were processed by using the SmartPLS3.0 software and generate results of value measurement testing revealed that all the reliability and validity requirements were fulfilled, as shown in Table 3.

TABLE 2: RESEARCH HYPOTHESIS

Hypothesis
H1a PE has positive influence to BI H1b Age affects the influence of PE to BI H1c Income affects PE's influence to BI
H2a EE has positive influence to BI H2b Age affects Effort Expectancy's influence to BI H2c Income affects Effort Expectancy's influence to BI
H3a Social Influence has positive influence to BI H3b Age affects Social Influence to BI H3c Income affects Social Influence to BI
H4a Facilitating Condition has positive influence BI H4b Age affects Facilitating Condition's influence to BI H4c Income affects Facilitating Condition's influence to BI
H5a PriceValue has positive influence to BI H5b Age affects Price Value's influence to BI H5c Income affects Price Value's influence to BI
H6a Perceived Security &Risk has positive influence to BI H6b Age affects Perceived Security &Risk's influence to BI H6c Income affects Perceived Security &Risk's influence to BI

Having the test results that all variables were valid and reliable, then the next step of PLS was to get the value of the path coefficients and R-square. To test if the path coefficients is valid or not, the study compared the path coefficients with the t values. Table 4 shows T-values for each variable in this research.

Based on the results shown in Table 4, it can be concluded that the independent variables Price Value, Performance Expectancy, Perceived Security and Risk, Effort Expectancy, Social Influence and Facilitating condition hadpositive influences on the adoption of Smart Metering.

To know if the proposed model can be used to predict the behaviour intention to adopt Smart Metering, it can be seen from the R-square.The R-square resulted from calculation of PLS Algorithm was 0.63. This means that the model had substantial power to predict the behaviour intention to adopt Smart Metering.

TABLE 1: OPERATIONALIZATION VARIABLES

Var	Definition	Items
PE	The degree in which a potential user expect that Smart Metering will be useful and will deliver advantages compared to the present way of working	1. Using Smart Metering would allow me to live more energy efficient 2. Using Smart Metering would allow me to do monitoring my electricity consumption every time 3. Using Smart Metering would allow me to do monitoring my electricity consumption anywhere 4. Using Smart Metering helps me monitoring my electricity consumption more quickly. 5. Using Smart Metering would make me work more efficiently 6. I believe Smart Metering is useful for me
EE	The degree of ease associated with the use of Smart Metering	1. Learning how to use smart phone to access Smart Metering is easy for me. 2. Using smart phone to access Smart Metering is easy to work with. 3. It is easy for me to become skill full at using Smart Metering. 4. Understanding the use of smart phone to access the Smart Metering is easy. 5. The use of smart phone to access the Smart Metering is obvious to me.
SI	The degree to which an individual perceives that important others believe he or she should use the Smart Metering	1. People who influence me think that I should use Smart Metering. 2. People who are important to me think that I should Smart Metering. 3. Most people surrounding with me think that I should use Smart Metering. 4. My neighbour think that I should use Smart Metering 5. My teamwork think that I should use Smart Metering
FC	The degree to which an individual believes that an organizational and technical infrastructure exist to support use of Smart Metering	1. I have the resource necessary to use Smart Metering. 2. I have the knowledge necessary to use Smart Meter 3. I can get help from others when I have difficulties using Smart Metering. 4. There is a helpdesk system to help when I have difficulties using Smart phone to access Smart Metering. 5. There a lot of smart phone available to access the Smart Metering. 6. I have smart phone that can be used to access Smart Metering
PV	Consumer's cognitive tradeoff between the perceived benefits of the Smart Metering and the monetary cost for using them	1. Costs on using Smart Metering outweighed by the benefits will I get. 2. Smart Metering is beneficial for me, so I do not mind spending a reasonable cost for using the Smart Metering. 3. I do not mind that I will spend cost to be able to use Smart Metering. 4. I can accept when there is a reasonable extra cost for the use of Smart Metering
PSR	Safety issued that can affect customer perception of Smart Metering	1. I believe in the ability of the Smart Metering to protect privacy and personal information. 2. I believe that other people can not access information about my electricity level. 3. I feel safe informing my personal data via Smart Metering. 4. I feel safe making purchases of electrical pulses via Smart Metering. 5. Smart Metering Network provider has reliability and security of the network.

The study also measured the effect of two moderating variables, age and income, to the relationship among variables in the model. To measure the moderating effects, the study used group comparison. The results of group comparison in each variable tested were showed in Table 5.

TABLE 3: RESULT OF VALUE MEASUREMENT

Variable	AVE	CR	CA
PE	0.5	0.86	0.81
EE	0.6	0.89	0.85
SI	0.5	0.81	0.71
FC	0.5	0.87	0.82
PV	0.6	0.87	0.71
PSR	0.6	0.88	0.83
BI	0.6	0.9	0.87

TABLE 4: T-VALUE OF EACH VARIABLE

Variable	Path	*t-Value*	Result
PV	0.265	3.047***	Accepted
PE	0.246	3.260***	Accepted
PSR	0.24	2.859***	Accepted
EE	0.136	1.410**	Accepted
SI	0.088	1.276*	Accepted
FC	0.059	1.095*	Accepted

Note : ***99.5% Confident Significance Level ,**90% Confident Significance Level , * 80% Confident Significance Level

TABLE 5: RESULTS OF MODERATION VARIABLES

Correlation of Variables	t-value for moderating variable			
	Age	Result	Income	Result
PSR	2.64***	Accepted	2.63***	Accepted
PV	2.29**	Accepted	2.12**	Accepted
PE	1.14	Rejected	1.95*	Accepted
FC	-1.17	Rejected	-1.08	Rejected
EE	1.13	Rejected	1.02	Rejected
SI	-0.39	Rejected	-0.33	Rejected

Note : ***95% Confident significance Level ,**90% Confident significance Level ,* 80% confident significance Level

Refer to the t-values in Table 5, it can be concluded that Age moderated the effect of Perceived Security & Risk and Price Value to Behavioral Intention to adopt Smart Metering, and Income moderated the effect of Perceived Security & Risk, Price Value and Performance Expectancy to Behavioral Intention to adopt Smart Metering.

VI. CONCLUSION AND SUGGESTION

A. *Conclusion*

There were six factors in the Modified UTAUT2 were proven to have a positive and significant influence on the intention to adopt Smart Metering in Indonesia,i.e. Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Condition, Price Value and Perceived of Security and Risk.

The factors were ordered from the highest to lowest affect respectively as follows: Price Value (0.265), Performance Expectancy (0.246), Perceived Security and Risk (0.24), Effort Expectancy (0.136), Social Influence (0.088) and Facilitating Condition (0.059).

The three most influential factors in this study were Price Value, Performance Expectancy and Perceived of Security & Risk. The Variable Price Value was considered good, with the conclusion that respondent do not mind spending a reasonable price for using Smart Metering outweighed by its benefits. The variable Performance Expectancy was also considered good, with the conclusion that by using Smart Metering, they can do monitoring their electricity usage anytime and anywhere. The variable Perceived Security & Risk was also considered good, with the conclusion that they believe that the provider of Smart Metering has reliability and security system

This research model had an R-Square value of 0.63 which mean that the 63% of behavior intention for Smart Metering in this model can be explained by Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Condition, Price Value and Perceived of Security and Risk.

B. *Suggestion*

A factor that became the most influential factor to the intention to adopt Smart Metering was the Price Value. Based on the result of this study, in order to make household customers want to adopt Smart Metering in their daily activities, the providers of Smart Metering should be able to deliver the product in accordance with the service level guarantee, always have the up to date feature so they do not mind spending a reasonable cost for using the Smart Metering.

Performance Expectancy was the second factors that also affect the intention to adopt Smart Metering. Based on the descriptive analysis, the respondent wanted that Smart Metering is able to monitor their electricity consumption usage anytime and anywhere. To meet that challenge, the Utility companies must be supported by reliable telecommunication network. By knowing this factor, the Utilities companies and Telecommunication provider should make a best collaboration to deliver this Smart Metering Service.

Perceived Security and Risk was the third factors that affect the intention to adopt Smart Metering. The fact related to the important item in this variable is that people still had the fear to inform their personal data via Smart Metering but they believe that the provider of Smart Metering has reliability and security system. So using that facts, the provider of Smart Metering should be able to

shown the security system especially in Smart Metering configuration, so the customer will belief and want to adopt the Smart Metering system. The provider of Smart Metering also can benchmark with the Banking system which had implemented the e-banking service that almost have the same characteristic with the Smart Metering system especially in security and risk.

For further research, it is necessary to explore the continuity of usage (use behavior) of this service. This study has proven that Price Value has the most significant impact on the intentions to adopt Smart Metering. Further research is needed to confirm the price schemathat needed and wanted by respondents.

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