

# A Study on the Impact of Quality Perception and Innovativeness of Cleaning Robot Users on Perceived Usefulness and Repurchase Intention

In-Ock Lee<sup>1</sup> and Myungsin Chae<sup>2\*</sup>

<sup>1,2</sup> Seoul Venture University

<sup>1</sup> [iolee@ninety.co.kr](mailto:iolee@ninety.co.kr), <sup>2</sup> [mlee31@naver.com](mailto:mlee31@naver.com)

## Abstract

*The production of cleaning robots is increasing annually in spite of customer dissatisfaction. Most previous studies on cleaning robots focused on initial acceptance. This paper examined the factors on repurchase intention of cleaning robot on the basis of the theory on post adoption behavior of new technology. The Expectation-Confirmation Model in IS was adopted in this paper as the theoretical background. The results suggested that the perceived usefulness of the cleaning robot was determined by subjective norms, product quality and confirmation between expectations before and experiences after using it. It also found that user satisfaction was determined by the perceived usefulness and the confirmation. Finally the satisfaction impacted the users' repurchase intention. All the hypothesized paths were moderated by the individual innovativeness of the users.*

**Keywords:** *Cleaning Robot, Post Adoption Model, Perceived Usefulness, Product Quality, Expectation Confirmation Theory, ECM-IS, Individual Innovativeness*

## 1. Introduction

In terms of the product life cycle, the cleaning robot is in the early growth stage. Cleaning robot production increased by 68% in the period between 2010 and 2013 but customer dissatisfaction rose by 227% in the same period [1]. There were a number of studies regarding customer behavior in terms of the acceptance of innovative products. However, according to [2], the eventual success of a new technology is more dependent on the users' continued usage of the technology rather than the initial adoption of the technology itself. Ineffective usage of the new technology after the initial adoption may cause undesirable costs or result in wasted effort in developing the technology [3].

Although customer dissatisfaction for the cleaning robot is still high its production is increasing annually. Moreover the cleaning robot is one of favorite home appliances purchased by newly married couples. This tendency seems above simple curiosity. Hence it is necessary to continue examining the factors on the purchase of the cleaning robot. Most previous studies focused on initial acceptance of the cleaning robot. It is necessary to study the causality on the post adoption behavior after initial acceptance in order to explain the increasing production of the cleaning robot in spite of increasing of customer dissatisfaction. This study examined the factors on the repurchase intention of the cleaning robot on the basis of theory on post adoption behavior of new technology.

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\* Corresponding Author

## 2. Theoretical Background

### 2.1. The Theory on the Continuance Usage of IS

Among the theories regarding the consumer post-purchase behavioral process, the Expectation-Confirmation Model (ECM) has been widely used to explain consumer satisfaction and the repurchase decision. Bhattacharjee [2] developed ECM-IS (Information Systems) to investigate the substantial differences between initial adoption and continued usage behavior in the IS context [3]. ECM-IS posits that a user's expectation toward using an IS product after gaining experience should be different from the user's expectation before using it. Individuals keep updating their expectations toward using an IS product as they gain experience from using it. From this perspective, ECM-IS theorized that expectation after initial adoption played an important role in determining IS users' satisfaction decision. ECM-IS represents the post-adoption expectation as perceived usefulness. Perceived usefulness has long been identified as the most consistent and salient factor in determining user intention in IS adoption and usage [4].

ECM-IS is also called Post Acceptance Model (PAM) because it focuses only on post-acceptance variables rather than pre-adopting variables. This is so because the effects of any pre-acceptance variables are already captured within the confirmation and satisfaction constructs. It also include ex post expectation, as well as the effects of pre-consumption expectation. Ex post expectation is represented as perceived usefulness in ECM-IS.

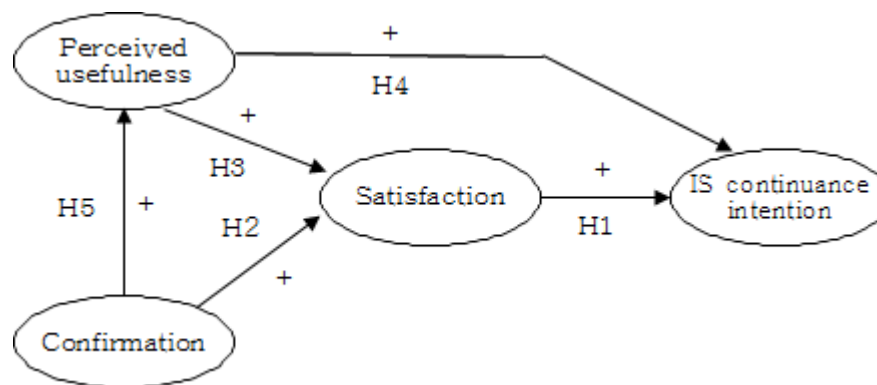


Figure 1. ECM-IS [2]

Perceived usefulness in ECM-IS was adopted from the Technology Acceptance Model (TAM), which was proposed by Davis in order to model users' acceptance of information systems (IS). Davis proposed perceived usefulness and perceived ease of use as the predictor of acceptance of IS. Davis defined perceived usefulness as the degree to which a person believes that using a particular system would enhance his or her job performance. He also defined perceived ease of use as the degree to which a person believes that using a particular system takes little effort [4, 5]. TAM has been investigated and cited since it was proposed by numerous researchers. They found that perceived usefulness was a strong determinant of usage intention, but perceived ease of use exhibited a less consistent effect on intention. Various TAM-based research models have been published most of which set external variables, including impact on perceived usefulness, involving factors such as social influence process and cognitive instrumental process. Subjective norms, voluntariness and image would belong to the first. Job relevance, output quality and result demonstrability in the second [6].

## 2.2. Previous Studies on the Service Robot

Robot can be classified as the manufacturing robot, the professional service robot and the personal service robot. The cleaning robot is categorized in the personal service robot [7]. Most studies on the service robot focus on technical or engineering aspects [8, 9, 10]. There are some studies which examined the factors influencing usage intention of the service robot in Korea. Most of them examined the usefulness of the service robot on the basis of TAM. Yoo-jung showed that personal innovativeness was negatively related to usefulness whereas usefulness influenced positively the attitude of service robot users [11]. Seong Tae showed that perceived usefulness played an important role in predicting the acceptance of intelligent home robot service [12]. Mi Ryang pointed out that intention to accept the robot in education was mostly influenced by the innovativeness of teachers, usefulness, ease of use and subjective norms [13]. Nam-Gue showed that the customer's innovation had no influence on usefulness, whereas the customer's innovation and usefulness had effects on use intention [14]. In short, previous studies pointed out that subjective norms, innovativeness and/or the degree of expectation-disconfirmation would be antecedents of the service robot users' use intention and or perceived usefulness.

## 3. Research Model and Methodology

### 3.1. Research Model

The research examines the factors influencing the repurchase intention of the cleaning robot. Thus, ECM-IS is adopted for the research model because it provides a framework for intention of continued use of a new technology after initial acceptance. Based on ECM-IS, perceived usefulness (PU) and confirmation (C) were set up as antecedents of satisfaction (S), and perceived usefulness and satisfaction were antecedents of IS continuance intention [2]. Repurchase intention (RI) replaced IS continuance intention in ECM-IS. Based on the studies on the IT post adoption and the cleaning robot, the subjective norm (SN) is a strong variable affecting IS usage or usage intention. Product quality (PQ) was an important factor influencing customers' satisfaction, because it has been the highest factor in customers dissatisfaction for the cleaning robot [1, 15]. In the early stage of an innovative product individual innovativeness (II) has been identified as a critical factor that has a persistent moderating effect on new technology acceptance and continuous usage. The study suggests the research model as shown in Figure 2.

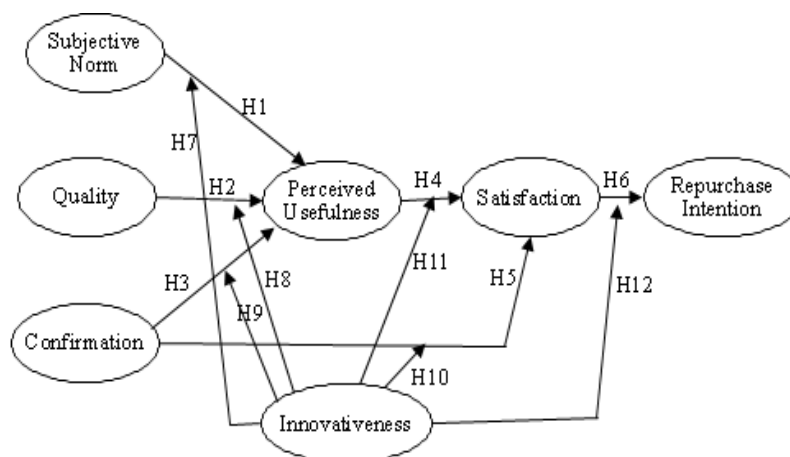


Figure 2. Research Model

## 3.2. Hypotheses

**3.2.1. Subjective norm and perceived usefulness:** The subjective norm is defined as the user's perception that most people who are familiar with him or her think he or she should or should not perform a particular behavior [4]. Various studies on new technology both initial and post adoption specify it as one of the influential variables affecting perceived usefulness of IT because it has strong network externality, and users perceive a kind of peer –pressure. For example Mi Ryang pointed out that the subjective norm was an antecedent of intention to accept the robot in education [13]. The cleaning robot is a highly new technology and people tend to decide to buy it based on their peers' recommendation. The number of users that complain about the cleaning robot is still very high but it became a trend for newly married couple to put it on their things-to-buy list. It clearly shows that the subjective the norm has been a critical factor for the purchase of the cleaning robot. Thus we suggest the following hypothesis.

Hypothesis 1. *The subjective norm will have a positive direct effect on perceived usefulness.*

**3.2.2. Product Quality and Perceived Usefulness:** Product quality is defined as the users consideration of how well the cleaning robot performs its tasks. Base on the survey by *Korean Consumer*, the highest concern on the cleaning robot was product quality [15]. Therefore, we suggest the following hypothesis.

Hypothesis 2. *Product quality will have a positive direct effect on perceived usefulness.*

**3.2.3. Confirmation and Perceived Usefulness:** Confirmation was an antecedent of perceived usefulness. Initially ECM focused on the difference between perceived usefulness and expected usefulness. The difference between them is disconfirmation and positive disconfirmation would be perceived as confirmation. The cleaning robot is still a very new technology and its performance is not standardized yet. Unlike the computer and smartphone, which have become commodities, there is low degree of confirmation in what to expect from cleaning robots [8]. From this point of view, the confirmation could be a critical factor for users' perceiving usefulness of the cleaning robots. Thus, we suggest hypothesis 3 as follows.

Hypothesis 3. *Confirmation will have a positive direct effect on perceived usefulness.*

**3.2.4. Perceived Usefulness and Satisfaction:** Satisfaction is an affect, captured as a positive (satisfied), indifferent, or negative (dissatisfied) feeling [2]. In the studies regarding post-adoption behaviors, perceived usefulness was posited as the most salient variable influencing users' satisfaction. Among service robot related research [12] found that perceived usefulness played an important role in predicting the acceptance of intelligent home robot service. So we suggest the following hypothesis.

Hypothesis 4. *Perceived usefulness will have a positive direct effect on satisfaction.*

**3.2.5. Confirmation and Satisfaction:** ECM-IS posits that user satisfaction is determined by the expectation of the IS and confirmation of the expectation, not by the level of functionality. [11] suggested the difference between perceived usefulness and expected usefulness of service robots was an antecedent of user satisfaction. Thus we propose the following hypothesis.

Hypothesis 5. *Confirmation will have a positive direct effect on satisfaction.*

**3.2.6. Satisfaction and Repurchase Intention:** IS users' continuance decision is similar to consumers' repurchase decision [3, 16]. Users' IS continuance intention is determined primarily by their satisfaction with prior IS use. Based on ECM-IS, satisfaction is the antecedent of users' repurchase intention of the cleaning robot [11, 12]. The cleaning

robot could be a kind of commodity. Users will use it every day once they are satisfied with it. Thus the study suggests the following hypothesis.

Hypothesis 6. *Satisfaction will have a positive direct effect on repurchase intention.*

**3.2.7. Moderate Effects of Individual Innovativeness:** A User Personal Characteristics Have Been A Critical Moderating factor as far as technology adoption related behavior [6, 17]. Mi Ryang showed that the intention to accept the robot in education was mostly influenced by the innovativeness of teachers, usefulness, ease of use and subjective norms [13]. Yoo-jung showed that personal innovativeness was negatively related to usefulness whereas usefulness had a positive influence on service robot users' attitude [11]. Nam-Gue showed that a customer's innovation had no influence on usefulness, whereas the interaction between a customer's innovation and usefulness had effects on use intention [14]. Thus, we suggest the following hypotheses.

Hypothesis 7. *Individual innovativeness will moderate the effect of the subjective norm on perceived usefulness.*

Hypothesis 8. *Individual innovativeness will moderate the effect of product quality on perceived usefulness.*

Hypothesis 9. *Individual innovativeness will moderate the effect of confirmation on perceived usefulness.*

Hypothesis 10. *Individual innovativeness will moderate the effect of confirmation on satisfaction.*

Hypothesis 11. *Individual innovativeness will moderate the effect of perceived usefulness on satisfaction.*

Hypothesis 12. *Individual innovativeness will moderate the effect of satisfaction on repurchase intention.*

### 3.3. Questionnaire

The items of the questionnaire were adopted from previous studies and reworded to suit the context of the current study. The measurement items in this study were comprised of 4 items on the subject norm, 4 items for individual innovativeness, 4 items on product quality, 4 items on confirmation, 5 items on perceived usefulness, 3 items on satisfaction and 3 items on repurchase intention. All items used a seven point Likert scale anchored between "strongly disagree" and "strongly agree".

### 3.4. Data Collection and Analysis Method

The survey was conducted online. The sample of 200 respondents consisted of panel members of an Internet survey company. All of them had experience in using a cleaning robot. SmartPLS 3.0 [18] was used for data analysis.

## 4. Empirical Analysis

### 4.1. Demographic Characteristics of Respondents

The demographic characteristics of the respondents showed that there were more males (103 respondents, 51.5%) than females (97, 48.5%), and the number of respondents in their 20s, 30s, 40s, 50s, and 60s were 23 (11.5%), 64 (32.0), 63 (31.5%), 31 (15.5%) and 19 (9.5%) respectively. The length of time that individuals owned the cleaning robot was less than one year, less than two years, and less than three years at 58(29%), 78(39%) and 31(15.5%) respectively.

#### 4.2. Measurement Model Estimation

A confirmatory factor analysis was conducted to estimate the measurement model using SmartPLS 3.0. PLS is the method of choice for success factor studies in marketing and for estimation the various national customer satisfaction index models [18].

Item reliability was assessed via loading value and Cronbach's alpha. All the loading values of the items were higher than 0.7 with significance at  $p < 0.001$ . All the Cronbach's alphas were higher than 0.7 (see Table 1). The reliability of construct was validated [19]. Construct validity was tested for the convergent validity testing. Composite reliabilities were higher than 0.7 and the average variance extracted (AVE) was higher than 0.5 (see Table 1). Convergent validity was validated [20].

**Table 1. Scale Properties**

	Outer loadings	T Statistics	Composite Reliability	AVE	Cronbach's alpha
SN1	0.733	12.475	0.935	0.872	0.926
SN2	0.858	28.579			
SN3	0.857	42.167			
SN4	0.894	56.543			
PQ1	0.843	35.505	0.944	0.848	0.911
PQ2	0.857	34.610			
PQ3	0.799	23.869			
PQ4	0.867	38.792			
C1	0.932	77.088	0.903	0.702	0.861
C2	0.930	85.181			
C3	0.947	130.418			
PU1	0.852	27.209	0.941	0.763	0.922
PU2	0.867	36.989			
PU3	0.875	40.243			
PU4	0.888	40.468			
PU5	0.884	43.805			
S1	0.943	113.132	0.907	0.709	0.864
S2	0.922	63.120			
S3	0.935	82.005			
RI1	0.925	69.871	0.955	0.876	0.929
RI2	0.921	63.700			
RI3	0.918	63.734			

The measure of discriminant validity is whether the square root of AVE for each construct should exceed the correlation between that and any other constructs [21]. As Table 2 shows the values of the square root AVE were mostly higher than the correlations. But the correlations between C and PQ and S and PU were higher than the square root AVE, which might be caused by multicollinearity. Variance inflation factors (VIF) were assessed by SmartPLS 3 without bootstrapping. All the VIFs were lower than 10, the cutoff value of the high possibility of multicollinearity [22]. Hence the possibility of multicollinearity was low, discriminant validity was also validated.

**Table 2. Correlations and Square Root AVE**

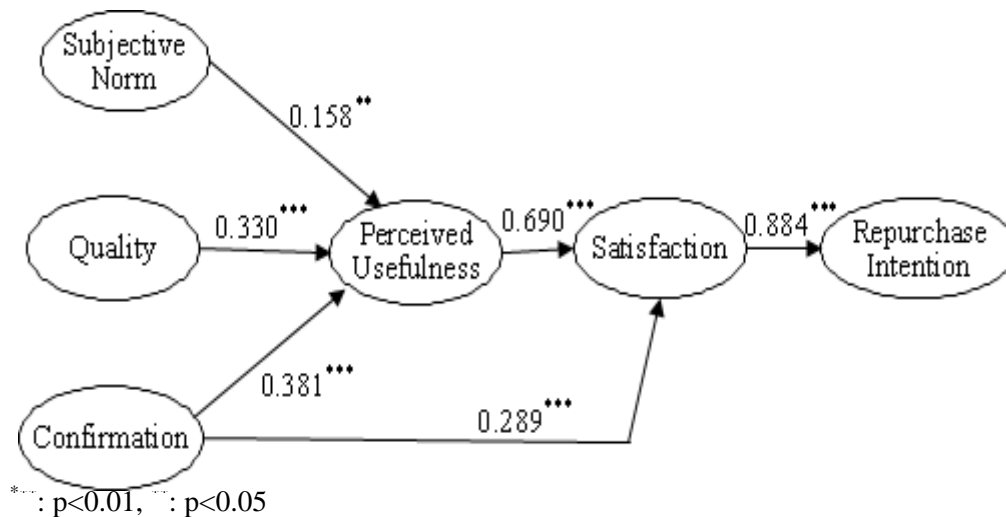
Construct	SN	PQ	C	PU	S	RI
SN	<b>0.838</b>					
PQ	0.710	<b>0.842</b>				
C	0.669	0.857	<b>0.936</b>			
PU	0.647	0.769	0.769	<b>0.873</b>		
S	0.667	0.807	0.820	0.913	<b>0.934</b>	
RI	0.680	0.772	0.771	0.858	0.884	<b>0.921</b>

Boldfaces in the diagonal figures are square root AVEs.

### 4.3. Structural Equation Model Estimation and Hypothesis Testing

The model fit of this study was estimated based on the variance explained ( $R^2$  value) of endogenous variables [20]. The model accounted for 64.9% of the variance in perceived usefulness, 86.7% in satisfaction and 78.2% in repurchase intention, which were higher than 10%. The model fit was validated [23].

The path significance of each hypothesized path in this study was examined. Figure 3 shows the path coefficients and path significances, as reported by SmartPLS 3 with bootstrapping.



**Figure 3. Structural Equation Model Analysis**

All six hypothesized paths in the model were significant at  $p < 0.01$ . Perceived usefulness was predicted by subjective norm ( $\beta=0.16$ ,  $t=2.412$ ), product quality ( $\beta=0.33$ ,  $t=3.297$ ) and confirmation ( $\beta=0.38$ ,  $t=3.383$ ). Satisfaction was predicted by perceived usefulness ( $\beta=0.69$ ,  $t=13.464$ ) and confirmation ( $\beta=0.29$ ,  $t=5.373$ ). Repurchase intention was predicted by satisfaction ( $\beta=0.88$ ,  $t=37.201$ ).

### 4.4. The Moderating Effect of Individual Innovativeness

The moderating effect of individual innovativeness was tested. The total mean of the innovativeness construct was 5.2. The number of correspondents with higher innovativeness than 5.2 and lower than 5.2 was 98 and 102 respectively. If the difference of path coefficients between the higher innovativeness group and the lower innovativeness group were significant, the moderating effect would be validated. The examination of significance of two different groups was tested by t test on the basis of equation (1) [18].

$$t = \frac{pc_1 - pc_2}{\sqrt{\frac{(n_1 - 1)^2}{n_1 + n_2 - 2} (se_1)^2 + \frac{(n_2 - 1)^2}{n_1 + n_2 - 2} (se_2)^2}} \sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \quad (1)$$

$pc_i$ ; path coefficients in group  $i$ ,  $n_i$ ; number of correspondents in group  $i$ ,  $se_i$ ; path coefficients standard errors in group  $i$

The results are summarized in Table 3. The differences between the high and low groups of all the paths were significant therefore, hypothesis 7 to hypothesis 12 were all adopted. This indicates that the higher innovativeness a user has, the higher the relationship between variables he or she has.

**Table 3. The Results of Moderating Effect**

Path	Examined group				t value
	Higher innovativeness(n=98)		Lower innovativeness(n=102)		
	$\beta_1$	SE <sub>1</sub>	$\beta_2$	SE <sub>2</sub>	
SN ->PU	0.220	0.012	0.167	0.009	3.463 <sup>***</sup>
PQ -> PU	0.259	0.013	0.350	0.013	-4.534 <sup>**</sup>
C -> PU	0.385	0.015	0.327	0.014	2.796 <sup>***</sup>
C -> S	0.324	0.009	0.263	0.007	5.225 <sup>**</sup>
PU -> S	0.666	0.009	0.695	0.007	-2.612 <sup>**</sup>
S -> RI	0.911	0.002	0.800	0.006	18.401 <sup>**</sup>

<sup>\*\*\*</sup>: p<0.01, <sup>\*\*</sup>: p<0.05

## 5. Conclusion

### 5.1. Summary of Study and Discussion

In spite of rising of customers' dissatisfaction cleaning robot production has been increasing. In order to clarify why this is true theoretically the predictor of perceived usefulness was examined on the basis of ECM-IS. The predictors of satisfaction and repurchase intention were examined. Also the moderating effect of individual innovativeness on these variables was examined.

First, the subjective norm, product quality and confirmation had a significant effect on the users' perceived usefulness of the cleaning robot. The results correspond to the previous studies' results on new technology acceptance [4, 6, 2], and on the service robot [13, 14]. Second, confirmation and perceived usefulness had a significant impact on satisfaction. The result also corresponds to the previous studies' result on the ECM-IS. [4, 6, 2], and on the service robot [11, 12]. Third, satisfaction had a significant impact on repurchase intention. These results for cleaning robot were somewhat consistent with the results of previous studies in innovative technology acceptance and continuous usage behavior. Fourth, individual innovativeness of the cleaning robot user had a significant moderating effect on all the relationships between each variable in this study. But the moderating effects between product quality and perceived usefulness and between perceived usefulness and satisfaction were negative. This all means that the group with lower levels of innovativeness perceived that the quality and usefulness of the cleaning robot were more important than the other factors.

### 5.2. Practical Implications

First, in terms of the size of the effect of predictors of perceived usefulness product quality ( $\beta=0.33$ ) and confirmation ( $\beta= 0.38$ ) were larger than subjective norm ( $\beta=0.16$ ). The loading factors of scale items in the product quality construct were 0.867 in A/S



quality, 0.857 in operating time, 0.847 in performance of dust cleaning and 0.799 in price. The results of the study mean that cleaning robot manufacturers should concentrate on quality improvement first of all. Then, they need to set up a policy to satisfy customers' desire for high A/S quality.

Second, in the effect sizes of predictors of perceived usefulness, confirmation was the largest one. There was possibility of multicollinearity between product quality and confirmation. The results of the study seem to show that the cleaning robot users' perception does not differentiate confirmation with production quality. It seems that their expectation is confirmed by the level of production quality. Therefore cleaning robot manufacturers should concentrate on the quality improvement.

Third, the number of correspondents in the higher innovativeness group and the lower innovativeness group were 98 and 102 respectively. It means statistically that the ratio of the higher innovativeness group to the lower innovativeness group is nearly the same. It seems that the users who do not care about the innovativeness of the cleaning robot perceive quality and usefulness as being more important, which are original reasons for buying a cleaning robot. It seems that the innovativeness of the cleaning robot is no longer necessary. Hence cleaning robot manufacturers should focus on quality and usefulness to improve the cleaning robot.

### 5.3. Limitations of the Study

This study suffers from several limitations. First, common method bias (CMB) was not considered. CMB is a methodological error that occurs when all variables of a research framework are measured by one common method. This study is not free from CMB because the self-report method was used. But there are conflicting studies in the self-report method. Some researchers who mention CMB suggest another measuring method with the self-report method. Some researchers assert that there is not a theoretical basis on measuring and controlling the error of this measuring method. They assert that thorough understanding should precede the construct concept itself, the measuring method itself and conditions of data collection [24]. Second, the scale items in the product quality construct were A/S quality, operating time, performance of dust cleaning and price. There are many studies based on the information success model in which quality is constructed as system quality, information quality and service quality [25-27]. If new scale items were extracted based on common quality factors from the previous studies on innovativeness and these factors were examined as significant to users' usefulness and/or satisfaction, it would provide fruitful and practical implications to cleaning robot manufacturers. Third, the survey was conducted online because of limited time and efficiency of data collection. It is possible to collect data in short period in this method. But not trying another data collection method is one of the limitations in this study. Data collection by interview with users who visit the cleaning robot A/S center is one of the other methods. If the results by that method are compared with the results in this study, it will be fruitful and useful to marketers and manufacturers of the cleaning robot.

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## Authors



**In-Ock Lee**, he is in the doctoral program in Seoul Venture University in Korea. He is the president of Ninety System which is a leading company in IoT (Internet of Things) solutions. He is interested in the customer behavior in innovative new product.



**Myungsin Chae**, she received Ph. D in MIS from the University of Illinois at Chicago in 2003. She is a professor in the department of MIS at Seoul University of Venture and Information at Seoul Korea. She teaches courses and conducts research in e-business and mobile business, and strategic IS management.

