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ACCEPTANCE INTENTION OF WEARABLES FOR TREATING DEPRESSION

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Abstract. *This study focuses on the acceptance intent of wearable devices for depression treatment. Transcranial Direct Current Simulation (TDCS) technology for depression treatment has shown a sharp increase in the number of depression patients in recent years and a growing interest in them. This study combines product and user characteristics to create a TAM (Technical Acceptance Model) based model for depression therapy wearable. Independent variables include innovation, social impact, mobility, perceived cost, proof of result variables, and dependent variables include perceived usefulness, perceived ease, attitude, and behavior intention. Based on 386 surveys, this study analyzes the degree of influence of independent variables using SmartPLS 3.0. Analysis shows that innovation, mobility, proof of results affect perceived usefulness, perceived ease, attitude, behavior intention, social impact, and perceived cost do not affect perceived edge. Therefore, since ease of use of the product is not significantly affected by social impact or cost, developing wearable technologies will need to focus primarily on product innovation and mobility, which will be a good proactive study of developing wearable products to measure various diseases or exercise, including depression.*

Keywords: Depression, Wearable device, TAM model, Acceptance intention, Treatment, Behavior intention, Attitude

1. **Introduction.** Depression is a very common disease worldwide, with more than 264 million patients, and prolonged depression can lead to suicide in severe cases [1] if it is not treated properly or interfering with daily life. Currently, the treatment of depression is mainly medication, but there are two disadvantages to this. First, the effectiveness is slow and the treatment period is long, and 30% of patients do not feel the effects of the drug. The second has a 50% chance of recurrence after the first outbreak, and the rate of recurrence after the second outbreak is higher [2]. In addition, patients are more intolerable in the early stages of depression and the psychotherapy process is slower than medication, making it very difficult to rely solely on psychotherapy [3]. With the recent development of the fourth industrial revolution, wearable devices and smart technologies have been widely used and distributed to the public. Among them, wearable technologies are widely utilized in many areas, particularly in healthcare [4]. Treatments such as Transcranial Direct Current Stimulation (TDCS), for example, are also attracting attention in the field of research as they reduce ease of use and economic burden, while emerging as a new way to treat depression [5]. This satisfies the healing and stability of people with mental illness, and as recent actions to improve this form of tourism, travel or leisure have become notable, various studies are needed on activities that satisfy this mental health.

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Therefore, researching users' product capacity and behavior for the development and development of these technologies will be invaluable data. Thus, for the dissemination and feasibility of these depression treatments, this study explores and analyzes the acceptance and impact factors of new treatments, TDCS and wearable technology, and in this study, hypotheses suitable for the technology acceptance model were identified and defined.

2. Theoretical Background.

2.1. Overview and treatment of depression.

Depression is a common neurological disorder, and its core symptoms are marked and persistent emotional decline and lack of pleasure, including from various causes. The cause and pathogenesis of depression are still unclear. In general, the major biochemical causes of depression include genetic factors such as norepinephrine (NE), 5-hydroxytryptamine (5-HT) and dopamine (DA) and social and environmental factors. It is thought to be related to negative factors [6]. According to research, depression is the largest disease in the world [7], and the economic burden caused by depression is currently one-third of all diseases in the world, and it is expected to rise to the top of the global burden of disease by 2030 [8]. Conventional physical therapy for depression includes Electroconvulsive Treatment (ECT), Repetitive Transcranial Magnetic Stimulation (RTMS), and Transcranial Electrical Stimulation (TES). ECT is widely used for urgent treatment of patients. Although this method has a short-term therapeutic effect, there is a risk of anesthesia, and there are side effects such as lethargy, muscle pain and nausea, or damage to the patient's memory and cognitive function [9]. Recently, as the Transcranial Direct Current Stimulation (TDCS) technique, a type of transcranial electrical stimulation, has been reported, it is emerging as a promising new treatment for depression. This is because it can be used without anesthesia and has little economic burden [4].

2.2. Overview and development of wearable.

Wearable technology is a scientific technology integrated into the user's clothing or parts equipment, developed primarily for direct wear [10]. Wearable technology is being completed day by day with advances in science and technology, and it not only provides people with a more convenient life, but is also relevant in the medical military field [11]. In recent years, wearable technology has been applied to the healthcare sector, controlling patients' health, such as accurately giving medicines or motor assistance in hospitals and home environments, and related products have already been increasingly applied for clinical use in basic research [12]. Wearable technology not only monitors the biological symptoms of patients, athletes, children and elderly chronic patients, but also provides remote monitoring in remote area [13,14]. It is also effective in preventing, diagnosing, treating and controlling diseases by providing measurement collected data and bio mark feedback to users [13]. However, current wearable devices have limitations in consumer product demand and acceptance, clothing comfort, and monitoring data reliability [11]. Therefore, in order to identify the problems, acceptability, and ease of use of these wearable devices, this paper intends to establish and verify research hypotheses including various prior studies, such as technology acceptance models.

3. Research Model.

Based on previous studies of user acceptance theory and related models, this study extracted key influencing factors for wearable devices that can treat depression by combining home medical devices with user characteristics. In addition, the TAM technology acceptance model introduced persisted usefulness, persisted eyes, attitude, and behavior as dependent variables [15]. This study constructed an acceptance model for wearable devices that affects depression treatment between independent and dependent factors, and the contents are shown in Figure 1.

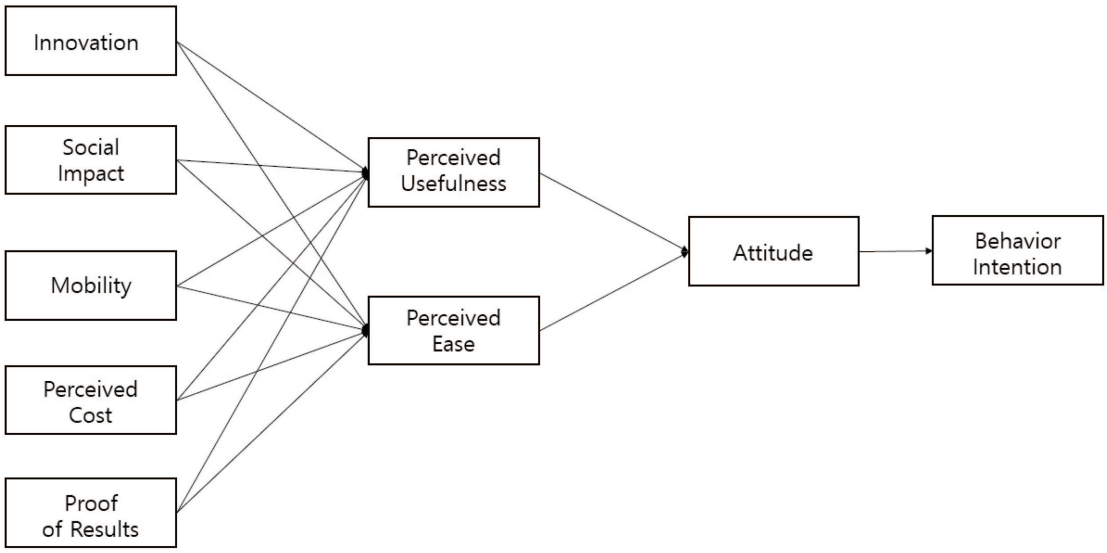

FIGURE 1. Research model

In this study, the following hypotheses were established by combining the analysis of factors affecting users' characteristics and acceptance with the acceptance model for the wearable technology product for the treatment of depression constructed in this study.

H1-1 INN will have a positive effect on PE
H1-2 INN will have a positive effect on PU
H2-1 SI will have a positive effect on PE
H2-2 SI will have a positive effect on PU
H3-1 MOB will have a positive effect on PE
H3-2 MOB will have a positive effect on PU
H4-1 PC will have a negative effect on PE
H4-2 PC will have a negative effect on PU
H5-1 PR will have a positive effect on PU
H5-2 PR will have a positive effect on PE
H6 PE will have a positive effect on ATT
H7 PU will have a positive effect on ATT
H8 ATT will have a positive effect on BI

In order to verify the research model presented above, a self-filling questionnaire was prepared in this study. The references that are the basis for the selection of variables in this research model were presented as described in the theoretical review, and questionnaire items are described in Table 1.

4. **Result of Analysis.** This study used Flow, a wearable technology product for treating depression. It collected the final results using a total of 386 copies in a survey from 10 July 2020 to 31 July 2020 to study the degree of acceptance of depression-treated wearable technology products and factors that affect their intentions to use them. Among the respondents, women were much higher than men, with 73.6% in their 20s by age, followed by 15.3% in their 30s, most of them have academic backgrounds, and 21.7% in graduate and graduate schools. By occupation, 37.8% of students and other occupations did not have a large gap. The results of the demographic frequency analysis of the respondents are shown in Table 2.

In this study, the analysis was conducted using the SmartPLS methodology. Accordingly, the reliability and feasibility analysis of the results of the survey data in the sample shows that all variables have a Cronbach's Alpha coefficient of 0.7 or higher, and that the Composite Reliability (CR) is all more than 0.8, and reliability has been secured. In

Table 1. Questionnaire items

Variables	Definition	Related research
Innovation	Spontaneous acceptance of new wearable technology products for the treatment of depression	[16,17]
Social impact	Degree of influence of peripheral layers on acceptance of wearable technology products for the treatment of depression	[18-20]
Mobility	Degree of evaluation of features without time and space constraints for wearable technology products for the treatment of depression	[21,22]
Perceived cost	Material payment of wearable technology products for the treatment of depression and the degree of price-performance evaluation	[23]
Proof of results	Trust and acceptance of the possibility of academic certification of wearable technology products for the treatment of depression	[20,24]
Perceived usefulness	The degree of usefulness of self-sensing for wearable technology products for the treatment of depression	[15,24]
Perceived ease	Degree of self-sensing use and ease of manipulation for wearable technology products for the treatment of depression	[15]
Attitude	Degree of evaluation of wearable technology products for the treatment of depression	[15]
Behavior intention	Intention to purchase and use wearable technology products for depression treatment	[15,24]

Table 2. Demographic analysis

Variables	Particular	n.	%
Gender	Male	125	32.4
	Female	261	67.6
Age	10-19	7	1.8
	20-29	284	73.6
	30-39	59	15.3
	40-49	28	7.3
	50-59	8	2.0
Education	Below middle school	37	9.6
	High school graduation	32	8.3
	Graduated from college (including attending college)	213	55.2
	Graduated from university (including attending university)	84	21.7
	Graduate school (including current students) graduation	20	5.2

validity verification, the Average Variation Extract (AVE) recognizes values greater than 0.5 as valid, so the measurements in each question were consistent with the requirements of confidence and validity indicators, as shown in Table 3.

In this study, discriminant factor analysis is performed using the relatively strict AVE (average square root) method, and each factor's AVE value must be greater than the correlation coefficient for each pair of variables, indicating that there is discriminant validity between factors. This study has discriminant validity because it is larger than the standardized correlation coefficient outside the diagonal of each factor.

This study utilized the statistical program Smart PLS 3.0 version, which is a Structural Equation Modeling (SEM), and the analysis results are shown in Figure 2.

Table 3. Construct reliability and validity

Factors	Indicators	Outer loadings	Cronbach's Alpha	rho_A	Composite Reliability (CR)	AVE
Innovation	INN1	0.876	0.815	0.827	0.943	0.729
	INN2	0.818				
	INN3	0.866				
Social impact	SI1	0.883	0.821	0.829	0.893	0.736
	SI2	0.837				
	SI3	0.854				
Mobility	MOB1	0.852	0.864	0.868	0.907	0.710
	MOB2	0.835				
	MOB3	0.822				
	MOB4	0.861				
Perceived cost	PC1	0.813	0.804	0.815	0.883	0.717
	PC2	0.856				
	PC3	0.869				
Proof of results	PR1	0.864	0.831	0.833	0.899	0.748
	PR2	0.850				
	PR3	0.881				
Perceived usefulness	PU1	0.878	0.871	0.872	0.921	0.796
	PU2	0.893				
	PU3	0.905				
Attitude	ATT1	0.895	0.856	0.857	0.913	0.777
	ATT2	0.868				
	ATT3	0.881				
Behavior intention	BI1	0.879	0.845	0.845	0.906	0.763
	BI2	0.872				
	BI3	0.869				

Table 4. Correlation of the latent variables in the measurement model

	ATT	BI	INN	MOB	PC	PE	PU	PR	SI
ATT	0.881								
BI	0.591	0.873							
INN	0.335	0.284	0.854						
MOB	0.368	0.337	0.372	0.842					
PC	−0.282	−0.310	−0.432	−0.394	0.847				
PE	0.507	0.434	0.452	0.464	−0.366	0.879			
PU	0.618	0.488	0.501	0.503	−0.489	0.549	0.892		
PR	0.328	0.313	0.401	0.443	−0.405	0.435	0.516	0.865	
SI	0.344	0.313	0.377	0.416	−0.444	0.384	0.487	0.374	0.858

Furthermore, the Variability Inflation Factors (VIF) show that multicollinearity is largely distributed around less than 5, 2 and 3, so there is no problem with multicollinearity between variables (Table 5).

In this study, the test results for the entire hypothesis to be demonstrated by the PLS-SEM analysis were produced as shown in Table 6.

5. **Conclusions.** In this study, a conceptual model was constructed through theoretical analysis, and the model was modified through empirical studies to derive a model of acceptance intention of wearable technology products for the treatment of depression.

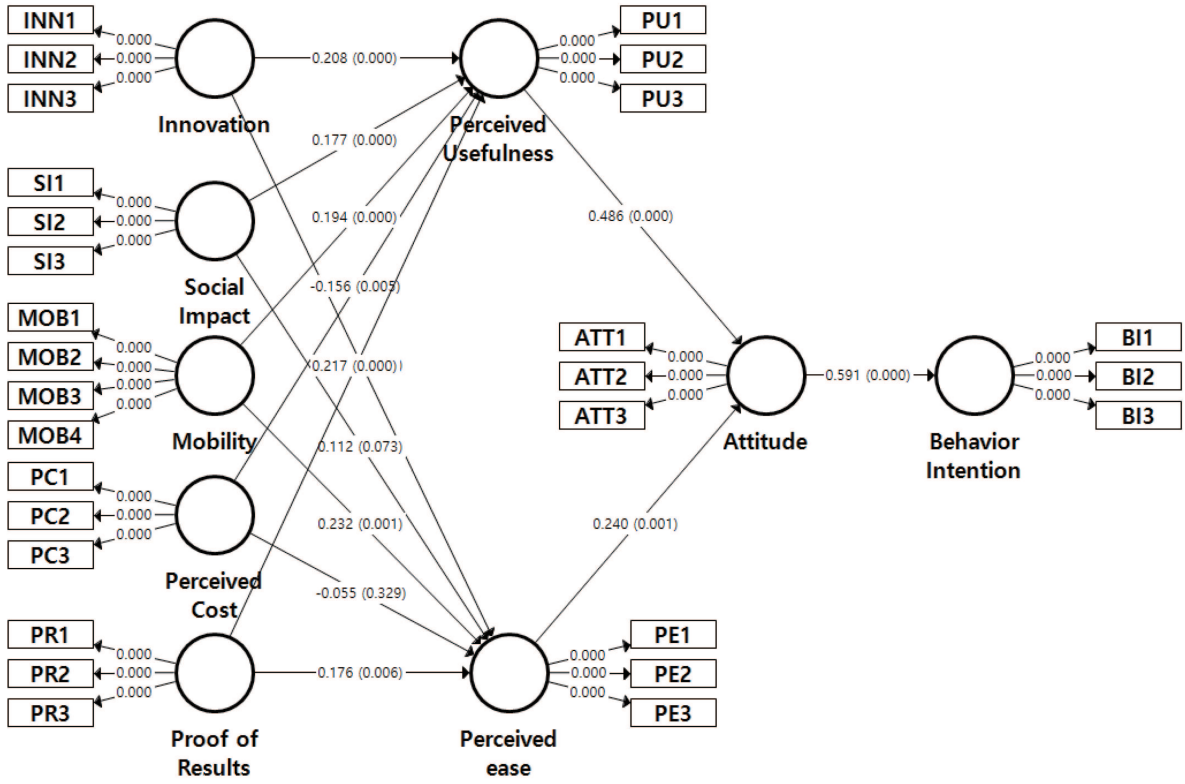

FIGURE 2. PLS-SEM

TABLE 5. Variance inflation factors

Items (Indicators)	VIF	Items (Indicators)	VIF
INN1	1.928	PR1	1.910
INN2	1.728	PR2	1.833
INN3	1.779	PR3	2.022
SI1	1.943	PU1	2.147
SI2	1.765	PU2	2.330
SI3	1.840	PU3	2.581
MOB1	2.113	PE1	2.228
MOB2	2.075	PE2	1.961
MOB3	1.886	PE3	2.178
MOB4	2.107	ATT1	2.316
PC1	1.705	ATT2	1.962
PC2	1.646	ATT3	2.216
PC3	1.961	BI1	2.129
		BI2	2.016
		BI3	1.944

Recently, with the development of the 4th industrial revolution technology, wearable devices and smart technologies have been widely distributed and widely used by the public. Therefore, it will be very valuable data to study user's product acceptance and behavior for the development and development of these technologies. Also, as well-being, wellness, etc. become an issue, people tend to improve their quality of life by healing mental health in addition to physical health [26]. This satisfies the healing and stability of people with mental illness, and as recent actions to improve this form of tourism, travel or leisure have become notable, various studies are needed on activities that satisfy this mental health. In the research hypotheses presented in this study, all but H2-2 (SI→PE) and

Table 6. Hypotheses analysis results

Paths	Sample mean	STDEV	T statistics	P values	Result
(H1-1) INN→PU	0.210	0.045	4.595	0.000***	Accept
(H1-2) INN→PE	0.242	0.057	4.286	0.000***	Accept
(H2-1) SI→PU	0.179	0.046	3.861	0.000***	Accept
(H2-2) SI→PE	0.112	0.065	0.718	**0.086**	Reject
(H3-1) MOB-PU	0.196	0.041	4.683	0.000***	Accept
(H3-2) MOB→PE	0.232	0.067	3.472	0.001***	Accept
(H4-1) PC→PU	−0.152	0.056	2.774	0.003***	Accept
(H4-2) PC→PE	−0.057	0.060	0.915	**0.360**	Reject
(H5-1) PR→PU	0.216	0.055	3.974	0.000***	Accept
(H5-2) PR→PE	0.175	0.064	2.775	0.006*	Accept
(H6) PU→ATT	0.491	0.072	6.752	0.000***	Accept
(H7) PE→ATT	0.242	0.068	3.510	0.000***	Accept
(H8) ATT→BI	0.064	0.023	4.045	0.000***	Accept

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

H4-2 (PC→PE) were validated. Consequently, it was concluded that INN (H1-1, H1-2) significantly affects PE and PU, which affects ATT and BI, and SI (H2-1) only affects PU and ATT and BI. MOB (H3-1, H3-2). Based on the advantages of having convenient mobility among wearable device characteristics, given the significant impact on PE and PU and the impact on ATT and BI, this affects the user's BI and ATT. In this paper, we define that PC will have negative effects on PU, PE, ATT, and BI, all of which were negative effects, and among them, PC had a significant negative impact on PU→ATT→BI. This indicates that the magnitude of the cost until the user is willing to pay for the device has a significant impact on the attitude and behavior of the device. Therefore, it is deemed necessary to check sensitively how much it costs compared to medication and psychotherapy to treat depression. It was also shown that PR affects (H5-1, H5-2) PE, PU, which demonstrates that it affects users' ATTs and BI. Based on these analyses, we can conlude that a variety of external factors, such as innovation, mobility, proof of results, affect the perceived usefulness and the perceived ease of a wearable device for future developments, will help us better understand consumer acceptance and customer-tailored development. Model analysis also shows that potential consumers' high acceptance of wearable technology products to treat depression shows that future market value, economic value, and new ways to treat depression can be implemented in the future, increasing awareness of equipment reliability and usefulness. Finally, the analysis of this study will strengthen the awareness of depression and the dissemination of treatments, which will enhance the function of social impact, as well as increase awareness and confidence in the treatment path and treatment of depression patients.

However, there may be some difficulty in generalizing what the survey subjects in this study have felt and felt about the device in its entirety. Users with direct experience may have a stronger correlation, so there may be differences in attitudes formed by whether the user's experience is a direct or indirect experience [28], and in future studies, it will be necessary to investigate and define problems separately from the direct and indirect experience. Therefore, in the future, we would like to come up with a new plan to supplement these problems and redesign more precise experiments and research problems so that more accurate predictions and theories can be supplemented.

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REFERENCES

[1] S. L. James, D. Abate, K. H. Abate, S. M. Abay, C. Abbafati, N. Abbasi and A. M. Briggs, Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease Study 2017, *The Lancet*, vol.392, no.10159, pp.1789-1858, 2018.

[2] M. R. Levinstein and B. A. Samuels, Mechanisms underlying the antidepressant response and treatment resistance, *Frontiers in Behavioral Neuroscience*, vol.8, DOI: 10.3389/fnbeh.2014.00208, 2014.

[3] J. H. Kocsis, A. J. Gelenberg, B. O. Rothbaum, D. N. Klein, M. H. Trivedi, R. Manber et al., Cognitive behavioral analysis system of psychotherapy and brief supportive psychotherapy for augmentation of antidepressant nonresponse in chronic depression: The REVAMP trial, *Archives of General Psychiatry*, vol.66, no.11, pp.1178-1188, 2009.

[4] M. A. Rosa and S. H. Lisanby, Somatic treatments for mood disorders, *Neuropsychopharmacology*, vol.37, no.1, pp.102-116, 2012.

[5] H. S. Jung, Trends and prospects of healthcare wearable devices, *KHIDI Brief*, vol.115, pp.3-20, 2014.

[6] X. D. Wang, W. Hao, L. J. Li and X. Yu, The frontiers and prospects of clinical psychiatry in psychiatry – Dare to ask where the way is, *Chinese Mental Health Journal*, pp.481-486, 2019.

[7] M. J. Friedrich, Depression is the leading cause of disability around the world, *The Journal of the American Medical Association (JAMA)*, vol.317, no.15, pp.1517-1517, 2017.

[8] World Health Organization, *Depression: A Global Crisis*, World Mental Health Day, October 10 2012, World Federation for Mental Health, Occoquan, VA, USA, 2012.

[9] F. Fregni, P. S. Boggio, M. A. Nitsche, M. A. Marcolin, S. P. Rigonatti and A. Pascual-Leone, Treatment of major depression with transcranial direct current stimulation, *International Journal of Psychiatry and Neurosciences*, vol.8, pp.203-205, 2006.

[10] A. Z. Qureshi, FCPS training in the speciality of physical medicine and rehabilitation for physicians in Pakistan: The option less known, *J. Pak. Med. Assoc.*, vol.66, no.1, pp.93-96, 2016.

[11] Y. Liu and S. Cong, Application of wearable technology to human health monitoring, *Journal of Textile Research*, vol.39, no.10, pp.175-179, 2018.

[12] X. Shan, T. Zhang and X. Zhang, A study on the application of wearable technology in the field of rehabilitation accessories, *Chinese Journal of Rehabilitation Medicine*, vol.31, no.10, pp.1149-1151, 2016.

[13] S. Ajami and F. Teimouri, Features and application of wearable biosensors in medical care, *Journal of Research in Medical Sciences: The Official Journal of Isfahan University of Medical Sciences*, vol.20, no.12, p.1208, 2015.

[14] L. R. Yingling, V. Mitchell, C. R. Ayers, M. Peters-Lawrence, G. R. Wallen, A. T. Brooks, J. N. Saygbe et al., Adherence with physical activity monitoring wearable devices in a community-based population: Observations from the Washington, D.C., Cardiovascular Health and Needs Assessment, *Behav. Med. Pract. Policy Res.*, vol.7, pp.719-730, DOI: 10.1007/s13142-016-0454-0, 2017.

[15] F. D. Davis, R. P. Bagozzi and P. R. Warshaw, User acceptance of computer technology: A comparison of two theoretical models, *Management Science*, vol.35, no.8, pp.982-1003, 1989.

[16] M. S. Choi, An empirical study on the factors of smart phone acceptance –Based on the personal innovativeness, social influence and user interface–, *Korea Design Forum*, vol.33, pp.189-200, 2011.

[17] S. J. Lim, J. S. Han and M. R. Jung, A study on the relationship between smart mobile devices use and work performances of public agencies: Focused on verification of the relationship between performances using TAM, *Journal of Digital Contents Society*, vol.18, no.7, pp.1465-1474, 2017.

[18] I. Ajzen, From intentions to actions: A theory of planned behavior, in *Action Control. SSSP Springer Series in Social Psychology*, J. Kuhl and J. Beckmann (eds.), Berlin, Heidelberg, Springer, 1985.

[19] V. Venkatesh, M. G. Morris, G. B. Davis and F. D. Davis, User acceptance of information technology: Toward a unified view, *MIS Quarterly*, pp.425-478, 2003.

[20] V. Venkatesh and F. D. Davis, A theoretical extension of the technology acceptance model: Four longitudinal field studies, *Management Science*, vol.46, no.2, pp.186-204, 2000.

[21] C. Coursaris and K. Hassanein, Understanding m-commerce: A consumer-centric model, *Quarterly Journal of Electronic Commerce*, vol.3, pp.247-272, 2002.

[22] S. W. Kim, S. K. Muna and H. T. Kang, Understanding consumers' intention to use mobile payment services: The perspective of university students, *Industrial Economics Research*, vol.20, no.4, pp.1739-1766, 2007.

[23] T. Z. Chang and A. R. Wildt, Price, product information, and purchase intention: An empirical study, *Journal of the Academy of Marketing Science*, vol.22, no.1, pp.16-27, 1994.

[24] Y. S. Heo, M. N. Chang and Y. B. Choi, Review of the relationship between characteristics of smart tourism information and tourist behavioral intentions using meta-analysis, *Journal of Tourism & Industry Research*, vol.39, pp.13-21, 2019.
[25] J. F. Hair, Jr, M. C. Howard and C. Nitzl, Assessing measurement model quality in PLS-SEM using confirmatory composite analysis, *Journal of Business Research*, vol.109, pp.101-110, 2020.
[26] J. H. Kim, M. N. Chang, M. J. Choi and M. C. Kim, Jeju wellness therapy nogorogi: Experimental analysis for the possibility, *Journal of Tourism & Industry Research*, vol.40, pp.51-59, 2020.
[27] Y. S. Kang, H. Kim, Y. B. Choi, M. C. Kim and M. S. Jung, Recognition investigation on wellness tourism activities, *Journal of Tourism & Industry Research*, vol.38, pp.29-46, 2018.
[28] J. Y. Park, A study on determinants of trial intension toward brand extensions, *Journal of Tourism & Industry Research*, vol.37, pp.23-28, 2017.