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Why Do Individuals Adopt Smart Devices? Model of Factors Influencing Individuals' Adoption of Smart Devices

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Abstract: There has been a rapid increase in the use of smart devices by users and they have become a topic of interest to many researchers. In this study, we develop a research model to investigate the impacts of three main characteristics user, technological and social characteristic on the intention of a user to adopt a smart device which is then followed by the actual adoption of a smart device. To test the proposed research model, we perform a survey and collect 399 responses from randomly selected smart device users. The results of the Structural Equation Model (SEM) show that three characteristics significantly impacted user's intentions to adopt smart devices as well as actual adoption. The findings imply that the usage of smart devices depends on the unique circumstances of the individual users, the technology and the surrounding environment.

Key words: User characteristic, technological characteristic, social characteristic, smart devices, SEM

INTRODUCTION

In recent times, smart technology has become a popular topic in many sectors of society and an increasing number of organizations and individuals are interested in its use for various purposes. As more people use smart devices and services, smart-commerce, also called s-commerce has become a new trend and is expected to be the next big wave in our society. A number of mobile device, smart devices, services and applications have been developed and are already in use by a wide cross section of individuals as well as business functions (Looney *et al*., 2004; Mallat *et al*., 2004). However, one missing link in the study of smart technology is a clear understanding of the motivation surrounding the use and adoption of such technologies from a user perspective. It is clear that without explaining the proliferation of smart devices and related applications, additional studies, e.g., smart commerce may face various difficulties in explaining user's behaviors of such technologies.

Even though the literature on the use and adoption of technology are quite extensive, there are surprisingly few academic studies regarding the use and adoption of smart devices (Pedersen, 2005). Furthermore, most of the technology adoption studies are based on three well-known theories, namely the Technology Acceptance Model (TAM) (Davis, 1989), the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) and the Theory of Planned Behavior (TPB) (Ajzen, 1985). For example, Hu *et al*. (1999) studied the adoption of telemedicine services using the TAM and Kwon and Chidambaram (2000) extended the TAM to study the adoption of cellular phones. Pedersen and Ling (2002) used the TPB to study mobile internet services. However, an extension of either the TAM or the TPB may not be appropriate for studies on the adoption of smart technology because the technology has characteristics that are different from those of wired technologies such as mobility and its ability to be researched.

Sarker and Wells (2003) claimed that existing theories may explain the adoption of technologies and may include smart services but in a new context, they may ignore unique issues that are associated with smart services. Therefore, at the early stages of the smart technology era, we require a clear understanding of how and why individuals (potential s-commerce consumers) use and adopt smart devices which would help to study the use and adoption of s-commerce or any other topic in the field of smart technology. Based on the limitations in the literature, the purpose of this study is to develop a theoretical model that examines factors that drive individual's use and adoption of smart devices, particularly smart watches. As reported in the literature, this study develops a research model based on feedback from actual users of smart watches rather than applying the existing technology adoption models because they may ignore the unique characteristics of smart devices.

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To achieve the purpose of this study, the main research question being asked is "What are the factors that drive individual's use and adoption of smart devices?" We propose a research model that is based on prior studies and responses from actual smart device users. We employ Structural Equation Modeling (SEM) to analyze responses from a total of 399 individuals who use smart devices. The SEM analysis results indicate that all of the proposed hypotheses were significantly supported, implying that individuals have a greater intention of adopting smart devices owing to factors that may be classified according to the users as well as technological and social characteristics.

Literature review: There is an abundance of literature in the area of technology acceptance. In general, there are three possible approaches that may be followed when investigating technology adoption. These are the adoption approach, diffusion approach and domestication approach (Pedersen and Ling, 2002). Three models that are widely applied in the adoption approach include the TAM (Davis, 1989), TRA (Fishbein and Ajzen, 1975) and TPB (Ajzen, 1985). These models focus on the individual's level of behavior and are primarily used to explain the individual adoption and acceptance of technologies (Davids, 1989; Venkatesh and Davis, 2000; Venkatesh, 1999). Many studies have adopted one of these three models to test the use and adoption of different technologies. For example, the TAM has been widely used to examine the consequences of the perceived ease of user interfaces with different applications such as Windows, Lotus and WWW (Agrawal *et al*., 2000; Agarwal and Prasad, 1999; Anandarajan *et al*., 2002; Dishaw and Strong, 1999).

In addition, Venkatesh and Brown (2001) modified the TPB in order to develop a model that represents the adoption of technology by households. Pedersen (2005) examined the end-user behavior in terms of the adoption of mobile Internet services. To do this, he used both the TAM and the TPB. Khalifa and Cheng (2002) used the TPB model as their theoretical basis in order to study the impact of exposing m-commerce to an individual and the individual's intention to adopt m-commerce. These adoption models give a good understanding of the characteristics of a particular information system, product, service, end-user behavioral intention and adoption requirement.

Diffusion theories include the Diffusion of Innovation (DOI) proposed by Rogers (1995), the Bass New Product Growth Model and the Multi-Generation Technology Diffusion Model (Bass, 1969; Norton and Bass, 1992). The DOI model has been widely used to determine consumer behavior in the marketing, organization adoption and diffusion behavior in a social system and in the information system field (Black *et al*., 2001; Crawford, 1996, Robertson and Gatignon 1986). The Bass (1969) model was developed to explain how customers adopt consumer durables. Norton and Bass (1992) combined the Bass model with Fisher and Pry (1971)'s technological substitution model which was developed to examine the sales behavior of high technology products and it encompasses both diffusion and substitution. Jain *et al*. (1999) and Danaher *et al*. (2001) studied cellular phone services in the US and European markets by integrating marketing-mix variables using this model.

In spite of the multiple studies in the area of technology adoption and diffusion, there are surprisingly few studies that focus on the adoption of smart devices on an individual level. One main reason for this is believed to be that the use of such technologies is a relatively recent trend. Some studies used the TAM as a guide to develop the adoption of wireless devices. For example, Kwon and Chidambaram (2000) tested the TAM in the case of cellular telephone adoption. Pedersen (2005) proposed a decomposed TPB to study the adoption of mobile Internet services. Others such as Constantiou *et al*. (2004) and Sarker and Wells (2003) developed a model for the use and adoption of wireless device and services based on a survey and user-experiences. In addition, Kshetri and Cheung (2002) developed the model for mobile diffusion in China based on the political and economic changes that were experienced there.

List of key variables and proposed model: Figure 1 represents the proposed research model for the adoption of smart devices along with the hypotheses. The essence of the proposed model is that the degree and types of uses of smart devices are influenced by a number of characteristics in the external environment, including the user, technological and social characteristics. For each characteristic, we identified various crucial factors that influence the use and adoption of smart devices.

User characteristics: The user characteristics are critical to examining individual's intention and adoption of various technologies. Several factors that influence an individual's adoption of smart devices are connection, convenience and savings:

- Connection: the measure of anytime, anywhere communication capability
- Convenience: the measure of the degree of comfort of users of smart devices

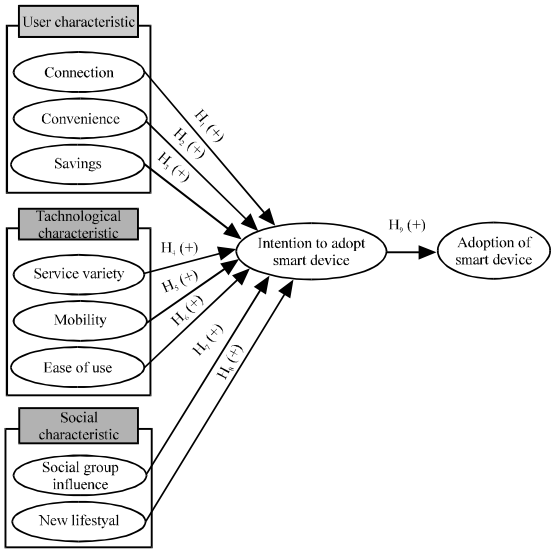

Fig. 1: Research model and hypotheses

- Savings: the degree of tangible and intangible savings achieved, particularly with respect to the time and money savings realized by using smart devices compared to other technologies that provide the same services

Technological characteristics: Smart devices have their own unique characteristics. Some of the crucial factors that influence an individual's adoption of smart devices are service variety, mobility and ease of use.

- Service variety: the measure of the number of services provided by a smart device
- Mobility: the measure of the ability to perform any action through a range of movement via the smart device
- Ease of use: the extent of the individual's capability to operate and use the smart device

Social characteristics: Some social characteristics such as social group influence and changing lifestyle have been identified as important factors that influence the use and adoption of smart devices.

- Social group influence the amount of pressure that an individual feels based on other person's feelings towards the use and adoption of smart devices or whether he or she should follow suit
- New lifestyle: changes of life style made by an individual in a society

Intention to adopt and adoption of smart device: The intention to adopt the use of a smart device is defined as the degree of an individual's willingness to use and adopt smart device. The adoption of a smart device is a dependent variable in the research model and is defined as the actual use of a smart device where it is measured by the weekly frequency of use of the smart device and the amount of time that individuals spend with his/her smart device.

Hypotheses development

User characteristic: The user characteristic is a crucial external environment in IT adoption (Pennings and Smidst, 2000; Schillewaert *et al*., 2000) and consists of an individual's demographics such as connection, convenience and savings, for adopting smart devices. Many people look for technologies to provide anytime-anywhere connection and the convenient use of features and services (Carroll *et al*., 2002). With smart devices, individuals can accommodate their busy daily lifestyles affecting their intentions to use such smart devices.

In addition, time and cost savings to be realized directly influence individual's adoption of smart devices. The price is always the primary factor considered by people when they are deciding whether to adopt new technologies. Rogers (1995) claimed that the rapidly falling cost and the capability of smart devices to save time offer a relative advantage. Furthermore, a multi country survey conducted by Vrechopoulos *et al*. (2002) found that the cost of the service is one of the key determinants of mobile wireless service adoption and use. Therefore, we hypothesize that:

- H_1: connection has a positive impact on a person's intention to adopt a smart device
- H_2: convenience has a positive impact on a person's intention to adopt a smart device
- H_3: savings has a positive impact on a person's intention to adopt a smart device

Technology characteristic: Smart devices have their own unique characteristics that drive individuals to adopt it. Several aspects of smart devices such as their variety of services, mobility and ease of use are convenient to users which consequently results in their adoption of the device. According to Sarker and Wells (2003), mobility and the variety of services may be the most touted advantage of mobile technologies, including smart devices. Because people can use smart devices anytime, anywhere, they achieve more convenience which leads them to adopt their use. In addition, Carroll *et al*. (2002) claimed that the familiarity of a technology is the main filter for technology adoption. The ease of the user interface is also found to be a significant factor in the

cellular adoption study done by Kwon and Chidambaram (2000). Most smart devices are small, so some persons may encounter difficulty in seeing all contents or in operating the devices. Therefore, the simplicity of the user interface is a crucial factor that determines whether individuals adopt or reject smart devices. Thus, we proposed the following:

- H_4: service variety has a positive impact on an individual's intention to adopt smart devices
- H_5: mobility has a positive impact on an individual's intention to adopt smart devices
- H_6: ease of use has a positive impact on an individual's intention to adopt smart devices

Social characteristic: The social characteristic is the external environment resulting from changes in the social phenomenon. Regardless of an individual's intention or willingness to adopt the use of a smart device, he/she may opt to adopt new technologies because of these social trends and phenomenon. Two factors in this characteristic are the social group influence and new lifestyle.

The social group influence is a well-known factor that influences the adoption of technology and it is an interpersonal influence within a group. Individuals are often influenced by peers in the same group to which they belong. If some members in a group use a certain technology, there is a high possibility that others will adopt the same technology. Pedersen *et al*. (2003) studied the adoption of the mobile Service-multimedia Messaging Service (MMS). They claimed that younger persons discovered text messaging to be instrumental in social coordination because all of the other members of their social network use it but they still feel little social pressure towards using text messaging services as a norm. In addition, the study of cellular adoption by Kwon and Chidambaram (2000) concluded that the age of the cellular users had a strong and significant association with the social pressure that they faced to use cellular telephones. Social influence is also a key factor affecting the adoption of other technologies. For example, Chiasson and Lovato (2001) studied the decision-support system adoption for health planning. They reported that the subjective norm is a significant antecedent of information system adoption intention. Morris and Venkatesh (2000) used the Theory of Planned Behavior (TPB) in order to investigate age differences in the adoption intentions and the continued use of Information Technology (IT). They also concluded that the subject norm influenced people, although, the age and length of exposure affected the effects. Based on the TPB, it is expected that the subjective norm will have an influence on the intentions of consumers to engage in online transactions.

Another, variable in social characteristic is new lifestyle which is defined as the degree of newness which individuals spend time from day-to-day. With new technologies, people have changed the way in which they live within a society. People who have complicated daily schedules communicate more with others, travel more often and adopt new technologies rapidly. Now a days, younger persons have more demands on their time and much fuller schedules than did past generations. They therefore, want technologies that can accommodate to this new lifestyle. Whether their keen ability to multitask is facilitated by technology or the technology encourages it, individuals appreciate and enjoy the ability to do many things simultaneously. Smart devices that leverage this behavior are therefore, very appealing to this market. Thus, the following hypotheses are suggested:

- H_7: social group influence has a positive impact on an individual's intention to adopt smart devices
- H_8: new lifestyles have a positive impact on an individual's intention to adopt smart devices

Relationship between intention and adoption: The intention to adopt the use of a smart device is defined as the degree to which an individual is willing to use a smart device, whereas the adoption of a smart device is defined as actual usage of the technology. The relationship between these two variables has been verified in many IT adoption researches (Davis, 1989; Morris and Venkatesh, 2000). In order to test whether the relationship is valid for smart devices, the following hypothesis is proposed:

- H_9: intention to adopt a smart device has a positive impact on an individual's adoption of a smart device

MATERIALS AND METHODS

Sample: We collected data from actual users of smart devices (e.g., smartphone, smart TV and wearable device). We distributed a total of 1,000 survey questionnaires to individuals occupied at organizations and at public places such as public libraries, train stations and the downtown area. We collected 399 responses (39.9% response rate). A total of 63% of the respondents were male. The participants ranged in age from 22 to over 50, with the average (28.3) falling within the 20-30-year age group which was the largest age group. Participants comprised professionals (53.3%), office workers (27.9%), university students (22.2%), technicians (10.8%) and others (8.0%).

Table 1: Breakdown of the study participants

Demographic categories/range	Percentage
Age (years)	
20-30	56.60
31-40	22.17
41-50	19.34
51+	1.89
Gender	
Male	63.00
Female	37.00
Occupation	
University student	22.20
Office workers	27.90
Technicians	10.80
Professional	53.30
Others	8.00
Type of smart device (multiple responses)	
Smartphone	100.0
Smart appliance	45.7
Wearable smart device	39.5
Others	4.0
Duration of use of smart device (years)	
<1	6.6
<2	3.3
<3	12.3
>3	77.8

Results showed that all participants currently use smartphones while 45.7% use smart appliances and 39.5% use wearable smart devices. The majority of the respondents (77.8%) have been using a smart device for >3 year. Table 1 shows the profile of the respondents.

Analysis of measurement model: Before analyzing the proposed research model, the measurement model was examined by testing the internal consistency (Cronbach's Alpha) and validity (convergent and discriminant validity). We calculated Cronbach's Alpha on the entire set of statements for each construct. Even if there is no set level of alpha regarded as a minimum acceptable level for reliability, the minimum acceptable level of alpha is 0.7 (Teo *et al*., 1999). All scales for variables in the research model displayed acceptable internal reliability. The alphas for each construct ranged from 0.78-0.95 Thus, it can be concluded that the reliability tests showed strong internal consistency.

Then, we examined the convergent validity which refers to the degree to which scores on one measure correlate with scores on other measures designed to assess the same construct, using Confirmatory Factor Analysis (CFA) with the value of factor loading. To demonstrate convergent validity, the item loading should exceed 0.7 for each latent variable (Chin, 1998). As shown in Table 2, all items have a factor loading of >0.7 indicating the convergent validity.

Finally, we examined the Average Variance Extracted (AVE) and Pearson's correlation of all of the latent variables in order to test the discriminant validity which refers to the degree to which scores on one measure do not correlate with scores from other measures that are not designed to measure the same construct. We assessed the discriminant validity by assigning the covariance combinations of various factors as "1" and then taking the difference in chi-squares between these models and the standard measurement model. We observed that all chi-square values were significant.

Table 2: Results of reliability and convergent validity.

Variables/items	Mean	SD	Factor loading	Cronbach's alpha
Connection				
Con1	5.14	0.12	0.83	0.80
Con2	4.57	0.59	0.89	
Con3	5.22	0.75	0.78	
Con4	4.97	0.32	0.82	
Convenience				
Conv1	5.20	0.34	0.80	0.89
Conv2	4.74	0.63	0.75	
Conv3	5.38	0.95	0.71	
Conv4	5.18	0.25	0.85	
Savings				
Sav1	3.26	0.61	0.77	0.90
Sav2	4.78	0.24	0.82	
Sav4	5.31	1.01	0.76	
Service variety				
Sv1	4.40	0.83	0.83	0.78
Sv2	5.24	0.45	0.71	
Sv4	5.03	0.12	0.82	
Ease of use				
Eou1	4.39	0.74	0.76	0.92
Eou2	5.26	0.79	0.93	
Eou3	4.92	0.17	0.89	
Eou4	5.83	0.62	0.82	
Social influence				
Si1	4.97	1.01	0.74	0.95
Si2	4.33	0.87	0.91	
Si3	5.09	0.32	0.76	
New life style				
Nl1	4.33	0.55	0.83	0.89
Nl2	4.01	0.69	0.79	
Nl3	4.98	0.71	0.83	
Intention to adopt smart device				
Iasd1	6.01	0.67	0.99	0.87
Iasd2	6.33	0.29	0.87	
Iasd3	5.99	0.47	0.91	
Adoption of smart device				
A1	5.82	0.10	0.86	0.81
A2	5.87	0.09	0.79	

RESULTS AND DISCUSSION

Hypotheses test: We formulated the SEM with AMOS 22.0 to test the proposed hypotheses. The standardized path coefficient (β) and the squared multiple correlation (R^2) are main outcomes from the SEM analysis for the hypothesis test and variance explained by exogenous variables. We examined eight variables in three influence categories in order to determine their impact on the intention to adopt smart devices as well as how much they explain the variance in the intention to adopt smart devices. First, three variables in user characteristic had a

Table 3: Results of discriminant validity

Models	χ^2	χ^2 difference	df
Base model	407.6	-	
Connection-convenience	433.3	25.7	1
Connection-savings	448.9	41.3	1
Connection-service variety	520.1	112.5	1
Connection-mobility	448.3	40.7	1
Connection-ease of use	523.1	115.5	1
Connection-social group influence	501.6	94.0	1
Connection-new lifestyle	505.6	98.0	1
Connection-intention to adopt smart device	434.0	26.4	1
Connection-adoption of smart device	427.2	19.6	1
Convenience-savings	426.0	18.4	1
Convenience-service variety	439.3	31.7	1
Convenience-mobility	441.4	33.8	1
Convenience-ease of use	438.7	31.1	1
Convenience-social group influence	424.5	16.9	1
Convenience-new lifestyle	420.8	13.2	1
Convenience-intention to adopt smart device	431.7	24.1	1
Convenience-adoption of smart device	427.1	19.5	1
Savings-service variety	465.7	58.1	1
Savings-mobility	452.2	44.6	1
Savings-ease of use	465.4	57.8	1
Savings-social group influence	446.4	38.8	1
Savings-new lifestyle	447.3	39.7	1
Savings-intention to adopt smart device	429.6	22.0	1
Savings-adoption of smart device	427.3	19.7	1
Service variety-mobility	452.2	44.6	1
Service variety-ease of use	509.6	102.0	1
Service variety-social group influence	523.6	116.0	1
Service variety-new lifestyle	523.3	115.7	1
Service variety-intention to adopt smart device	427.6	20.0	1
Service variety-adoption of smart device	426.3	18.7	1
Mobility-ease of use	452.5	44.9	1
Mobility-social group influence	449.3	41.7	1
Mobility-new lifestyle	451.9	44.3	1
Mobility-intention to adopt smart device	434.2	26.6	1
Mobility-adoption of smart device	427.4	19.8	1
Ease of use-social group influence	520.6	113.0	1
Ease of use-new lifestyle	517.9	110.3	1
Ease of use-intention to adopt smart device	432.6	25.0	1
Ease of use-adoption of smart device	425.6	18.0	1
Social group influence-new lifestyle	448.8	41.2	1
Social group influence-intention to adopt smart device	435.3	27.7	1
Social group influence-adoption of smart device	426.3	18.7	1
New lifestyle-intention to adopt smart device	435.6	28.0	1
New lifestyle -adoption of smart device	426.4	18.8	1
Intention to adopt smart device-adoption of smart device	427.2	19.6	1

Critical at 0.05 level

positive influence on the intention to adopt the use of a smart device. The path coefficient between the connection and intention to adopt a smart device was 0.345 which was signification at $p<0.01$. Thus, H1 was supported. Convenience and savings also had path coefficient values of 0.412 and 0.478, respectively. Thus, H_2 and H_3 were supported at $p<0.01$. These results imply that if a smart device user can enjoy continuous connection to a network with convenient capabilities at low price, they have a greater willingness to adopt such a technology as shown in Table 3.

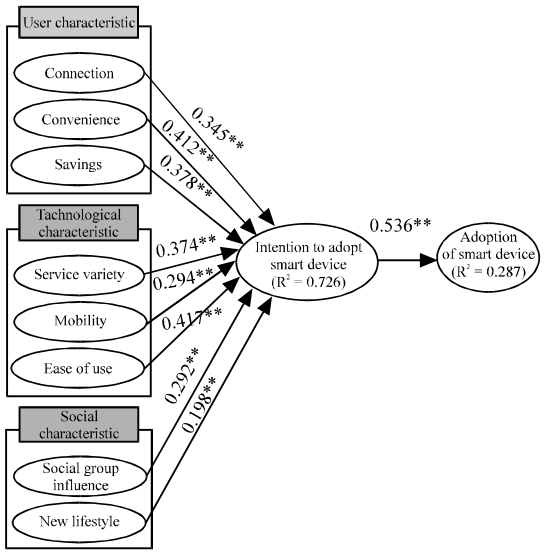

Fig. 2: Structural model

Second, three variables in technological characteristic had a positive impact on the intention to adopt a smart device, namely the service variety (β = 0.374), mobility (β = 0.294) and ease of use (β = 0.417). Thus, H_4-H_6 were supported at $p<0.01$. The findings imply that users of smart devices expect smart devices to have various services with high mobility and an easy-to-use interface which increases the intention to adopt such technology. Regarding two variables in the social characteristic, they had a positive impact on the intention to adopt a smart device. The path coefficient between the social group influence and the intention to adopt a smart device was 0.292 which was significant at $p<0.01$. Thus, H_7 was supported. In addition, new lifestyle had a significant influence on the intention to adopt a smart device (β = 0.374, $p<0.01$). Therefore, H_8 was supported. Finally, the relationship between the intention to adopt a smart device and the adoption of a smart device had a coefficient value of 0.536 which was significant at $p<0.01$. Thus, H_9 was also supported.

The adjusted R^2 of the model with eight external variables (connection, convenience, savings, service variety, mobility, ease of use, social group influence and new lifestyle) was 0.726, implying that about 72.6% of the variance in the intention to adopt a smart device was explained by these variables in the research model. Furthermore, the intention to adopt a smart device accounted for 28.7% of the variance in the adoption of a smart device. Figure 2 shows the results of the structural model analysis.

CONCLUSION

The findings of this study pertain to many areas, particularly the adoption of smart technology. First, this study contributes to our knowledge of the adoption of technology in general as well as helps to reveal the effects of new technology on human behavior and vice versa as many IT studies have done in the past. Straub *et al.* (1995) and Taylor and Todd (1995) reported that two main focuses in information system research are users' perceptions of and intention to adopt the use of information systems as well as the rate of diffusion and penetration of technology within and across organizations. This study can therefore assist in the understanding of these two main focuses.

Second, even though smart devices are of interest to many areas of our society, there are few studies that consider an individual's behavior in the use and adoption of these smart devices. In other words, the small number of studies on the use and adoption of smart devices from various perspectives would add more value to this study. In the near future, there is no doubt that many technologies will become "smart." Thus, this study provides a good framework for future research of both scholars and practitioners in this field.

Third, the findings of this study have significant implications for research on smart commerce (online-based commerce using smart devices). As mentioned earlier, by gaining an understanding of the use and adoption of smart devices, this research can support studies of smart commerce. Furthermore, the findings of this study indicate that there are important practical implications for the business world in terms of the design and development of smart devices.

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