Factors Affecting Satisfaction of Products Implemented by Wearable Devices: Focused on Product Attributes and Customer Attributes

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Abstract: Background/Objectives: The purpose of this study is to investigate the factors affecting the satisfaction of wearable devices through expanding the application scope of wearable devices that have been rapidly growing due to the development of IT technology. Methods/Statistical analysis: For the analysis method, the first, descriptive statistics and frequency analysis were conducted to identify general characteristics of the subjects. The second, exploratory factor analysis was conducted to confirm the construct validity of the measurement variables used in the study. The third, Cronbach alpha coefficient was used for reliability of each scale. Finally, the validity of the research problem was analyzed using multiple regression analysis of Enter method.

Findings: The perceived pleasure and the usefulness were selected as product attribute variables, and the innovation and the sensation seeking propensity were selected as customer attribute variables. Research results show the followings: the first, the product attributes (the perceived pleasure and the perceived usefulness) for wearable devices had a positive (+) impact on the satisfaction of products implemented by wearable devices. The Second, only the innovation among the customer attribute variables had a positive (+) effect on the satisfaction of the products implemented by the wearable devices. Finally, the relative influence of product attributes and customer attributes on the satisfaction of products implemented by wearable devices had positive (+) impact on perceived usefulness, perceived pleasure, and innovation in the order named. The research scope of the wearable devices is extended to the products, so that the research trend focusing on the things worn by people in the past has been eliminated. Improvements/Applications: This research would be able to provide useful practical implications to the relevant companies along with the academic achievement of extending the research scope of the wearable devices.

Keywords: Wearable, Wearable device, Product attributes, Customer attributes, Product satisfaction

I. INTRODUCTION

The world is now transformed into the next generation of industrial revolution, the Fourth Industrial Revolution, by integrating advanced information and communication technologies such as artificial intelligence (AI), object internet (Iot), and big data (Big data). The most noteworthy of these changes is the rapid growth of the industry related to the Internet of things. According to International Data Corporation (IDC), market researchers estimate that the expenditure size of Iot in the world will reach $ 737 billion in 2016, which is an increase of 17.9% from 2015, and an average annual growth rate of 15.6%, so that its annual expenditure size will reach to 1 trillion 290 billion dollars by 2020[1].

Wearable devices are the core industries of Iot, such as watches, bands, glasses, and clothing, and are rapidly growing in the healthcare and medical science fields. According to market researcher Gartner, sales of wearable devices will reach $ 61.7 billion by 2020, and the smart watch market, which currently has the largest market share among wearable devices, is expected to grow by nearly 50%. In 2019, it will grow to more than $ 17.4 billion in sales [2]. For this reason, global companies such as Google, Apple, Microsoft, Nike, and Samsung are competing in the wearable device development market and are concentrating on developing various wearable devices in order to create new growth engines.

As such, the widespread wearable device industry is growing rapidly due to the expansion of Iot, and the interests of industry and academia for this industry are growing, but related studies are still lacking. Particularly, the researches on existing wearable devices tend to involve researches based on approaches from the technical and engineering perspectives, and the researches have been focusing on wearable devices worn by humans. Therefore, the expansion of related research areas is more urgent than ever can do. Therefore, this study aims to extend the application scope of wearable devices, which are growing rapidly based on the Internet technology of things, to objects and objects rather than people and objects. Specifically, we want to extend the research into the products worn by wearable products, rather than using the existing research methods for the wearable devices. For this purpose, this study investigates the factors affecting the satisfaction of products implemented by wearable devices. Specifically, this study investigates the factors affecting the satisfaction of products implemented by wearable devices focusing on the product attribute variables and the customer attribute variables.

Therefore, this study aims to suggest that the scope of the wearable includes not only people but also various objects and devices. So, it can provide basic data for establishing marketing strategies useful for the industries related with the wearable devices.

Generally, a wearable device means a device that is worn on a part of the body. The meaning here is not simply to wear the body as an accessory,

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but also means to exchange various information in real time between devices attached to the body part and people. Therefore, 'wearable device' is a device that exchanges and interacts with various information between people and machines in real time. It is attached to glasses, earphones, clothes, wrists, shoes and collects various information of the human body and provides the necessary information to the customers through collaborating with tablet PC and smart phone [3]. Interests in these wearable devices have been ongoing for a long time. In the 1970s and 1980s, the research and development in the field of military technology in the United States have been underway [4], since the concept of wearable computing machine in the early 1960s was first studied in the MIT Media Lab. In the 1990s, the ubiquitous computing concept was introduced and electronic devices became lightweight, and the application to various industries began in earnest. In the 2000s, wearable computers for medical and entertainment purposes began to appear [4]. In the 2010s, technical limitations were overcome, and smart phones and various smart devices appeared, and general popular products using mobile devices were launched in earnest [4].

In recent years, as the technology of Iot has been merged and integrated, it has become possible to access the network from the wearable devices itself, and a variety of products based on the wearable device are being launched as the connection with other devices other than the smart phone becomes possible. In addition, its scope of application is expanding not only to the relations between people and objects but also to the relations between things and things, and many companies are competing in the related industries. These wearable devices are currently attracting the attentions in the fields of fitness, well-being, healthcare, medical care, military, and infotainment, but they are expected to widen their uses in various fields of industries[5].

Researches related to existing wearable devices are mainly focused on the researches on concepts and statuses related to wearable devices, and the development of technology and engineering viewpoints using algorithms. In recent years, however, there has been steady interest in the industry and academia, and the researches for the customers of wearable devices have emerged, so that the research scope has been extended. The followings are summarized data for the recent research for the wearable devices.

Jeong & Roh [6] analyzed the factors affecting the intention to use wearable devices, focusing on the modified technology acceptance model. The result of the analysis revealed that the perceived ease of use, individual innovation, subjective norm, and compatibility, etc., had effects to the intention to use wearable devices. In addition, Son, Lee & Cho [7] analyzed the factors affecting the students' intention to use wearable devices by using the extended integrated technology acceptance model. The results showed that performance expectations, social influences, promotion conditions, effectiveness, etc., had the effects on the students' intention to use wearable devices.

Shin & Lee [8] reported that the perceived usefulness and ease of use were influenced by the research on factors affecting purchase intention of wrist wearable devices. Shin & Lee [9] suggested that the innovation resistance influences the acceptance intention by mediating innovation attributes and consumer attributes through doing research on the acceptance of wrist wearable devices.

In addition, we can find various research output related with this area: for example, a research on acceptance factors of smart watches centering on the effect of innovation resistance [10], a research on the level of fashion seeking tendency focusing on wrist wearable devices [11], a study for college students' tendency on sports wearable devices focusing on innovation characteristics and innovation resistance [12], a study for consumers' buying behavior on wearable device fashion products through clothing consumption value [13], and so on.

However, the recent researches on wearable devices, such as those described above, show that these studies are focusing on the use or purchase intentions for potential users using technology acceptance model or innovation resistance model. Although researches centering on the customers have been actively carried out in the early development studies of technological and engineering perspectives, it is also true that the studies for wearable devices are focusing on the devices which are worn by human body or objects.

This study sets the following research questions through the preceding research and literature review as the purposes of this study.

Research Question 1: Will the product attributes for wearable devices affect the satisfaction of products implemented by wearable devices?

Research Question 2: Will the customer attributes for wearable devices affect the satisfaction of the products implemented by the wearable devices?

Research Question 3: If the product attributes and the customer attributes affect the satisfaction of products implemented by wearable devices, what are their relative influences?

II. MATERIALS AND METHODS

2.1. *Survey subject and data collection*

The subjects of this study were the male and female college students who were aware of wearable devices by male and female college students attending M University located in Daejeon city. The collection of data was done through the following three steps. The first stage describes the general concept of wearable device and introduces the wearable device 'pouring-ring' (see [Figure 1],This is a wearable device to be attached to a specific product (soju). Each time you follow a cup of soju, it senses and reacts. It is a product designed to enable real-time interaction via smartphone) used in this study and makes the subjects watch the pre-produced video clip (4 minutes 30 seconds).

In the second stage, we had time to directly experience 'pouring-ring', the wearable device watched through the video. In the last stage, we collected the data through the self - filling questionnaire through the structured questionnaire. Through cleaning processes for inaccurate responses and data, 172 were used for final analysis.

The sex distribution of the subjects was that 41.9% (72 persons)was male and 58.1% (100 persons)was female. The average age of the subjects was 21.9 years old.

Figure 1. Wearable device used in this study

2.2. *Operational definition and measurement tools*

2.1.1. Wearable device

The wearable device used in this study is a device that is made for a specific product (soju), whose name is 'pouring-ring'. Therefore, the wearable device in this study is 'pouring-ring', and this product is 'a product designed to cause the device to detect and react when the soju is poured into a glass'.

2.1.2. Perceived pleasure

The perceived pleasure in this study is defined as 'the degree of pleasure perceived by the individual in using the wearable device, pouring-ring". The measuring tool for this study was the tool developed by Lee et al. [19] based on the work of Ducoffe [14], Novak, Hoffman &Yunget[15], Moon & Kim [16], Koufaris [17], Lee[18]. This tool used four items developed by Lee et al. [19], but were adjusted into the Likert-type 5-point scale (1 = not at all, 5 = very similar) for the purpose of this study. The specific measurement items are as follows; ①The use of 'pouring-ring' is unusual and interesting. ②The use of 'pouring-ring' stimulates one's curiosity. ③The use of 'pouring-ring' is a pleasure.

2.1.3. Perceived usefulness

The perceived usefulness in this study was defined as 'the degree of belief that the wearable device, 'pouring-ring', would be helpful and useful in drinking'. The tools for measuring this were the Likert-type 5-point scale (1 = not at all, 5 = very similar), which were used in the study of Chang &Youm [3]. The specific measurement items are as follows. ①The use of 'pouring-ring' will make drink more pleasant. ②The use of 'pouring-ring' will help drinking party. ③The use of 'pouring-ring' ring will make drinking more convenient. ④The use of 'pouring-ring' will be useful for the general purposes.

2.1.4. Innovation

In this study, 'innovation' was defined as 'the desire of the individual to accommodate new things first'. The instruments used to measure this were the Likert-type 5-point scale (1 = not at all, 5 = very similar) consisted with the total of four items used in the study by Choi [20] and Chang &Youm [3]. The specific measurement items are as follows. ① I like to try new and strange things, ② I try new things before people around me, ③ I like to try various new ways of doing things, ④ When new media or new technologies appear, I belong to the group that used the thing first.

2.1.5. Sensation seeking traits

In this study, the sensation pursuit propensity was defined as 'the degree of desire of the individual to take risk and pursue adventure to experience new and various stimuli'. A tool for measuring this is the tool consisted with the four items extracted from the subscale of Brief Sensation Seeking Scale (BSSS)developed by Hoyle et. al.,[21], the four items are from the thrill, adventure and experience seeking tendency. This study used this four items which were used by Chang &Youm [3]using the Likert-type 5-point scale (1 = not at all, 5 = very much). The specific measurement items are as follows. ① I am inclined to be easily bored with things that are repeated. ② I am inclined to be fond of fresh and exhilarating experiences. ③ I am inclined to enjoy adventurous experiences. ④ I am inclined to like exciting and thrilling experiences.

2.1.6. Product satisfaction

In this study, product satisfaction was defined as 'degree of satisfaction with soju obtained after using the soju with wearable device'. A total of three items were used to measure the likelihood of this study. These items were used by Lee & Kim [22], Youm & Yu [23] and transformed into the Likert-type 5-point scale (1 = not at all, 5 = very much). The specific measurement items are as follows. ① I am generally satisfied with the soju attached with 'pouring-ring'. ② I am generally satisfied with drinking the soju with 'pouring-ring'. ③The soju with 'pouring-ring' meets my expectations. As a result of the reliability test of these three items, Cronbach α = .901 was found to be very good.

2.3. *Data analysis*

The statistical package SPSS / PC + Windows 21.0 program was used to analyze the data collected in this study. For the analysis method, the first, descriptive statistics and frequency analysis were conducted to identify general characteristics of the subjects. The second, exploratory factor analysis was conducted to confirm the construct validity of the measurement variables used in the study. Factor analysis was performed using principal component analysis and factor rotation was analyzed using VARIMAX rotation method. The third, Cronbach alpha coefficient was used for reliability of each scale. Finally, the validity of the research problem was analyzed using multiple regression analysis of Enter method.

III. RESULTS AND DISCUSSION

3.1. Verification of validity and reliability of measurement tools

Table 1 shows the results of verifying the reliability and validity of the measurement tools prior to the verification of the research problem.

Table 1: Validity and reliability of measured variables

Item	Factor1	Factor2	Factor3	Factor4	Commonality	Cronbach α
Perceived Usefulness4	.881				.837	.909
Perceived Usefulness3	.876				.833	
Perceived Usefulness2	.827				.788	
Perceived Usefulness1	.788				.7.09	
Innovation3		.883			.801	.879
Innovation4		.838			.724	
Innovation2		.829			.724	
Innovation1		.791			.685	
Perceived Pleasure2			.853		.830	.866
Perceived Pleasure3			.790		.705	
Perceived Pleasure1			.780		.632	
Perceived Pleasure4			.743		.741	
Sensation PursuitPropensity2				.786	.694	.794
Sensation Pursuit Propensity4				.780	.646	
Sensation Pursuit Propensity3				.778	.727	
Sensation Pursuit Propensity1				.722	.545	
Eigen value	5.583	2.973	1.769	1.299	-	-
Explanation Amount(%)	34.891	18.581	11.056	8.118	-	-
Accumulated Explanation Amount(%)	34.891	53.472	64.529	72.646	-	-
Cronbach α	.909	.879	.866	.794	-	-
KMO(Kaiser-Meyer-Olkin)=.839, Bartlett test χ^2=1610.559(df=120, p<.001)						-

First, all of the independent variables used in the research were used to verify the validity of the measurement tools. Principal component analysis was used for factor extraction and VARIMAX rotation was used for factor rotation. KMO measures (Kaiser-Meyer-Olkin) and Bartlett's spherical shape verification were performed. In this case, the number of factors was used based on the Eigen value of 1.0, and initial commonality and factor loadings were selected based on 0.4, and only the items exceeding this criterion were used for analysis [24]. As a result, the initial commonality value of all the items was 0.5 or more, the factor load was 0.7 or more, and 4 factors (perceived usefulness, innovation, perceived pleasure, sensation pursuit propensity: these 4 factors were over 1.0 Eigen value) were extracted, so the validity of the measurement tool was confirmed. The reliability of each extracted factor was more than Cronbach α of 0.7 and it was confirmed that there was no problem in reliability of all the scales used in the study because it exceeded the acceptance standard proposed by Nunnally [25].

3.2. Verification results for research question 1

Will the product attributes for wearable devices affect the satisfaction of products implemented by wearable devices? This study conducted a multiple regression analysis using two factors of product attributes as independent variables and product satisfaction as dependent variables. Table 2 shows the results.

The autocorrelation of dependent variables and the existence of multi - collinearity between independent variables were confirmed before achieving the results. The Durbin-Watson index was used as the autocorrelation of the dependent variables. The value of the autocorrelation was 1.870 (du = 1.774 <d = 1.870 <4-du = 2.226), which proved that the dependent variables were independent. The multi-collinearity between independent variables was calculated using VIF and the tolerance limit. The VIF index was 1.523, which was less than 10, and the tolerance limit was 0.657, which was larger than 0.1. As a result, it has been confirmed that there is no problem with multi-collinearity [26].

Therefore, this data can be judged to be suitable for the regression analysis. Based on the results, the results of the research question 1 confirmed that the perceived pleasure (t = 5.744, p<.001) and perceived usefulness(t = 6.826, p<.001) showed positive effects on the satisfaction of products implemented by wearable devices. In addition, the explanatory power for the satisfaction of the dependent variable product was 52.5% (adj R2 = .525).

These results are expressed as regression equations as follows.

(y=product satisfaction, =perceived pleasure, =perceived usefulness)

Table 2: Regression analysis results for the effect of product attributes on product satisfaction

model	B	S.E	β	t	Tolerance	VIF
invariable	.241	.235		1.023		
perceived pleasure	.417	.073	.373	5.744***	.657	1.523
perceived usefulness	.446	.065	.444	6.826***	.657	1.523

Durbin-Watson's*d*=1.870
R=.729, R^2=.531,*adj* R^2=.525,F=95.589(p<.001), ***p<.001

3.3. Verification results for research question 2

Will the customer attributes affect the satisfaction of the product implemented by the wearable device? This study conducted a multiple regression analysis using two factors of customer attributes as independent variables and product satisfaction as dependent variables. Table 3 shows the results. The results of this study are summarized as follows.

The autocorrelation of dependent variables and the existence of multi- collinearity between independent variables were confirmed before achieving the results. The autocorrelation of the dependent variable was determined using the Durbin-Watson index, which was found to be 1.799 (du = 1.774 <d = 1.799 <4-du = 2.226), so this fact proved that dependent variables were independent regardless of autocorrelation [26]. And the multi- collinearity between independent variables was calculated using VIF and tolerance limit. and the VIF index were 1.146, which was less than 10, and the tolerance limit was 0.872, which was larger than 0.1. As a result, it has been confirmed that there is no problem with multi-collinearity [26].

Therefore, it can be judged that this data is suitable for regression analysis. As a result of the verification of research question 2 confirmed that only innovation (t = 3.157, p<.01) had positive (+) influence on product satisfaction. In addition, the explanatory power for the satisfaction of the dependent variable product was 9.2% (adj R2 = .092).

These results are expressed as regression equations as follows.

(y=product satisfaction, =innovation, =sensory pursuit propensity)

Table 3: Regression analysis results for the effect of customer attributes on product satisfaction

model	B	S.E	β	t	Tolerance	VIF
invariable	1.798	.376		4.784***		
innovation	.274	.087	.246	3.157**	.872	1.146
sensation pursuit propensity	.175	.101	.135	1.730	.872	1.146

Durbin-Watson's*d*=1.799
R=.320, R^2=.103,*adj* R^2=.092,F=9.660(p<.001), ***p<.001, **p<.01

3.4. Verification results for research question 3

If the product attributes and the customer attributes affect the satisfaction of products implemented by wearable devices, what are their relative influences? This study conducted a multiple regression analysis using two factors of product attributes and one factor of customer attributes as independent variables and product satisfaction as dependent variables. Table 4 shows the results.

The autocorrelation of dependent variables and the existence of multi - collinearity between independent variables were confirmed before getting the results. The autocorrelation of the dependent variable was confirmed by using the Durbin-Watson index, which was 1.884 (du = 1.786 <d = 1.884 <4-du = 2.214). The VIF index was 1.007 ~ 1.557, which was smaller than 10, and the tolerance limit was 0.642 ~ 0.928, which was larger than 0.1. It is confirmed that there is no problem in multi-collinearity [26].

Therefore, it can be judged that this data is suitable for the regression analysis. Based on the results, it is found that the perceived usefulness (t = 6.645, p<.01, β = .431) the perceived pleasure(t = 5.436, p<.01, β = .354), and innovation (t = 2.014, p<.05, β = .109) had positive effects on the product satisfaction. These results show that the product attributes play a more important role in the satisfaction of the product implemented by the wearable device than the customer attributes. In addition, the explanatory power for the satisfaction of the dependent variable product was 53.4% (adj R2 = .534).

These results are expressed as regression equations as follows.

(y=product satisfaction, =perceived pleasure, =perceived usefulness, =innovation)

Table 4: Regression analysis results for the effects of product attributes and customer attributes on product satisfaction

Model	**B**	**S.E**	**β**	**t**	**Tolerance**	**VIF**
Invariable	-.031	.269		-.115		
Perceived Pleasure	.395	.073	.354	5.436***	.642	1.557
Perceived Usefulness	.433	.065	.431	6.645***	.650	1.539

Innovation	.121	.060	.109	2.014*	.928	1.077

Durbin-Watson'sd=1.884

R=.736, R^2=.542,adj R^2=.534,F=66.231(p<.001), ***p<.001, *p<.05

IV. CONCLUSION

The purpose of this study is to investigate the factors affecting the satisfaction of products implemented by wearable devices (which are rapidly growing due to the recent IT technology) through expanding the application range of wearable devices to the area between products and products. Specifically, this study categorized the perceived pleasure/ perceived usefulness as the variables belonging to the product variables, and innovation/ sensation pursuit propensity as the variables belonging to the customer variables and investigated how these variables effect on the satisfaction of products implemented by wearable devices.

First, the product attributes of wearable devices, ie, perceived pleasure and perceived usefulness variables, were found to have a positive (+) effect on the satisfaction of products implemented by wearable devices. That is, the greater the perceived pleasure and usefulness of the wearable device, the greater the degree of satisfaction of the product implemented by the wearable device, which proves that the product attributes are very important for creating the products satisfaction.

From these results, it can be seen that the innovative products made by using IT technology are very important in cultivating how much enjoyment when the users are using the products and how useful it is to their lives. Therefore, when we want to combine and attach wearable devices to specific products, we need some strategies that allow consumers to estimate the product attributes, ie, perceived pleasure and perceived usefulness high.

Second, it was confirmed that the innovation only among the variables belonging to the customer attributes affects the satisfaction of the product implemented by the wearable device (+). In other words, the stronger the desire to accommodate new things first than the others, the higher the satisfaction of products implemented by wearable devices. However, this fact does not imply that the desire to take risks and pursue adventures simply to experience something new is related to this result.

These results show that the innovation of consumers plays a very important role in the satisfaction of the products implemented by the wearable device, but the sensory pursue propensity of the customers are not significant in creating the customers' satisfaction of the products. In other words, this study can be interpreted as natural process if we can consider that the product called wearable device is an innovative product born from cutting-edge technology. Therefore, when developing a wearable device or establishing a marketing strategy, it is necessary to select a target group such as an innovative consumer or an early adopter if we can consider the characteristics of such consumers. In other words, it can be a very useful strategy for innovative products such as wearable devices to enter the market through targeted segmentation strategy when establishing marketing strategies for the innovative products.

Third, the relative influence of product attributes and customer attributes of wearable devices on product satisfaction was found to have a positive (+) effect in the order of perceived usefulness, perceived pleasure, and innovation.

This result can be interpreted like this: the effect of the product attribute variables on the satisfaction of the product implemented by the wearable device are significant rather than the customer attribute variables, despite for the results of the previous two studies. Therefore, in order to increase the satisfaction of the products implemented by wearable devices, it is necessary to have a marketing strategy that can be useful in perceiving the perceived usefulness and pleasure highly rather than the customer attributes as product attribute variables for wearable products.

In conclusion, the results of this study suggest that the perceived pleasure and usefulness are more important in using innovative products made by utilizing IT technologies such as wearable devices. Therefore, the related industries need to develop the products development and marketing strategies from the user's point of view so that the users can highly estimate these product attribute variables.

The results of this study can have the academic significance like this: this study expanded the research scope through escaping from the traditional research tendency to focus on the technology - oriented research and limit on the wearable device worn by people, so that the research scope can be extended from focusing on the relation between people and products to focusing on the relation between products and products. In addition, we expect to be able to provide practical implications for developing a device that meets the needs of customers and establishing marketing strategies for the industries related with wearable devices.

Finally, the limitations of this study and the suggestions for future research can be summarized as follows. First, by using a device designed for a particular product, rather than a general wearable device, it can be limited for considering various variables related to a particular product. For example, this research has been conducted under the situations where the variables such as involvement, familiarity, and favorability of existing brands are not effectively controlled.

Second, by using only some variables of product attributes and customer attributes, we could not cover more various related variables comprehensively. Therefore, if the subsequent studies can cover these limitations of this study, the future research will be helpful for generalizing the results of this study into larger areas.

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