Factors Influencing Smart Device Acceptance in Korea: Application of a Modified Technology Acceptance Model

Joon-Ho Lee¹

¹ Professor, Department of Communication & Media, Dong-eui University, Korea, joonlee@deu.ac.kr

Abstract: The recent advances in digital media technologies have been applied to smart media that are becoming the main tools for human communication and life throughout the world. They have raised an academic interest in what are the deciding factors for acceptance of new media technologies. This study proposed and analyzed a modified technology acceptance model (TAM) in order to explore determining factors for acceptance of smart devices in Korea. More specifically, the study empirically explored relationships among three categories of variables (external, TAM, and acceptance variables) which were fundamental elements of Davis' TAM model that described and explained the process of smart device acceptance. The external variables included enjoyment, income, and social pressure. The TAM variables were perceived usefulness and ease of use, and the acceptance variables consisted of the degree of acceptance and further acceptance intention. Face-to-face survey interviews were conducted using a sample of 691 respondents who were randomly selected proportionately by controlling the sex, age, and income. After a path analysis of a structural equation model, the following results were found. First, enjoyment was positively related to all the TAM variables and all the acceptance variables. Second, social pressure was positively associated with all the TAM variables and further acceptance intention. Third, income level had a positive relationship with the degree of acceptance. Finally, the TAM variables were still considered to be essential in the model. In conclusion, practitioners and marketers need to emphasize enjoyable traits and social pressure messages to increase the new device acceptance level. In addition, more possible external variables need to be developed and used in future relevant studies.

Keywords: TAM, Smart Device, Enjoyment, Social Pressure, New Technology

1. Introduction

The rapid development of communication technology and service has brought profound modifications in the forms of media, devices, and modes of human life. Especially, the rapid breakthrough and the worldwide diffusion of contemporary smart devices has provided diverse users with such functional advantages as accessibility to any type of content, convenience of use, universal usability, synchronization, interactivity, customization, and social physical presence. These changes in devices and media have expanded the range of smart device utility from simple communication among people to include almost all realms of human life and works.

Among the various types of smart devices, including smartphones, tablet PCs, smart TVs, smart speakers, and the Internet of Things (IoT) based wearables, smartphones are the most representative and necessary devices in daily life. They were adopted by almost every person because they intrinsically satisfy most basic human needs and desires. As of 2020, a decade after the beginning of the fast adoption of smartphones, over half of the people in advanced countries have adopted and used three or more types of smart devices[1].

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Since the emergence of smart devices, such new media platforms and IoT services such as pay-TV, OTT (Over-the-Top), SNS (Social Network Service), N-screen, Bluetooth, and RFID (Radio Frequency Identification) have started to reveal their functional and marketing superiority, and to make a majority of people depend on them. Also, VR/AR and wearable devices are additional innovative technologies and devices that are widely regarded as important tools for 3D visual image creation and for the IoT to improve virtual realities and connections among humans as well as between humans and non-human objects. These smart devices are becoming more and more suitable for cutting-edge smart media platforms and services that consistently attempt to increase their number of users and subscribers and advertising revenue. Thus, daily use of smart media is becoming a habitual behavior among the people surrounded by high-speed, ubiquitous Internet environments.

Assuming that the acceptance and usage of smart devices mainly depend on an individual's consumer considerations, choices, and decisions to purchase and adopt. In studying the phenomena regarding the changes in contemporary media environments, it is necessary not only to understand the present situation and determine how widely and diversely the devices are sold and used but also to analyze the relationships among traits of consumers and their actual acceptance of the new media or devices. There have been a large number of theoretical attempts to explore relationships among the factors for diffusion and adoption of new technologies and actual acceptance of them.

One of the most relevant theoretical attempts and explanations for this study is the technology acceptance model (TAM), originally designed and proposed by Davis in mid-1980s to theorize the acceptance and usage behavior of computer technology in workplaces. Based on the theoretical framework of TAM, this study conducted an interview survey and tried to empirically analyze factors and drivers in the process of smart device acceptance. More specifically, the study explored the relationship among a user's characteristics suggested or testified by the model and a user's past, present, and future smart device acceptance behavior and purchase intention.

2. Literature Review

2.1 Acceptance and Use of Smart Devices in Korea

South Korea has the 11th largest economy in the world and is one of the most advanced countries in terms of technology. It is known for its fast Internet speed and for having the latest technological infrastructure. This has caused rapid growth and the high degree of mobile smart device penetration throughout Korea. As of 2021, nearly 100% of Korean people who are below 60 years old have already adopted and are using smartphones, and 80% of those who are 60 or above have adopted smartphones. Two-thirds of Koreans perceive that a smartphone is an inevitable medium for life and over 90% of them use it for watching video content on OTT and VOD platforms[2].

Another type of smart device is tablet PCs. The speed of tablet PC penetration was not as fast as smartphone penetration until the COVID-19 pandemic began in early 2020, however, the total number of tablet PCs sold in Korea increased by over 30% during 2020, as well as by 17% in the world[3]. The lingering virus pandemic radically increased the demand for suitable and convenient devices usable for online classes and video conferences.

The demand for 4K or 8K video quality and larger screen size, UHD blue-ray, HDR (High Dynamic Range) technology, high-definition content, and web-surfing using smart TVs has increased household penetration of the smart TV in Korea first exceeding 50% in 2013.

By 2020, this trend had risen 80% with most TV viewers watching TV by using a smart TV that is connected to the Internet and contains innumerable applications and links to web platforms and services[4]. TV still maintains its functional position at the center of an active home entertainment system with a big, high-quality screen and audio quality because TV viewing behaviors are becoming

more active and purposive with the help of synchronous connections to the Internet and other digital devices[5]. The functionalities of smart TV's superior characteristics and innovativeness compared to traditional TV have naturally attracted the attention of media users. They function well as a complement to small mobile devices for viewing abundant movies, IPTV, and online video services (OTT) in Korea.

The other types of smart media and devices, such as wearable devices and realistic media, are beginning to attract special interest in advanced countries where smartphones and tablet PCs have reached a degree to which most people have already accepted and used them. The production and sales of these types of smart media have been led by the USA and China to a large extent. Popular forms of wearable devices now include wristwatches, glasses, accessories, clothes, and shoes. The main functions many users prefer are those connected to physical and mental health, security, navigation, fitness, IoT, entertainment, and environmental monitoring. The wearable technology market has grown over the last ten years with the sector seeing triple-digit percent growth with few occasions of decrease. As of 2021, the Korean smart device wearable market stands now for smart watches and wireless earphones with a market penetration rate of 12% and 41%, respectively. In Korea, smart glasses adopting AR technology have been the type mostly imported, however, LG U+ started producing domestic devices in 2020[6].

Considering the current situation in the Korean smart device market above, it is necessary to understand latest smart media acceptance factors of consumers by analyzing theoretically proven factors influencing the means of accepting, buying, and using the devices. Also, it is important to additionally analyze underlying social-psychological processes of their resulting influence on acceptance and purchasing behavior.

2.2 Technology Acceptance Model (TAM)

The most relevant theoretical analyses and explanations to the topic and the purpose of this study have started with the 'technology acceptance model (TAM).' It originated from the theory of reasoned action and the theory of planned behavior, which aim to explain the relationship between attitude/belief and behavior/behavioral intention within human action, and were elaborated by Fishbein and Ajzen in 1970s. The TAM has evolved to become an essential model for exploring predictors of human attitude toward actual acceptance or rejection of new digital technologies. This paper will review key theoretical frameworks of the TAM and recent replication studies and their main findings. It will then try to find the applicability of these results by analyzing data in terms of Korean smart device acceptance behaviors. To accomplish this, an interview survey was performed.

To review the TAM specifically, the user's acceptance pattern for new technologies and products has been used as the major analytical frame of research in many academic fields since the late 1980s when a series of TAMs were first proposed by Fred Davis. In 1986, Davis originally conceptualized a model explaining users' acceptance or rejection of technologies or systems in organizations or workplaces in order to analyze the adoption and actual use of new systems or technologies[7]. He proposed a possible causal relationship among three variables based on the basic neo-classical psychology frame (S-O-R frame) of analysis: These three variables are: (1) features and capabilities of new system or technology (stimulus), (2) the user's motivation to use the new system or technology (organism), and (3) the actual use of them (response). Later, Davis elaborated on his original model to suggest the first TAM ([Fig. 1]). In formulating the model, he relied on theories explaining the relationship between attitude and behavior, and on other related research findings that dealt with a user's motivation. The variable of user motivation can be further divided into three sub factors: (1) perceived ease of use, (2) perceived usefulness, and (3) attitude toward using the system or technology[8].

Later, Davis modified and refined his original TAM three times in 1989[9], 1993[10], and 1996[11] by including additional variables and transforming the causal relationships that he initially drew

according to results from additional empirical studies. The final version of TAM shown in [Fig. 2] was proposed in 1996 with the elimination of the user motivation, and the addition of the behavioral intention. The variable of system characteristics was extended to the external variables in meaning because there might be other factors in addition to system characteristics that influence the perceptions and attitudes of a user or a non-user toward a new system or technology. These external variables may include user participation, user environment, user training, user experience, social pressure or persuasion to use, the implementation process, and so on. Many subsequent replication studies have relied on this version of TAM to investigate mechanisms and processes for the actual acceptance cases[12].

[Fig. 1] Original Technology Acceptance Model (TAM) (1986)

[Fig. 2] The Most Recently Revised Framework of TAM (1996)

2.3 Prior Research Findings

2.3.1 Acceptance of Smartphones, Smart TVs, and Tablet PCs

In a replication study about the diffusion of smartphones and their adoption and use, all the analyzed characteristics of users (perceived usefulness, ease of use, enjoyment, and social pressure) proved significant positive factors affecting adoption behaviors (earliness, acceptance, and intention to accept). In the early stage of smartphone diffusion, the factors proposed by the TAM plus income were decisive in terms of whether to adopt, when to adopt, and willingness to adopt the mobile device[13].

Another replication study about the applicability of TAM factors in the process of smart TV acceptance applied three external variables (perceived enjoyment, social pressure, and functional traits) and two moderating variables (perceived usefulness and ease of use). The result was that all the external variables, such as income, age, social-psychological characteristics, and functionality, significantly affected the acceptance and intention for future purchase of smart TVs[14]. A relevant study about smart TV adoption and usage, focusing on perceived functional attributes of smart TVs, emphasized that perceived functional advantages of smart TVs had a strong influence on the purchase intention and the further uses of smart TV, followed by significant factors such as entertainment, cost for how to use, web-browsing, and n-screen functions[15].

In terms of tablet PC acceptance processes and behaviors, a comprehensive empirical study found that some other factors for wide acceptance besides the factors in the TAM were suggested. The study

examined factors influencing tablet PC diffusion in 43 countries. The results showed that a lower tablet PC price contributes to tablet PC diffusion, and that high levels of social network penetration and income helped the initial acceptance aspect of tablet PCs. The study also found that tablet PCs are a complement to smartphones in the early period of smart device diffusion, and that tablet PCs and smartphones are likely to substitute preceded PCs in the initial diffusion period of tablet PCs[16].

2.3.1 Acceptance of Wearable Devices

Such wearable devices as smart glasses, smartwatches, smart clothes, and HMD (head-mounted displays) adopting and applying AR (augmented reality), VR (virtual reality), and IoT (Internet of things) technologies will substantially influence the media, communication, production, construction, and medical industries. Many studies regarding this type of device have been performed to testify and theorize about a consumer's acceptance behaviors. Most of these studies used the TAM or a framework of diffusion of innovation for their analyses. One study investigated the role of a user's personality in predicting the awareness, acceptance, and usage of smart glasses, and showed a result whereby open and emotionally stable consumers tend to be more aware of Google Glass. Those consumers who perceive the potential for high functional benefits and the social conformity of smart glasses are more likely to adopt such wearables[17]. Another empirical study using multiple regression analyses examined the relationship between seven factors and compared the intention to use wearable devices mainly based on the TAM framework. Among the seven factors, perceived usefulness and self-efficacy proved to be the most significant predictors for use intention among wearable devices[18].

2.4 Theoretical Framework for Analysis

In the ongoing process of new technology-oriented smart devices becoming widespread, the penetration rate and speed are not the only factors to explore. Except for smartphones, other types of smart devices that are emerging in the market are still around or under 50% of penetration and there are still high possibilities and much room for further acceptance of these devices. It is desirable to explore what has made users accept smart devices and what will make them accept or purchase additional or new technologies. To accomplish the objectives of this research, it is necessary to analyze the causal relationship between eligible factors and smart device acceptance behavior by using the TAM. Based on the theoretical models, literature, and prior findings, five main factors have been proposed and defined as follows after being applied to the modified model analyzed in this study [Fig. 3].

- (1) TAM variable1: Perceived usefulness, (2) TAM variable2: Perceived ease of use,
- (3) External variable1: Enjoyment, (4) External variable2: Income,
- (5) External variable3: Social pressure

[Fig. 3] Modified TAM Model Used for Analysis

These would have influenced in turn two-dimension acceptance effects, as follows;

- (1) Acceptance variable1: Degree of acceptance - the number of smart device types accepted for use
- (2) Acceptance variable2: Further acceptance intention – willingness to adopt new or additional devices

2.5 Research Questions and Hypotheses

Based on the purpose of the study and the newly constructed theoretical framework above, the following research questions and related specific hypotheses were proposed.

RQ 1. What is the relationship between the external variables (enjoyment, income, social pressure) and the TAM variables (perceived usefulness and ease of use)?

H1-1. Enjoyment, income, and social pressure are positively related to perceived usefulness.

H1-2. Enjoyment, income, and social pressure are positively related to perceived ease of use.

RQ 2. What is the relationship between the external variables and the acceptance variables (degree of acceptance and further acceptance intention)?

H2-1. Enjoyment, income, and social pressure are positively related to degree of acceptance.

H2-2. Enjoyment, income, and social pressure are positively related to further acceptance intention.

RQ 3. What is the relationship between the TAM variables and the acceptance variables?

H3-1. Perceived usefulness and ease of use are positively related to degree of acceptance.

H3-2. Perceived usefulness and ease of use are positively related to further acceptance intention.

3. Method

3.1 Research Design and Survey Questionnaire

This study used a randomized interview survey to gather data on the variables proposed in the research framework [Fig. 3] from anonymous Korean respondents. Before conducting the survey, a questionnaire was made based on the theoretical model proposed in this study and on operationalized questions frequently used in prior related studies. The first draft of the questionnaire was carefully reviewed and validated by two professors who were specialized in the related field. Then, a pilot survey was conducted using a small sample of 20 smart device users to check reliability and validity of the questions.

[Table 1] Variables, Operationalization, and Reliability Testing

Variables		Questions (Degree to agree; 5-point Likert Scales)	Reliability Coefficient (Cronbach's α)
TAM Variable	Usefulness	1. The devices are useful in daily life. 2. The devices are useful for work. 3. Functions of the devices are satisfactory.	.879
	Ease of Use	1. It is easy to learn how to operate the devices 2. It is not difficult to use the devices. 3. I frequently teach others how to use the devices.	.816
External Variable	Enjoyment	1. Using the device is enjoyable. 2. Many entertaining things are provided by the devices. 3. Daily life will be more fun with the devices.	.853
	Income	5-scale levels of monthly household income	-
	Social Pressure	1. Many other people around me use the devices. 2. My friends or peers recommend buying the devices. 3. I feel nervous to hear others talk about what I do not have.	.735
Acceptance Variable	Degree of Acceptance	The number of types of devices each respondent already has.	-
	Further Acceptance Intention	1. How strongly do you want to buy new or additional ones? 2. When do you plan to buy the new or additional devices?	.784

The questionnaire consisted of seven parts and all of them were measured by using a 5-point Likert Scales [Table 1]. To measure the TAM variables, three specific, operationalized questions were given to analyze each variable (usefulness and ease of use). Also, each of the two variables in the external variable category consisted of three specific questions for measurement. The reliability values which were calculated as Cronbach's alpha coefficient were well over .7, satisfying the minimum criterion for combining each question into an index. The variable set of new or further intention to accept or purchase was measured by using two specific questions and its reliability coefficient was .784.

3.2 Sampling and Data Collection

The questionnaire was distributed to 14 interviewers who were trained beforehand. The interviewers visited targeted respondents and interviewed them. A stratified sampling method was used to control proportions of demographic characteristics among the respondents, and the distributions of sex, age, income were found to be quasi-normal. The survey was performed for two months in March and April, 2021. The reason why the survey employed face-to-face interviews is that there were a small number of questions and that the demographics needed to show a similar distribution among the entire population to enhance external validity. To keep the health protocol, the interviewers and respondents were forced to wear masks and to finish asking and answering as quickly as possible. All the interviewees were informed that their answers would be used for only research purposes anonymously and agreed on collecting their personal data.

The total number of respondents was 700, however, the final sample size selected and used for the analysis was 691 because 9 of them skipped answering an unacceptable number of essential questions. The sample consisted of 364 males (52.7%) and 327 females (47.3%). Their ages ranged from 21 to 64. The distribution of demographic characteristics of the respondents is shown in [Table 2].

[Table 2] Demographic Distribution of Respondents (N=691)

Sex	Male: 364 (52.7%)			Female: 327 (47.3%)	
Age	20s: 92(13.3%)	30s: 275(39.8%)	40s: 218(31.5%)	50s: 85(12.3%)	60s & older: 21(3.0%)
Monthly Income (Korean Won)	Under 2 mil. 92 (13.3%)	2-3.99 mil. 275 (39.5%)	4-5.99 mil. 241 (34.9%)	6-7.99 mil. 87 (12.6%)	8 mil. & above 21 (3.0%)
Education	High school graduate and lower: 165 (23.9%)	Ever attended college 107 (15.5%),		College graduate 379 (54.8%),	Ever attended graduate school: 40 (5.8%)

3.3 Data Analysis

Structural equation modeling (SEM) was used for data analysis by using AMOS v.25. A test of discriminant validity of the measurement scales for use was conducted by calculating the correlation coefficients and the square root of the AVE (average variance extracted) as shown in [Table 3].

All the indices of the square root of the AVE for each variable (**bold**) were higher than the matched correlation coefficients, indicating that the measurement model proved satisfactory validity level.

[Table 3] Correlation Matrix and Discriminant Validity

Variables	Usefulness	Ease of Use	Enjoyment	Income	Social Pressure	Degree of Acceptance	Acceptance Intention
Usefulness	.801						
Ease of Use	.606	.813					
Enjoyment	.556	.615	.820				

Income	-.005	.029	-.019	.685			
Social Pressure	.422	.378	.475	.041	.796		
Degree of Acceptance	.084	.107	.088	.089	.006	.722	
Further Acceptance Intention	.215	.192	.241	.125	.341	.192	.764

4. Results

To give solutions to the three research questions and the six sets of hypotheses generated above, a series of path analyses were conducted for structural model testing. [Table 4] and [Fig. 4] show the results of the hypothesis testing and the structural model testing.

[Table 4] Result of Hypothesis Testing

Hypotheses & Paths		β	t	p	Support
H1-1	Enjoyment $\rightarrow$ Usefulness	.556	17.498	.000***	Yes
	Income $\rightarrow$ Usefulness	-.005	-.135	.265	No
	Social Pressure $\rightarrow$ Usefulness	.421	12.133	.000***	Yes
H1-2	Enjoyment $\rightarrow$ Ease of Use	.616	20.426	.000***	Yes
	Income $\rightarrow$ Ease of Use	.031	.799	.107	No
	Social Pressure $\rightarrow$ Ease of Use	.378	10.657	.000***	Yes
H2-1	Enjoyment $\rightarrow$ Degree of Acceptance	.112	2.391	.026*	Yes
	Income $\rightarrow$ Degree of Acceptance	.105	2.282	.035*	Yes
	Social Pressure $\rightarrow$ Degree of Acceptance	.005	.120	.274	No
H2-2	Enjoyment $\rightarrow$ Further Acceptance Intention	.247	8.019	.000***	Yes
	Income $\rightarrow$ Further Acceptance Intention	-.003	-.120	.302	No
	Social Pressure $\rightarrow$ Further Acceptance Intention	.333	11.963	.000***	Yes
H3-1	Usefulness $\rightarrow$ Degree of Acceptance	.096	2.251	.039*	Yes
	Ease of Use $\rightarrow$ Degree of Acceptance	.126	2.836	.006**	Yes
H3-2	Usefulness $\rightarrow$ Further Acceptance Intention	.208	7.208	.000***	Yes
	Ease of Use $\rightarrow$ Further Acceptance Intention	.192	6.611	.000***	Yes

* $p < .05$, ** $p < .01$, *** $p < .001$

The RQ 1. and its subsets of H1-1 and H1-2 examined the relationships between the external variables and the TAM variables. Enjoyment and social pressure were positively associated with perceived usefulness ($\beta=.556$; $\beta=.421$, $p<.001$) and perceived ease of use ($\beta=.616$; $\beta=.378$, $p<.001$). However, income had no significant relationship with them. Therefore, H1-1 and H1-2 were supported except in the case where an income variable was involved.

The RQ 2. and its subsets, H2-1 and H2-2, examined the direct relationships between the external variables and the acceptance variables. Enjoyment and income seemed to positively influence the degree of acceptance ($\beta=.112$; $\beta=.105$, $p<.05$). However, social pressure did not affect the degree of acceptance. In terms of the additional or new acceptance intention of smart devices, enjoyment and social pressure were significant positive contributors ($\beta=.247$; $\beta=.333$, $p<.001$). Income did not affect the intention to accept. Therefore, H2-1 was supported except in terms of the income variable, while H2-1 was supported except regarding the social pressure variable.

The RQ 3. and its subsets, H3-1 and H3-2, examined the relationships between the two TAM variables and the acceptance variables. The perceived usefulness and the perceived ease of use had a significantly positive association with the degree of acceptance ($\beta=.096$, $p<.05$; $\beta=.126$, $p<.01$) and with the further acceptance intention ($\beta=.208$; $\beta=.192$, $p<.001$).

[Fig. 4] Structural Model Testing

5. Discussion

This study analyzed factors and drivers in the process of smart device acceptance based on the theoretical framework of TAM and on a modified structural model. The study explored the relationship between user characteristics suggested or testified by prior studies and the user's past, present, and future acceptance behavior and subsequent intention to use smart devices. The results from the structural equation modeling analysis show that most hypotheses proposed were accepted with few exceptions. The findings were consistent with most prior research. These results and implications are threefold.

First, the greater levels of perceived enjoyment from smart devices and of the perceived social pressure of accepting them directly led the respondents to a higher level of perceptions of their usefulness and ease of use as well as to a higher degree of accepting behavior and intention of new devices. This implies that it will be essentially important for producers and marketers to strengthen enjoyable traits and to provide promoting messages about the social pressure to buy smart devices as soon as possible.

Second, the income variable functions just as a purely external variable because it had no significant relation with the TAM variables. Income was directly and positively associated with the degree of smart device acceptance that occurred in the past, however, it did not predict the intention to purchase the device because those with a higher income tended to purchase most of their favorable devices already.

Third, the TAM variables, usefulness and ease of use, were still inevitable predictors and significant moderating variables in the acceptance process of smart devices. This comes from the fact that the ranges of their concepts were very wide in their meaning. Even though the coefficient values (direct predicting power of explaining the variances of acceptance variables) of the TAM variables were not higher than the external variables', they were strongly and positively related to the enjoyment and social pressure. They then functioned as successful moderators in the structural model.

6. Conclusion

Considering the Korean market and the consumers who are willing to accomplish most things other people have achieved and are somewhat practical adopters of new devices, social pressure, income, and TAM variables are critical factors to be considered in the process of new technological acceptance.

The limitation of this study is that it dealt with the acceptance patterns of current smart devices in general. Therefore, it is suggested that future research needs to focus on acceptance and acceptance intention of specific and individual types of smart devices. In addition, more possible external variables along with more specifically operationalized TAM variables need to be proposed and analyzed.

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