International Journal of Advanced Culture Technology Vol.11 No.4 302-309 (2023)
DOI https://doi.org/10.17703/IJACT.2023.11.4.302

IJACT 23-12-35

How to Enhance Perceived Usefulness, Ease of Use, and Fit of Wearables: An Exploratory Study about the Physical Attributes of Smart Wristbands and Smartwatches

[1]Shim, Soo In, [2]Yu, Heejeong

[1]Department of Fashion Design, Jeonbuk National University/Research Institute of Human Ecology, Jeonbuk National University, Korea
sooinshim@jbnu.ac.kr
[2] Department of Human Ecology, Jeonbuk National University, Korea
heejeongyu@jbnu.ac.kr

Abstract

Wearable devices, attached to the human body, track and enhance users' activities, health, and communication. Therefore, considering ergonomic factors in product design is crucial. However, previous research has somewhat overlooked the importance of integrating ergonomic design elements into a broad spectrum of design factors. This study aims to examine the impact of physical attributes inherent in smart wristbands and smartwatches on the perceived functional value, specifically, perceived usefulness, ease of use, and fit. A survey was conducted among 289 US adults who had experience using smart wristbands or smartwatches. The collected data were analyzed using descriptive statistics, factor analysis, Cronbach's alpha, t-test, MANOVA, and regression analysis in SPSS version 29. The results showed that the shape of the front display significantly influenced perceived ease of use, and the product's weight had a substantial impact on both perceived ease of use and fit. Furthermore, distinct technical features on the front display had varied effects on perceived usefulness, ease of use, and fit. Notably, the presence of activity tracking, alarm, and calendar functionalities led to distinct differences in ease of use and fit. Features such as distance tracking, phone call, social media notifications, text messaging, and time display functions showed significant influences on the perception of fit. These findings provide insights into the physical values of smart wristbands and smartwatches as perceived by users.

Keywords: *Wearables, Smart wristbands, Smartwatches, Perceived usefulness, Ease of Use, Fit*

1. INTRODUCTION

Wearables refer to electronic devices or technologies that are worn on the body as accessories or embedded in clothing, often equipped with sensors, computational abilities, and wireless connectivity, designed to track, monitor, or augment various aspects of human activity, health, or communication in a portable and user-friendly manner[1]. Wearables encompass smart wristbands, smartwatches, AR/VR headsets, and smart clothing, with smart wristbands and smartwatches historically dominating the market due to widespread

Manuscript received: October 6, 2023 / revised: October 22, 2023 / accepted: November 5, 2023
Corresponding Author: sooinshim@jbnu.ac.kr
Tel:+82-063-270-3846, Fax: +82-063-270-3799
Professor, Dept. of Fashion Design, Jeonbuk National Univ., Korea

adoption and multifunctionality[2]. Both smart wristbands and smartwatches exhibit shared characterist

ics, encompassing wearable designs conducive to wrist placement, integrated sensors for health monitoring, wireless connectivity, compatibility with mobile applications, and battery-powered operations. However, smartwatches demonstrate a more expansive array of functionalities, extending beyond health tracking to include communication features and diverse utility functions, distinguishing them from smart wristbands.

The smart wristband market segment exhibits a steady yet relatively moderate growth trajectory compared to smartwatches[3]. With an estimated market size projected to reach several billion dollars, key brands in this sector include Fitbit (now a part of Google), Xiaomi, and Huawei, emphasizing cost-effective solutions with accurate fitness tracking sensors[3][4]. Success in this domain relies on factors such as affordability, precise health monitoring capabilities, extended battery life, and user-friendly interfaces tailored for fitness enthusiasts, aiming to capture a niche market seeking economical wearable options dedicated to fitness tracking[5]. In contrast, the smartwatch market showcases robust growth dynamics, poised to achieve substantial market valuation driven by heightened demand for health-centric features[3]. Leading brands like Apple, Samsung, and Garmin dominate this space due to their pioneering advancements in functionalities, design innovation, and ecosystem integration[3]. Critical determinants for market leadership encompass continuous technological innovation, prolonged battery longevity, seamless smartphone integration, diverse app ecosystems, and a fusion of style and utility[5]. Smartwatches, serving a broader spectrum of lifestyle needs, maintain a prominent position in the wearable technology landscape owing to their multifunctionality and diverse feature sets[5].

Academic research scrutinizes the determinants that shape consumer perceived value in smart wristbands and smartwatches, emphasizing pivotal features within these wearable devices[6][7]. The precision of health monitoring functionalities, encompassing metrics like heart rate accuracy, sleep pattern analysis, and step counting, significantly influences consumers' perceived value[7]. Furthermore, the aesthetic attributes and functional capabilities of these wearables play integral roles in shaping consumer perceptions[8]. Sleek designs, durable materials, and ergonomic considerations positively impact perceived worth, while the breadth of functionalities offered, especially beyond health tracking, contributes to perceived value[8][9]. User experience elements, such as intuitive interfaces and seamless usability, also significantly influence consumer assessments[9][10][11]. Moreover, academic inquiries delve into brand reputation and consumer trust in manufacturers, highlighting their substantial impact on the perceived value of smart wristbands and smartwatches[10][12]. Through empirical studies and consumer behavior analyses, academic investigations comprehensively analyze these features to unravel their nuanced roles in shaping consumers' perceptions of value in wearable technology[7][9].

Ergonomic considerations encompass the design principles that prioritize user comfort, convenience, and usability[13][14]. In the context of smart wristbands and smartwatches, ergonomic features may include factors such as strap materials, device weight, shape, and how comfortably they fit on the wrist during various activities. The influence of ergonomic considerations on perceived value is likely to be substantial[15][16]. Devices that prioritize ergonomic design tend to offer a more comfortable and unobtrusive wearing experience, aligning better with users' lifestyle and activities. Enhanced comfort and convenience contribute positively to consumers' perceived worth of these wearables[17]. A well-designed, ergonomic device minimizes discomfort during prolonged wear, allowing users to seamlessly integrate these devices into their daily routines without significant inconvenience[18]. As a result, users often attribute higher value to devices that prioritize ergonomic considerations due to their enhanced usability and user-centered design, thus positively impacting their perceived value[19].

Academic studies generally incorporate ergonomic considerations within broader investigations of design, usability, and user experience in smart wristbands and smartwatches. However, specific studies singularly focusing on the direct effects of ergonomic features on perceived functional value within this context are limited. Existing research acknowledges the significance of ergonomic design in enhancing user comfort and usability but often integrates it into a wider spectrum of design elements impacting perceived functional

value[20]. Therefore, while recognizing the importance of ergonomic considerations, academic studies tend to lack dedicated exploration isolating the exclusive impact of physical features on consumers' perceived functional value in these wearables. Further research specifically targeting and dissecting the individual influence of ergonomic design on perceived functional value could offer more precise insights into its direct impact on consumer perceptions.

The purpose of this study is to examine the effects of physical attributes inherent in smart wristbands and smartwatches on the perceived functional value. Within this context, the perceived functional value encompasses two pivotal components: perceived usefulness and perceived ease of use, recognized as fundamental factors in users' acceptance of novel technologies, particularly within the Technology Acceptance Model[21]. Additionally, acknowledging the distinct nature of wearables, especially their placement on the user's body, the subjective perception of the device's alignment with the body and its comfort during wear (referred to herein as perceived fit) constitutes a vital factor of perceived functional value. This scholarly endeavor contributes significantly by providing intricate insights within a specific context, delineating the discernible impact of diverse physical features inherent in wearables on perceived usefulness, ease of use, and fit. Consequently, this study anticipates offering practical implications for enhancing wearable design by identifying the pivotal physical attributes that enhance perceived fit.

2. METHODS

A web-based survey was undertaken, targeting a sample of adult individuals residing in the United States with prior experience utilizing smart wristbands or smartwatches. The selection process involved engaging a specialized research firm to ensure a balanced representation of gender and age across their panel. A randomized distribution of survey invitations via email was conducted among the selected panelists, providing a survey URL to respondents upon acceptance. Upon accessing the questionnaire website via the survey URL link, respondents were initially queried regarding their recent usage of smart wristbands or smartwatches subsequent to providing informed consent. Only participants affirming their utilization of smart wristbands or smartwatches within the preceding year were permitted to advance to the survey questionnaire. Conversely, respondents lacking experience in using these devices were granted the opportunity to complete the survey.

The questionnaire encompassed inquiries concerning respondents' familiarity with and utilization patterns of smart wristbands or smartwatches, encompassing diverse physical attributes (such as front display shape, wristband color, wristband material, size, weight, and functionalities) of their currently utilized devices. Additionally, it delved into assessments of perceived usefulness, ease of use, and fit. Demographic characteristics were also included. The measurement scales employed for assessing perceived usefulness and ease of use adhered to the established framework of the Technology Acceptance Model[22]. Measurement items pertaining to perceived fit were developed by drawing insights from relevant prior studies[23][24][25][26].

Descriptive statistical analyses were initially conducted on the dataset comprising 289 respondents to delineate characteristics of the respondents. Next, the examination of measurement item validity and reliability ensued through exploratory factor analysis and Cronbach's alpha assessment. Subsequently, in order to ascertain the influence of physical attributes of wearables on perceived usefulness, ease of use, and fit, a series of statistical tests including t-tests, multivariate analysis of variance (MANOVA), and linear regression analysis were conducted. These analytical procedures were executed employing SPSS software version 29."

3. RESULTS

3.1. Sample demographics

The demographic composition of the 289 respondents who participated in the analysis was 39.44% male and 60.55% female, indicating a slight preponderance of female respondents. By age, 25.95% were 20-29 years old, 33.22% were 30-39 years old, 19.03% were 40-49 years old, and 21.11% were 50-59 years old, with slightly more people in their 30s, but distributed relatively evenly. In an inquiry regarding awareness of

wearables, respondents provided multiple responses: 260 individuals acknowledged awareness of smartwatches, 245 of smart wristbands, 164 of smart glasses, and 68 of smart clothes. An analysis of the respondents' history with smart wristbands or smartwatches through frequency analysis revealed that 56.76% reported experience with smart wristbands, while 43.25% reported experience with smartwatches.

Regarding the physical features of smart wristbands or smartwatches utilized by respondents, findings indicate a predominant preference for certain attributes. Among the respondents, 114 individuals (39.45%) favored the rectangle shape for the front display, followed by 101 individuals (34.95%) opting for the square shape, 43 individuals (14.88%) choosing the circle shape, and 29 individuals (10.04%) selecting the oval shape. Concerning color preference, black emerged as the most popular choice with 163 respondents (56.40%), followed by white with 25 respondents (8.65%), and blue with 20 respondents (6.92%). Subsequent preferences included charcoal or dark gray (f = 19, 6.57%), rose gold or pink (f = 15, 5.19%), silver or light gray (f = 13, 4.50%), violet (f = 8, 2.77%), gold (f = 5, 1.73%), brown and red (f = 4 each, 1.38%), beige (f = 3, 1.04%), orange and green (f = 2 each, 0.69%), and yellow (f = 1, 0.35%). Regarding wristband materials, 149 respondents (51.56%) favored rubber or similar material, followed by hard plastic (f = 50, 17.30%), metal (f = 44, 15.22%), and leather (f = 41, 14.19%). In exploring the preferred functions of smart wristbands or smartwatches, findings indicated a high usage rate for various functions. The activity tracker function was reported by 224 respondents (77.51%), followed by the fitness tracker function reported by 186 respondents (64.36%). Subsequent functions included the alarm clock function (f = 176, 60.90%), distance tracking (f = 167, 57.79%), calorie tracker (f = 150, 51.90%), calendar function (f = 109, 37.72%), GPS (f = 97, 33.57%), email (f = 78, 26.99%), and camera (f = 42, 14.53%)."

3.2. Checking validity and reliability of measurement scales

An exploratory factor analysis was conducted on sets of 3 items each related to perceived usefulness, perceived ease of use, and perceived fit. Utilizing Promax rotation with an eigenvalue threshold of 1, two primary factors emerged. Factor 1 predominantly loaded the 3 items of perceived ease of use and the 2 items of perceived fit with factor loadings exceeding 0.5, while Factor 2 predominantly loaded the 3 items of perceived usefulness. However, one perceived fit item presented factor loadings of 0.41 and 0.36 across both factors, compromising both convergent and discriminant validity.

Given the robust support for perceived usefulness and perceived ease of use from prior research(Abdullah, Ward, & Ahmed, 2016; Huarng, Yu, & Lee, 2022 ; Kang & Hwang, 2022), they were likely to constitute two latent variables, with perceived fit integrated within them. A reassessment utilizing a fixed three-factor structure confirmed that each set of 3 items related to perceived usefulness, perceived ease of use, and perceived fit loaded significantly onto their respective factors with loadings exceeding 0.5, ensuring a simple factor structure and meeting criteria for convergent and discriminant validity [TABLE 1]. Consequently, a three-factor model, aligning with theoretical foundations and showing a clean interpretable factor structure, was adopted, labeling Factor 1 as perceived usefulness, Factor 2 as perceived ease of use, and Factor 3 as perceived fit. Calculations of Cronbach's alpha coefficients for each factor's constituent items yielded values above 0.7, establishing their reliability [TABLE 1].

Table 1. Three-factor structure of perceived functional value

Item Factor	Perceived usefulness	Perceived ease of use	Perceived fit	Commu-nality
My product helps me organize my life better.	0.86			0.65

My product makes my life more effective.	0.78			0.76
My product increases my productivity.	0.64			0.60
Using my product is self-explaining.		0.85		0.67
Learning to use my product is simple.		0.66		0.61
My product is easy to use.		0.62		0.68
My product is comfortable to be worn.			0.78	0.67
The feel of my product on my skin is good.			0.71	0.61
My product fits well.			0.58	0.56
Eigenvalue	5.15	1.03	0.69	-
Variance Explained %	57.17	11.42	7.69	-
Cumulative variance %	57.17	68.59	76.28	-
Cronbach's alpha	0.85	0.84	0.81	-

Note: Factor loadings below 0.30 are not shown to improve readability

3.3. Verifying the effects of physical attributes on perceived functional value

Although the Wilks' lambda value yielded non-significance in the MANOVA to assess disparities in perceived usefulness, ease of use, and fit concerning variations in the front display's shape, notable significance emerged within the subsequent ANOVA. Specifically, the multivariate analysis indicated a Wilks' lambda value of 0.94, $F(12, 746.39) = 1.52$, $p = 0.11$, suggesting a lack of statistical significance across the range of dependent variables. However, within the subsequent ANOVA, perceived usefulness ($F(4, 284) = 2.59$, $p < 0.05$) exhibited significant group differences. This signifies discernible disparities among groups concerning these individual variables, albeit when considering the comprehensive analysis, the overall intergroup differences did not attain statistical significance. Consequently, when consolidating these outcomes, it appears that the group disparities are constrained to a specific variable (i.e., perceived usefulness). Subsequent examination through LSD post hoc testing to evaluate the mean disparity in perceived usefulness across different shapes demonstrated noteworthy distinctions between circle and oval shapes ($MD = 0.43$, $p < 0.05$) as well as between circle and rectangle shapes ($MD = 0.37$, $p < 0.05$). Following MONOVA designed to explore the potential variances in perceived usefulness, ease of use, and fit in relation to variations in the color ($\lambda = 0.96$, $F(9, 688.90) = 1.37$, $p = 0.20$) or material ($\lambda = 0.93$, $F(15, 776.12) = 1.35$, $p = 0.17$) of the wristband, no statistically significant relationships were observed among these variables.

After conducting a series of linear regression analyses aimed at assessing the influence of both the size of the product's front display and the product's weight on perceived usefulness, ease of use, and fit, notable findings emerged. Although the overall F-value for the regression model including perceived usefulness did not reach significance ($F(2, 286) = 2.27$, $p = 0.11$), an individual analysis via t-tests on the regression coefficients revealed a significant influence for the size of the product's front display ($t = 2.06$, $p < 0.05$). This outcome suggests that while the regression model as a whole failed to assert statistical significance in explaining the variance of perceived usefulness, the size of the product's front display demonstrated a noteworthy association with perceived usefulness. Hence, while the model's collective explanatory power remains insignificant, the singular impact of the size of the product's front display in relation to perceived usefulness warrants careful consideration. More importantly, statistically significant results were observed in relation to perceived ease of use ($F(2, 286) = 5.86$, $p < 0.01$) and fit ($F(2, 286) = 4.97$, $p < 0.01$). While the size of the product's front display did not yield significant effects on perceived ease of use ($t = 0.18$, $p = 0.86$)

and fit ($t = 1.20$, $p = 0.23$), the weight of the product exhibited discernible impacts on both perceived ease of use ($t = -3.17$, $p < 0.01$) and fit ($t = -3.15$, $p < 0.01$), with both relationships being statistically significant. Specifically, the weight of the product demonstrated negative effects on perceived ease of use ($\beta = -0.2$) and fit ($\beta = -3.15$), signifying that a lighter product weight leads to increased perceived ease of use and greater wearability.

Upon conducting an independent samples t-test to assess the disparity in perceived usefulness, ease of use, and fit concerning the presence or absence of individual technical functions in smart wristbands or smartwatches, significant associations emerged. Technical functionalities such as alarm clock ($t = -2.80$, $p < 0.01$), calendaring ($t = -3.54$, $p < 0.001$), calorie tracker ($t = -2.53$, $p < 0.05$), camera ($t = -3.21$, $p < 0.01$), email ($t = -2.72$, $p < 0.01$), GPS ($t = -2.88$, $p < 0.01$), heart rate monitor ($t = -2.08$, $p < 0.05$), music player ($t = -3.79$, $p < 0.001$), phone call ($t = -5.40$, $p < 0.001$), social media notifications ($t = -3.91$, $p < 0.001$), and text messaging ($t = -4.14$, $p < 0.001$) were found to significantly influence perceived usefulness. These findings suggest an enhanced perceived usefulness among users when these technological features are integrated into smart wristbands or smartwatches. Regarding perceived ease of use, technical functions such as active tracker ($t = -2.33$, $p < 0.05$), distance tracker ($t = -2.19$, $p < 0.05$), and phone call ($t = -2.51$, $p < 0.05$) exhibited significant impacts. This indicates that the inclusion of these technical functionalities in smart wristbands or smartwatches enhances users' perception of ease of use. Furthermore, technical functions including active tracker ($t = -2.23$, $p < 0.05$), alarm clock ($t = -2.42$, $p < 0.05$), calendaring ($t = -2.82$, $p < 0.01$), distance tracker ($t = -2.28$, $p < 0.05$), phone call ($t = -2.73$, $p < 0.01$), social media notifications ($t = -2.35$, $p < 0.05$), text messaging ($t = -2.21$, $p < 0.05$), and time display ($t = -2.40$, $p < 0.05$) significantly influenced perceived fit. These outcomes imply an increased fit perception among users when these specific technical functions are integrated into smart wristbands or smartwatches.

4. DISCUSSION

The investigation delved into the influence of diverse physical features inherent in smart wristbands and smartwatches on the perceived functional value, specifically evaluating perceived usefulness, ease of use, and fit. The findings revealed that the front display's shape markedly impacted perceived usability, while the product's weight significantly influenced perceived ease of use and fit. Moreover, the manifestation of distinct technical features on the product's frontal facet engendered varied effects on perceived usefulness, ease of use, and fit. Notably, discernible discrepancies in ease of use and perceived fit were observed contingent upon the presence or absence of an activity tracker, while disparities in usability and perceived fit were contingent upon the presence or absence of alarm and calendar functionalities. Additional features that instigated significant disparities in the perception of fit encompassed the distance tracker, phone call, social media notifications, text messaging, and time display function.

This study contributes significantly to the academic field by investigating the nuanced impact of physical attributes and technological features of smart wristbands and smartwatches on users' perceived functional value. Wearables represented by smart wristbands and smartwatches represent a rapidly expanding technological domain in contemporary society[2], exerting substantial influence on users' daily lives and functionality. Through an in-depth analysis of the product's physical elements and technological features on user perceptions, this research offers insights for future development and enhancement of product design and functionality that further influence consumer behavior and product preferences[27][28]. In particular, the research outcomes distinctly outline the precise technical functionalities of wearables that notably influence perceived fit (i.e., activity tracker, alarm, calendar, distance tracker, phone call, social media notifications, text messaging, and time display function), which deserve further attention as they are new findings rarely found in previous research. These research results contribute to expanding and in-depth understanding of user experience, technology adoption, and product design in the realm of wearable technology, while also providing new

implications and laying a new foundation for academia.

This research holds practical significance by shedding light on the crucial relationship between the physical characteristics of smart wearable devices and users' perceptions of functionality. By identifying specific features that significantly affect user experience, such as the impact of display shape on usefulness and the weight of the product on ease of use and fit, this study offers actionable insights for manufacturers and designers. The variability in the visually displayable area is contingent upon the display shape, potentially influencing the spectrum of feasible technical features. However, endeavors aimed at expanding the display area might inadvertently lead to an increase in the product's weight. This implies that in the design of smart wearable devices, efforts to enhance usefulness could potentially engender trade-offs, diminishing ease of use and fit. Moreover, the findings of this study indicated a notable increase in perceived fit among smart wristbands or smartwatches integrating technical features such as activity tracker, alarm, calendar, distance tracker, phone call, social media notifications, text messaging, and time display function. These shared technical features converge upon their user-centric nature, catering to ubiquitous daily life usage patterns. Consequently, it behooves manufacturers and designers of smart wearable devices to conscientiously prioritize ergonomic design considerations when incorporating these technical features into their products. Moreover, a meticulous assessment of user-perceived fit should be rigorously conducted prior to product launch. These findings can guide the development of future wearable technologies that align more closely with user preferences and needs, ultimately enhancing user satisfaction and market competitiveness.

The focus of this study primarily rested on the interrelation between specific product physical features and product evaluation; however, it did not comprehensively consider the influence of various external factors on user perceptions. Moreover, the selected features investigated in this study may potentially fail to adapt to evolving user demands over time. Subsequent research endeavors should delve deeper into the intricate interplay between external environmental variables and technological elements, incorporating a predictive aspect regarding the evolution of user demands. Additionally, there is a critical need for investigations encompassing diverse user cohorts and in-depth explorations of preferences for specific functionalities or designs. Furthermore, empirical studies focusing on novel design concepts that prioritize user experience, aiming to enhance convenience and satisfaction, warrant significant attention.

REFERENCES

[1] M. Billinghurst and T. Starner, “Wearable devices: new ways to manage information,” *Computer*, vol. 32, no. 1, pp. 57-64, Jan. 1999. DOI: 10.1109/2.738305

[2] S. Seneviratne, Y. Hu, T. Nguyen, G. Lan, S. Khalifa, K. Thilakarthna, M. Hassan and A. Seneviratne. “A survey of wearable devices and challenges,” *IEEE Communications Surveys & Tutorials(IEEE)*, Vol. 19, NO. 4, pp. 2573-2620, July 2017. DOI: 10.1109/COMST.2017.2731979

[3] Counterpoint, Submission of manuscript. https://www.counterpointresearch.com

[4] IDC, Submission of manuscript. https://www.idc.com

[5] CNET, Submission of manuscript. https://www.cnet.com

[6] S. Jin, “A Study on the Effect of Individual Characteristics on Acceptance Intention of Wearable Healthcare Devices: Focusing on the UTAUT2 and Innovativeness.” *Journal of the Korea Society of Computer and Information(KSCI)*, Vol. 25 No. 3, pp. 129-143. March 2020. DOI: 10.9708/jksci.2020.25.03.129

[7] G. Shin, M. H. Jarrahi, Y. Fei, A. Karami, N. Gafinowitz, A. Byun and X. Lu, “Wearable activity trackers, accuracy, adoption, acceptance and health impact: A systematic literature review,” *Journal of Biomedical Informatics(JBI)*, Vol. 93, pp. 103-153, May 2019. DOI: 10.1016/j.jbi.2019.103153

[8] J. Jeong, Y. Kim and T. Roh, "Do consumers care about aesthetics and compatibility? The intention to use wearable devices in health care," *SAGE Open*, Vol. 11, No. 3, August 2021. DOI: 10.1177/21582440211040070

[9] K. L. Hsiao and C. C. Chen, “What drives smartwatch purchase intention? Perspectives from hardware, software, design, and value,” *Journal of Telematics and Informatics(TI)*, Vol. 35, No. 1, pp. 103-113, April 2018. DOI: 10.1016/j.tele.2017.10.002

[10] J. H. Chung, "The Effect of Design Innovation Attributes on Product and Brand Attitudes and Purchase Intention -Focusing on Smart Watches-." *Journal of The Korean Society Design Culture(JKSDC)*, Vo. 25, No. 3, pp. 403-414, September 2019. DOI: 10.18208/ksdc.2019.25.3.403

[11] J. Choi and P. Kim, "A Study on the Impact of Service Improvement on the Satisfaction Level of Smart Watch Functions," *Korean Journal of Business Administration(KJBA)*, Vol. 34, No. 5, pp. 807-825, May 2021. DOI: 10.18208/ksdc.2019.25.3.403

[12] B. Ramkumar and Y. Liang, "How do smartwatch price and brand awareness drive consumer perceptions and purchase intention? *A perceived value approach," International Journal of Technology Marketing(IJTM)*, Vol. 14, No. 2, pp. 154-180, September 2020. DOI: 10.1504/IJTMKT.2020.110126

[13] Planner 5d, Submission of manuscript. https://planner5d.com/

[14] B. Sklar, Digital Communications, Prentice Hall, pp. 187, 1998.

[15] K. H. Na, "A Study on the Mediating Effect of Brand Authenticity Between Design Innovation of Smart Watches and Loyalty Intention," *A Journal of Brand Design Association of Korea(BDAK)*, Vol. 21, No. 2, pp. 127-140, May 2023. DOI: 10.18852/bdak.2023.21.2.127

[16] J. Y. Jeong, K. K. Chang, "A Smart Strap Design Proposal on the Utilisation of SCAMPER -focused on MR TIME," *Journal of Basic Design & Art(JBDA)*, Vol. 23, No. 1, pp. 481-494, January 2022. DOI: 10.47294/KSBDA.22.2.22

[17] J. H. Hong, "A Study on the Understanding of Smart Watch on Intention of Continuous Use in Health Care," *Journal of Global Convergence Research(JGCR)*, Vol. 1, No. 2, pp. 93-102, December 2022. DOI: 10.57199/jgcr.2022.1.2.93

[18] Etnews, Submission of manuscript. https://www.etnews.com

[19] S. Fleury and N. Chaniaud, "Multi-user centered design: acceptance, user experience, user research and user testing," *Theoretical Issues in Ergonomics Science(TIES)*, pp. 1-16, December 2023. DOI: 10.1080/1463922X.2023.2166623

[20] K. H. Na, "A Study on the Mediating Effect of Brand Authenticity Between Design Innovation of Smart Watches and Loyalty Intention," *Journal of Brand Design Association of Korea(JBDAK)*, Vol. 21, No. 2, pp. 127-140, June 2023. DOI: 10.18852/bdak.2023.21.2.127

[21] H. Yang, J. Yu, H. Zo and M. Choi, "User acceptance of wearable devices: An extended perspective of perceived value," *Telematics and Informatics(TI)*, Vol. 33, No. 2, pp. 256-269, 2016. DOI: 10.1016/j.tele.2015.08.007

[22] S. H. W. Chuah, P. A. Rauschnabel, N. Krey, B. Nguyen, T. Ramayah and S. Lade, "Wearable technologies: The role of usefulness and visibility in smartwatch adoption," *Computers in Human Behavior(CHB)*, Vol. 65, pp. 276-284, December 2016. DOI: 10.1016/j.chb.2016.07.047

[23] J. H. Thun, C. B. Lehr and M. Bierwirth, "Feel free to feel comfortable—an empirical analysis of ergonomics in the German automotive industry," *International Journal of Production Economics(IJPE)*, Vol. 133, No. 2, pp. 551-561, October 2011. DOI: 10.1016/j.ijpe.2010.12.017

[24] G. B. Pratama, A. Widyanti, N. Nurfitrisari and S. A. Salma, "Ergonomic Product Design: An Empirical Study on The Influencing Factors to Use and to Buy," *Strategic Design Research Journal(SDRJ)*, Vol. 15, No. 3, pp. 248-262, December 2022. DOI: 10.4013/sdrj.2022.153.03

[25] L. Bonapace, The ergonomics of pleasure. WS Green, & PW, Jordan. Human factors in product design, current practice and future trends, *Taylor & Francis*, pp. 234-248, 1999.

[26] M. A. Rupp, J. R., Michaelis, D. S. McConnell and J. A. Smither, "The role of individual differences on perceptions of wearable fitness device trust, usability, and motivational impact," *Applied Ergonomics(AE)*, Vol. 70, pp. 77-87, July 2018. DOI: 10.1016/j.apergo.2018.02.005

[27] R. Mugge and J. P. Schoormans, "Newer is better! The influence of a novel appearance on the perceived performance quality of products," *Journal of Engineering Design(JED)*, Vol. 23, No. 6, pp. 469-484, September 2012. DOI: 10.1080/09544828.2011.618802

[28] R. Mugge, D. W. Dahl and J. P. Schoormans, ""What you see, is what you get?" Guidelines for influencing consumers' perceptions of consumer durables through product appearance," *Journal of Product Innovation Management(JPIM)*, Vol. 35, No. 3, pp. 309-329, June 2018. DOI: 10.1111/jpim.12403