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# When the Future Technology is Now: Paradoxical Attitudes of Consumer and Evaluation of IoT Service

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***Abstract***

*The aim of this study is to develop a new research framework that explains consumer attitude toward internet of thing (IoT) service. Based on the literature on IoT service, technology paradox, and consumer values, an empirical structural model is developed and tested. This study collects quantitative survey data from Korean IoT users. The empirical test results show that utilitarian values such as efficiency, technology trust, performance ambiguity, chaos give influences to paradoxical attitudes of consumer and these attitudes give influences to IoT service evaluation separately while, hedonic value like hedonic enjoyment gives influence to IoT service evaluation directly without any mediating variables. This initial research on IoT service from a consumer point of view may stimulate further research on IoT-based consumer service innovations.*

***Keywords:*** *IoT, Internet of Things, Technology Evaluation, Consumer Attitude, Technology Paradox*

## 1. Introduction

Internet of Things (IoT) service has been conceptualized as one of the most promising technology services that general consumers can experience. A new era of IoT service development is being ushered in by the emerging version of new technologies, which will connect everything a consumer can have [1]. No one is going to elude IoT service technology in the near future – home network, smart TV, smart car, and many kinds of smart sensors.

The term 'IoT' was originally introduced first in 1999 [2]. It has been taken wide interests and has introduced a large number of innovative applications in many areas. Naturally, massive researches have focused on IoT design, architecture and implementation issues from the technical point of view [2] [3] [4]. These researches provided a framework to understand IoT technologies and identified major technological issues, including security, interoperability, heterogeneity, and identification [5]. However, the academic efforts to understand IoT from a consumer point of view is rare and the attitude of consumers toward the IoT service is little known.

In general, there are many previous researches about the relationship between consumer and general technologies. Understanding consumer acceptance and use of technology has been one of the most mature streams of technology service research. One leading view contends that technological progress is a beneficial thing for the most consumers, thus academic researchers should pay more attention to their deed of adoption [6]. By comparison, the only little amount of research has been performed to understand negative aspects of new technology adoption including IoT service adoption.

As a consequence, these lacking academic interests in IoT, will make understanding consumer attitude evaluate IoT service difficultly. Thus, this research on IoT service tries to broaden the academic understanding of the new technology and its user consumer through empirical research. Also, this study will review both bright and dark side of

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consumer technology for a full understanding of IoT service and its impacts to consumer behavior.

## 2. Theoretical Background

### 2.1 IoT Service and Technology Paradox

The IoT describes objects that are able to communicate via the net and the IoT technology is being applied in many regions such as tracking, line control, logistics, home automation, mobile payment, health maintenance, and the private domain [7]. These related IoT services will provide great benefits across many industries and their benefits to consumers are important [8]. Especially, Korea proved to be fertile ground for the emergence of IoT service and related technologies, in large part because of the high penetration rate of high-speed internet connection and mobile service.

Korea has been a pioneer for broadband internet service and is the first state to introduce mobile TV services to the users. Agreeing to the KCC (Korea Communications Commission) report, mobile phone penetration rate was over 114%, and 70% of Korean wireless subscribers were using smartphone in 2014 [9]. Koreans seem more addicted to new technology like IoT service than any other culture. But this passion for connection technology does not necessarily mean that Korean consumers like every aspect of IoT service.

Consumers often see their daily experiences with technology to be ambivalent. Although consumers enjoy the benefits of new technology, they are often mixed up and confused with the characteristics of technology [10] [11]. Some researchers argue that technology provides efficiency, freedom, and control in daily life and labor. Notwithstanding, some view technology negatively. For example, Glendinning (1990) contends that technology brings negative side effects such as human dependency and passivity [12].

Those inconsistent views toward technology deny pure polemics [13]. Some researchers argue that technology itself is paradoxical. For instance, Winner (1994) insists that the same technology that generates positive feelings of intelligence and efficacy can also create feelings of stupidity and ineptitude [14]. Mick and Fournier (1998) offer a new conceptual framework on the paradoxes of technological products and show that technology paradoxes arise both positive and negative emotions [13].

The same paradoxical ambiguity could be found in IoT service too. The spread of new consumer technologies such as the IoT will increase efficiency and convenience, but also will increase technological enslavement indicated by continuous attention and addictive behavior. For example, the benefits of ubiquitous availability of mobile device could be countered by concern for privacy, and security problems [15]. Despite these paradoxical experiences are critical to most users and give a huge impact to service adoption, they still remain unaddressed by researchers until now.

### 2.2 Consumer Competence/Incompetence

Regrettably, modern consumers lack competence with respect to many views of consumption [16]. Their behaviors usually show several deficiencies. They would be frail and vulnerable because of their low level of product knowledge and experience in some fields [16] [17]. Many consumers admit themselves, not knowing how to consume properly [18]. Particularly, the consumers' difficulties of understanding rising technology such as IoT service technology are alarming realities. Therefore, it seems important to know whether people possess the necessary competence to realize, accept and purchase IoT services.

Consumer competence could be defined as knowledge and skills related to all stages of the acquisition and use of product and service [19]. Ölander and Neuner (2007)

 

understand consumer competence as the ability to take a decision as well as possible match their own consumer needs and wishes [20].

However, consumer competence also denies pure polemics, and is a kind of paradoxical attitude. Mick and Fournier (1998) summarize eight central paradoxes of technology and competence/incompetence is one of them [13]. According to their qualitative research, competence/incompetence means that technology can facilitate less effort or time spent in certain activities, and technology can lead to more effort or time in certain activities.

This competence/incompetence paradox is understandable in view of the daily challenges. For instance, when a consumer buys an IoT device such as smart TV, the device looks intelligent and powerful, but he will find himself very soon that he's not able to connect the smart TV to the Wi-Fi internet correctly.

### 2.3 Motivations and Technology Adoption

Hirschman (1984) asserted that all consumer behaviors involve the stimulation of thoughts and accordingly they would be viewed as a process that gives both cognitive and affective influences to consumers [21]. This dichotomy of cognitive and affective dimension corresponds to 'utilitarian' and 'hedonic' value of consumer [22].

Utilitarian consumer behavior is mainly explained through task-oriented rational actions [23]. A consumer receives utilitarian value when the IoT service provides benefits in the form of effectiveness and efficiency in their life and job. Compared to utilitarian behavior, hedonic consumer behavior is based on the value created through the holistic emotional sensations of excitement, fun and pleasure [21]. It will include experiential feelings of enjoyment while using IoT services. According to Ölander and Neuner (2007) [20], consumer competence consists of knowledge, decision-making skills, motivation and need reflection. Thus, consumer competence/incompetence is a typical concept representing utilitarian values. Nevertheless, it is difficult to find emotional indicators among the four components.

To provide an antecedent of hedonic value in the model, this study is particularly interested in hedonic enjoyment. In brief, enjoyment has been conceptualized as a major antecedent of new technology acceptance in various studies [24] [25].

## 3. Research Model

The conceptual model is outlined in [Figure. 1] proposes antecedents that affect perceived competence/incompetence separately. Competence/incompetence are a typical paradox of technology operationalized by the previous researches [11] [13]. Consistent with the previous researches on technology paradox, the model proposes that conflicting positive and negative experience underlies the evaluation of a technology [13] [26]. Similarly, this model insists that positive satisfiers such as efficiency, technology trust affect perceived competence, while negative dissatisfiers such as performance ambiguity, chaos affect perceived incompetence, resulting in IoT service evaluation. Besides, hedonic enjoyment gives direct influence to IoT service evaluation.

### 3.1 Satisfiers and Competence

The more consumers expect that applying a technology will improve their performance, the more probable they are to like it [27]. It is because they believe that there must be a relationship between performance in their life and job and efficient technology. Efficiency results from a tradeoff between time and effort for using a technology and the resulting performance of the technology [11]. Thus, when consumers regard IoT service as efficient by virtue of time and effort saved, they are likely to consider IoT service a more competent.

H1. Efficiency will have a positive effect on perceived competence.

In general, technological innovations come with risk and the perceived risk associated with a service has gained importance in understanding consumer behavior [28]. In the context of IoT service, people's experience with new IoT service has been found to be a critical concern in regard to the security problems. For instance, making pass toll payment by using IoT technology is often associated with a high loss potential related to vehicle data and transaction itself [5]. As a result, a consumer feels uncertainty and heightened risk in their service evaluation. In the computer-mediated environment, trust toward the technology has a strong positive effect on consumer attitude and intention [29]. Therefore, we hypothesize as bellows.

H2. Technology trust will have a positive effect on perceived competence.

### 3.2 Dissatisfiers and Incompetence

Performance ambiguity is a dissatisfied and distorts consumer ability to evaluate the service properly [11]. The more a user expected that using a technology will improve his performance, the more likely he is going to trust the ability of the technology [27]. Thus, when a user is not sure about the performance of technology, he will get a sense of incompetence.

H3. Performance ambiguity will have a positive effect on perceived incompetence.

Chaos is concerned with the notion that technology can create disorder and upheaval [13]. For instance, IoT service's chaos can include fear. A mistakenly used GPS location information from IoT devices may result in possible immediate private information leak. Besides, according to the emotion elicitation theory, chaotic feelings generate negative emotions, which may increase perceived incompetence [30]. Also, consumers prefer to avoid functions designed to improve the service if they consider these new functions too complicated [31]. Such avoidance may cause incompetence regarding the capability of the technology.

H4. Chaos will have a positive effect on perceived incompetence.

### 3.3 IoT Service Evaluation

The ability of technology to improve task performance has been identified as a critical motivation for technology adoption [32]. Perceived competence of IoT service is expected to increase productivity and efficiency by consumers. Therefore, we hypothesize as bellows.

H5. Perceived competence will have a positive effect on IoT service evaluation.

Consumer intention to use the new technology depends on his self-efficacy [33]. The higher the consumer's self-efficacy, the higher the consumer's intention to evaluate the technology positively. Perceived incompetence which has strong relations with low self-efficacy of consumer will give a negative effect on IoT service evaluation.

H6. Perceived incompetence will have a negative effect on IoT service evaluation.

Enjoyment has been found to be a major intrinsic motivation and a driver for new technology adoption in many researches [5] [34]. Consumers who feel pleasure from employing a technology product are more likely to form positive attitude and behavioral intention to use the product [35]. A positive motivation variable such as enjoyment is strongly argued to lead to an enhanced attitude of the consumer [24].

H7. Hedonic enjoyment will have a positive effect on IoT service evaluation.

 

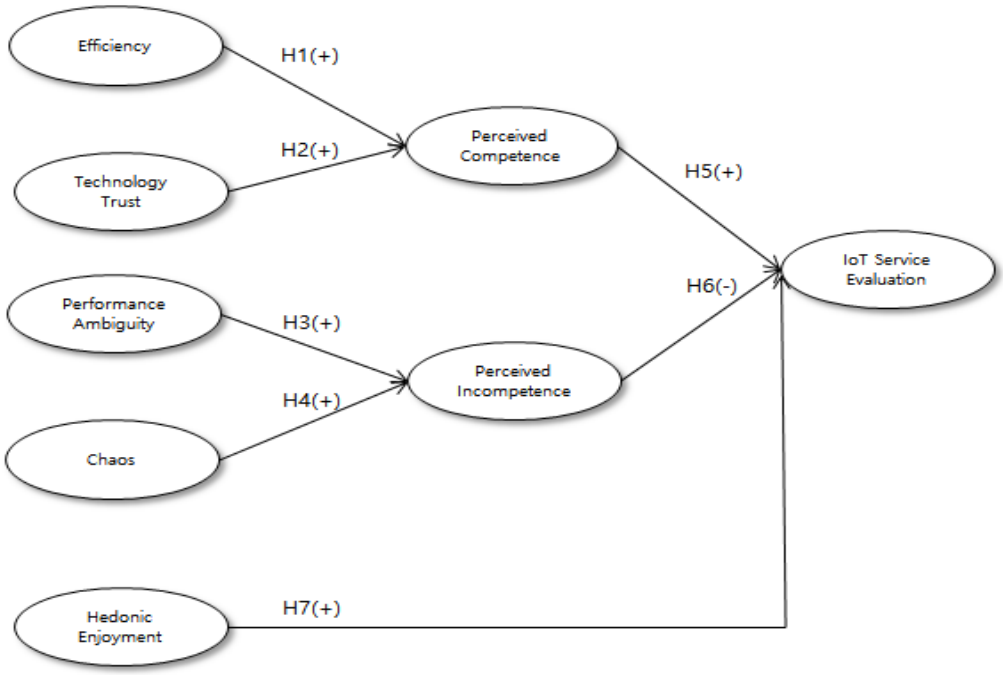


**Figure 1. Structural Model**

## 4. Analysis Result

### 4.1 Sample Characteristics

To test the research hypotheses, quantitative survey data were collected from Korean college students in 2015. There are several IoT commercial service providers in the Telco market and plenty of users in Korea have used the IoT service already. IoT services in Korea are relatively developed than other nations. For instance, most vehicle drivers are a user of ETC (Electronic toll collection) service which name is 'Hi-pass', and Samsung Galaxy smartphone models with mobile payment function through NFC technology are the hottest bestsellers. And other IoT services such as smart wallet, RFID-based transportation ticket is in a growth stage and entering into the mature stage in Korea.

Especially, research participants who are in their twenties were considered appropriate for this research for several reasons. First, younger people tend to more easily accept new technology like IoT service compared to their older counterparts and are heavy users of mobile service. Second, they belong to innovative opinion group and use social media very well, which is a key to service diffusion.

A survey of the entire population of 238 respondents was taken via the survey web site. The on-site questionnaire was accompanied by a cover letter and short movie explaining the purpose of the research and showing the real life service concept of IoT service. The respondents comprise 51.7% male and 48.3% female. All respondents are older than 19 years and the average age of the respondents is 27.9 years old.

### 4.2 Measurement and Validity

The every measurement in this research was developed by using the previous researches [11] [13] [35] [36]. Mick and Fournier (1998) conceptualized the major concepts such as efficiency, technology trust, performance ambiguity, chaos through qualitative research methods [13] and Johson et al. (2008) developed actual scale items to within a PC banking context [11]. Besides, the hedonic enjoyment scale was developed by

Davis (1992), Chun et al. (2012) [35] [37]. And IoT service evaluation adopted from the research of Ganesan (1994) [36]. Every measure in this study was changed to be suitable for IoT service context, and was measured using 5-point Likert scales ranging from '(1) strongly disagree' to '(5) strongly agree'.

After we created a web based questionnaire in Korean, the questions were reviewed for content validity by a group of marketing academics. As the questionnaire was administered in Korean, we turned the original English questionnaire to Korean and then back to English again to ensure translation equivalence [38]. A professional translator and a research assistance independently participated the processes.

After these processes, Reliability of measures in the questionnaire was tested by analyzing Cronbach's alpha score. Cronbach's alpha scores were found to be more than 0.7 in every variable, satisfying Nunnally (1967)'s reliability criteria [39].

**Table 1. Measurement Scale**

| |
|---|
| Efficiency (Cronbach's α=.906) |
| a1. With IoT service, I now spend less time involved in maintaining my personal finances.<br>a2. I can save time by easily automating payments with IoT service.<br>a3. IoT service makes it more efficient to coordinate multiple related transactions. |
| Technology Trust (Cronbach's α=.783) |
| a4. I can rely on IoT technology to execute my transactions reliably.<br>a5. Given the state of existing IoT technology, I believe that technology-related errors are quite rare.<br>a6. In my opinion, IoT technology is very reliable. |
| Performance Ambiguity (Cronbach's α=.805) |
| a7. It is difficult for me to determine whether IoT service is executing all of my transactions correctly.<br>a8. I might never know whether IoT technology is malfunctioning.<br>a9. Unless it is brought to my attention, errors in my IoT service could go unnoticed. |
| Chaos (Cronbach's α=.748) |
| a10. As I use IoT service, I often get the feeling that mistakes could have catastrophic outcomes.<br>a11. As I use IoT service, I sometimes think that errors could go totally unnoticed.<br>a12. I fear that mistakes in IoT service are potentially devastating. |
| Hedonic Enjoyment (Cronbach's α=.900) |
| a13. Using IoT service will be a refreshing experience to help stress itself<br>a14. I will use IoT service for pleasure. |
| Perceived Competence (Cronbach's α=.936) |
| b1. IoT service will definitely improve my ability to manage my personal<br>b2. My ability to make payments at precise times has improved with IoT service<br>b3. My ability to budget more precisely has improved with IoT service |
| Perceived Incompetence (Cronbach's α=.905) |
| b4. I am often surprised how things I don't understand about IoT service turn out to be simple.<br>b5. I sometimes feel embarrassed after asking for instructions about IoT service.<br>b6. Sometimes its service makes me feel like my technology skills are limited. |
| IoT Service Evaluation (Cronbach's α=.907) |

 

b7. IoT service is pleasing.
b8. IoT service is contending
b9. IoT service is satisfying

To test the validity of variables, scales for the research model were subjected to EFA (exploratory factor analysis) in separate groups of endogenous variables and exogenous variables. In the test with VARIMAX rotation option, factors were extracted successfully as anticipated. Results are displayed in [Table. 2] and [Table. 3].

**Table 2. EFA of Exogenous Variable**

| Variable | Factor 1. Efficiency | Factor 2. Performance Ambiguity | Factor 3. Technology Trust | Factor 4. Chaos | Factor 5. Hedonic Enjoyment |
|---|---|---|---|---|---|
| a2 | **.909** | .022 | .041 | .086 | .183 |
| a1 | **.894** | .008 | .059 | .113 | .137 |
| a3 | **.870** | .047 | .024 | .054 | .232 |
| a8 | .035 | **.902** | -.118 | .189 | .018 |
| a7 | -.109 | **.859** | .146 | .072 | -.008 |
| a9 | .178 | **.721** | -.248 | .174 | -.026 |
| a6 | .090 | -.092 | **.865** | -.172 | .029 |
| a4 | -.072 | .075 | **.848** | -.132 | -.049 |
| a5 | .140 | -.195 | **.712** | -.123 | .270 |
| a12 | .087 | .139 | -.132 | **.836** | -.043 |
| a10 | -.012 | .071 | -.239 | **.812** | .124 |
| a11 | .156 | .188 | -.056 | **.712** | -.042 |
| a14 | .245 | -.039 | .085 | -.001 | **.912** |
| a13 | .262 | .032 | .072 | .030 | **.904** |
| Igen value | 2.621 | 2.190 | 2.166 | 2.021 | 1.851 |
| % ofVariance | 18.718% | 15.642% | 15.471% | 14.436% | 13.224% |
| Total Variance | 77.490% | | | | |

**Table 3. EFA of Endogenous Variable**

| Variable | Factor 1. Perceived Competence | Factor 2. Perceived Incompetence | Factor 3. IoT Service Evaluation |
|---|---|---|---|
| b2 | **.950** | .015 | .153 |
| b3 | **.929** | .029 | .202 |
| b1 | **.879** | .113 | .230 |
| b5 | .019 | **.929** | -.098 |
| b6 | .052 | **.927** | -.121 |
| b4 | .069 | **.883** | -.059 |
| b8 | .182 | -.061 | **.915** |
| b7 | .179 | -.098 | **.893** |
| b9 | .215 | -.140 | **.876** |
| Igen value | 2.658 | 2.548 | 2.547 |
| % of Variance | 29.533% | 28.313% | 28.305% |
| Total Variance | 86.150% | | |

As a next step, maximum likelihood CFA (confirmatory factor analysis) in separate groups of endogenous variables and exogenous variables was carried out to check convergent validity and discriminant validity. All variables were permitted to correlated. The $x^2$ indicates that there is a significance difference between the sample covariance matrix and restricted covariance matrix. However, it is common where sample sizes are large, thus, this research relies on the remaining other measures which support an acceptable model fit [40]. The overall model fit scores, GFI, CFI, NFI, and RMSEA were satisfactory and acceptable in general. The analysis outcome proved that the proposed model and the data were good for the further analysis.

**Table 4. CFA of Exogenous Variable**

| Factor | Variable | Std. b | C.R(p-value) | AVE | Composite Reliance | Model fits |
|---|---|---|---|---|---|---|
| Efficiency | a1 | .853 | 15.893(.000) | .921 | .972 | $x^2$(d.f)= 169.981(67), p = .000, GFI(AGFI) =.911(.861), CFI =.935, NFI =.898, RMSEA =.081 |
| | a2 | .925 | 18.019(.000) | | | |
| | a3 | .849 | 15.792(.000) | | | |
| Technology Trust | a4 | .694 | 10.991(.000) | .867 | .950 | |
| | a5 | .648 | 10.190(.000) | | | |
| | a6 | .906 | 14.845(.000) | | | |
| Performance Ambiguity | a7 | .741 | 11.762(.000) | .855 | .944 | |
| | a8 | .939 | 15.261(.000) | | | |
| | a9 | .569 | 8.859(.000) | | | |
| Chaos | a10 | .765 | 11.887(.000) | .825 | .933 | |
| | a11 | .588 | 8.840(.000) | | | |
| | a12 | .780 | 12.144(.000) | | | |
| Hedonic Enjoyment | a13 | .922 | 14.992(.000) | .916 | .956 | |
| | a14 | .886 | 14.341(.000) | | | |

**Table 5. CFA of Endogenous Variable**

| Factor | Variable | Std. b | C.R(p-value) | AVE | Composite Reliance | Model fits |
|---|---|---|---|---|---|---|
| Perceived Competence | b1 | .845 | 15.984 | .917 | .970 | $x^2$(d.f)= 36.300(24), p = .051, GFI(AGFI) =.968(.940), CFI =.993, NFI =.979, RMSEA =.047 |
| | b2 | .956 | 19.569 | | | |
| | b3 | .936 | 18.854 | | | |
| Perceived Incompetence | b4 | .792 | 14.306 | .907 | .967 | |
| | b5 | .912 | 17.606 | | | |
| | b6 | .926 | 18.063 | | | |
| IoT Service Evaluation | b7 | .866 | 16.271 | .913 | .969 | |
| | b8 | .907 | 17.492 | | | |
| | b9 | .864 | 16.232 | | | |

### 4.3 Empirical Results

The structural model was estimated using Amos 20.0 s/w. The analyzed results displayed in the below show acceptable fit statistics with a $x^2$ goodness of fit of 480.661 with 211 degrees of freedom, a GFI of .852, a CFI of .920, and RMSEA of .073. An examination of the hypotheses and significance levels provided clear support for the overall model with all coefficient signs showing the expected direction. Every hypothesis are supported successfully.

**Table 6. Result of Test**

| Hypothesis | | | | b (Std. b) | S.E | CR | p* (p<.05) |
|---|---|---|---|---|---|---|---|
| H1 | Efficiency | → | Perceived Competence | .538(.482) | .071 | 7.551 | .000* |
| H2 | Technology Trust | → | Perceived Competence | .342(.296) | .076 | 4.502 | .000* |
| H3 | Performance Ambiguity | → | Perceived Incompetence | .287(.226) | .090 | 3.204 | .000* |
| H4 | Chaos | → | Perceived Incompetence | .219(.190) | .094 | 2.346 | .019* |
| H5 | Perceived Competence | → | IoT Service Evaluation | .161(.183) | .049 | 3.303 | .000* |
| H6 | Perceived Incompetence | → | IoT Service Evaluation | -.092(-.123) | .042 | -2.222 | .026* |
| H7 | Hedonic Enjoyment | → | IoT Service Evaluation | .671(.660) | .066 | 10.236 | .000* |
| * Fit : $x^2$(d.f) = 480.661(211), p = .000, GFI(AGFI) = .852(.806), CFI = .920, NFI = .868, RMSEA = .073 | | | | | | | |

## 5. Conclusion

The result of this study has both theoretical and managerial implications. The main theoretical contribution is that it theorizes the antecedents influencing the consumer evaluation of IoT service from a unified perspective, including utilitarian and hedonic variables. This research proposes a dual path framework of IoT service evaluation by integrating pure hedonic attributes and utilitarian attributes inherent in the IoT technology. We investigate the paths in which, efficiency, technology trust, performance ambiguity, chaos through perceived competence and perceived incompetence influence IoT service evaluation. We also analyze the direct association of hedonic enjoyment with IoT service evaluation.

With regard to hypothesis 1 and 2, the empirical results show that perceived competence is influenced by both efficiency and technology trust, indicating that perceived competence of IoT service is a result of utilitarian variables. With regard to hypothesis 3 and 4, the results indicate that perceived incompetence is influenced by performance ambiguity and chaos significantly.

Compare to other hypotheses, hypothesis 5 shows that emotional value like hedonic enjoyment gives direct effect to IoT service evaluation. Therefore, hedonic motivation plays an important role in predicting intentions for IoT service. The findings indicate that people perceive IoT service as a mean for hedonic pleasure partly.

Also, the relationships between paradoxical consumer attitude (perceived competence/incompetence) and IoT service evaluation are supported significantly. The

outcome is a new framework on the paradox of IoT service evaluation of consumer and implies that technology paradox arise strong, often negative attitude triggers slow IoT service adoption.

This research has some restrictions. First, the IoT service is in its introductory stage in the marketplace and is not used widely yet. Therefore, some consumers with little user experience could answer according to their expectations. Second, the research focus was only on Korean consumers. It is recommended that further research can be performed again after the IoT service gets into growth stage to find out more managerial implications. Third, future work can examine other key IoT services and product categories to generalize the research results. In addition, future research needs qualitative research to gain better and deeper understanding of consumer perspectives toward IoT service.

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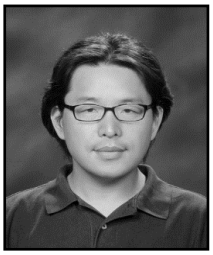

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