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Wearable Designs for Hair Designers with 3D Virtual Images and 3D Printed Models

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Abstract

Improving work efficiency and satisfying customers through personalized services is becoming more important in an increasingly competitive hair industry. Wearables may help to improve hair designers' work efficiency and customer satisfaction by analyzing customer and hair designers' conditions and provide hair styling-related data. However, there is limited research on developing wearables for hair designers (WHDs), and many existing wearables were developed without understanding user needs and perceptions. This research investigated preferences, perceptions, and intentions on WHDs based on hair designers in the U.S., which is the largest hair market. Specific design options that hair designers preferred and possible options to meet requirements that hair designers expect for wearables were identified and suggested in WHD design guidelines. Second, most people preferred a WHD design of a black-colored bracelet/watch that can be a necklace designed with preferred functions; in addition, 3D virtual images and 3D printed models were prototyped. Third, developed designs were evaluated. More than 70% of users were satisfied and considered it as useful and easy to use, with an intention to purchase. The results are expected to provide insights to designers when developing WHDs.

Key words: Wearable, Hair designer, Work efficiency, Customer satisfaction, Design

I. Introduction

The hair salon industry has kept growing annually since 2012 (IBISWorld, 2019), and the hair care market is also expected to be $211.1 billion in 2025 worldwide (Grand View Research, 2018a). It will expectedly increase further as the aging population experiences increasing hair loss and dryness and decreasing volume and thickness (Grand View Research, 2018b). As the hair market competition is intensifying, improving work efficiency and satisfying customers through personalized services is becoming more important in the hair industry than before. Hair designers need to quickly grasp information about customers' hair condition and preferred style through communication with customers, and provide accurate hair stylings with appropriate methods and procedures. However, it is difficult for hair designers to identify and analyze various customers' information while simultaneously providing services and treatments to several customers. Hiring a large number of employees to share the work can also be a burden for hair salons due to the increased labor costs.

Technologies have been applied in the hair market (Lisa, 2017; Park, 2017; Sin & Ji, 2019), such as German-based company Hengel's brand Schwarzkopf. Professionals have applied wearables with apps that analyze customers' hair conditions, moisture content, and actual hair colors to provide real-time information on

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hair products, pharmaceuticals, and treatment methods suitable for customers (Takahashi, 2018). Wearables are electronic devices that can be worn and communicate with users in real time (Guk et al., 2019). Wearables can non-intrusively and continuously collect information about the surrounding environment or personal changes of the individuals and enable users to utilize information in real time. Thus, wearables have the potential to improve hair designers' work efficiency and customer satisfaction by analyzing customer and hair designers' conditions and providing hair styling-related data. However, there is a lack of research on developing wearables for hair designers (WHDs), and many existing wearables were mainly developed with a focus on technologies, without understanding users (Perry et al., 2017). The widespread use of wearables for customer's self-haircare and styling may decrease the number of customers' visits at hair shops and threaten hair designers' positions in the market. The hair salon business is becoming more competitive and hair designers would need to find ways to remain special and competent in the market (Choi, 2020). Wearables could be a win–win solution for hair designers by increasing hair designers' work efficiency and by satisfying customers more.

Thus, this study aimed 1) to develop WHDs reflecting hair designers' preferences, perceptions, and intentions in terms of functions, designs, and requirements; 2) to investigate how to develop WHDs to improve hair designers' work efficiency and customer satisfaction; and 3) to understand how consumer characteristics (innovativeness, trend leadership, and self-efficacy) affect those results for the future WHD design diversification.

The U.S. is 29.6% of the global hair market, which is the largest in the world, and more than 80,000 hair salons exist in the U.S. (Grand View Research, 2018b). Also, the wearable market in the U.S. is the second largest and is expected to grow by 4.4% annually, expanding to about $3,844 million by 2024 (Statista, 2019). Thus, this research targeted the hair designers working and living in the U.S. After understanding hair designers' preferences, perceptions, and intentions for WHDs, design guidelines and design prototypes were developed and then evaluated for modifications. The results of this study are expected to provide insights on how to develop WHDs to improve work efficiency and customer satisfaction, to ultimately enhance hair designers' competence in the rapidly changing and competitive hair markets, as well as to vitalize the wearable market for the hair industry, which has great potential for development.

II. Literature Review

1. Hair Designers' Work Characteristics and Customer Satisfaction

Hair designers create beauty through hair and need to understand not only information such as customers' taste, personality, and occupation but also hair condition to create a suitable hairstyle through accurate hair treatment procedures and methods (Jang & Jin, 2016; Jeon, 2010). Therefore, hair designers are required to have comprehensive information-processing abilities (Jang & Jin, 2016; Jeon, 2010). Hair designers are also required to know and apply hair trends and new techniques to their work and conduct appropriate procedures and treatments for each customer's hair condition. In addition, it is necessary to establish trust with customers through communications to make loyal customers who continuously visit their hair salons. Many hair designers have diseases due to stresses from repetitive physical and mental tasks, which require proper procedures according to real-time clients and situations under limited time (Cho et al., 2017; Kim & Ji, 2019).

Consumer satisfaction, which is the result of interactions between the hair design and the customer through valued and qualified services, is the biggest challenge in the hair industry (Ko, 2009; Sung & Jin, 2019). Customer satisfaction is not just related to service but influences customers' intentions to revisit hair salons (Sung & Jin, 2019). Thus, there is a need to provide personalized services, procedures, and products to meet the diverse needs and wants of customers, although it is difficult for hair designers to remember all clients' prefer-

red styles, procedure records, and information and to analyze their hair conditions accurately.

Also, the use of strong heat or high concentrations of chemicals can cause hair damage, which can be maximized if the procedure is not conducted properly. Other physical and chemical damages to hair, such as hair cuticle damage and decrease of amino acid content and tensile strength, may occur during hair treatment. If wearables can enable identification of customers' hair types and conditions and provide customer information, and appropriate hair styling methods and procedures in real time, it could enable hair designers to provide more appropriate and customized hair treatments and services to customers.

2. Wearables in the Hair Industry

Demand for wearables for hair/beauty industry in the U.S. is rapidly growing (Grand View Research, 2018b). Thus, many companies have developed wearables such as L'Oréal, which has been working on a project called Matrix Class for Glass that enables hair designers to record their hair styling procedures through Google Glass using videos and photos and to e-mail the files to customers, and they can maintain and manage the same styles by following hair designers (seb chalmeton, 2014). VO5, the UK's largest hair styling brand, has developed a product called Hair Fit Clip, which users attach like a hairpin. Its built-in sensor detects hair health and conditions such as dryness, oiliness, and heat damage, and the hairpin can provide real-time monitoring of environmental changes affecting hair health and conditions and send the information to the user's smartphone (Thompson, 2015). There is also a helmet-type wearable that can treat hair loss and monitor environmental conditions such as UV and environmental pollution that can affect hair health and conditions (De Vecchi et al., 2019).

However, there is a stronger trend of development of wearables for customers to do home care and treat hair loss than for hair designers. Apira Science introduced iGrow, a product that energizes hair root cells and promotes hair growth through use for 20 minutes a day for 4 months (DiMeglio, 2016). Similarly, Theradome, Hair Alpha Ray and Wintech, TS Trillion, and Biocell also developed a helmet-type wearable for treating hair loss using light-emitting diodes (LEDs) (Hairfear, 2014; Kim, 2019). As more companies enter and develop related products, the market for helmet-typed wearables for hair loss treatment is expected to grow.

Also, hair itself has been used as a wearable material. Professor Paulos of UC Berkeley's team applied Internet-of-things (IOT) technology to protein filaments like hair; the hair can move automatically to notify the user when a text arrives, and texts can be sent by simply touching the hair (Hart, 2018). Typical smartwatches and fitness bracelets can also help hair designers get real-time customer texts and calls, check schedules, and monitor their movements (Ericsson, n.d.). Wearables have the advantage of providing hair designers with real-time information and personalized service to customers, but there is a lack of research focusing on developing WHDs.

3. Requirements of WHDs

Literature related to requirements for WHDs were reviewed and the following requirements were identified.

1) Safety

Wearables should minimize the discomfort and physical fatigue caused by long-term wearing and ensure safety against battery power and electromagnetic waves (Kang, 2015; Lee, 2015). Safety and quality tests of wearables can be performed such as electrical safety tests, chemical hazard tests, mechanical tests, and electromagnetic absorption rate tests (TÜV SÜD, n.d.). WHDs should be safe for hair designers and for customers and staff due to working in close proximity to customers and staff.

2) Soft Material

Stiff materials can cause skin wounds and make it difficult to wear long term so soft material is recommended (Koo & Fallon, 2018; Yeo et al., 2016). Soft materials that are commonly used for wearables include silicone (Yi et al., 2016) and conductive smart fa-

bric materials (Aroganam et al., 2019); these soft materials can reduce the heterogeneity of clothing to skin and provide a comfortable fit for users.

3) Ease of Wear and Removal

Wearables should be easy to wear and removal (Guo et al., 2008). It is expected that hair designers will use WHDs for a long time and frequently if they are easy to wear and removal. Fasteners, such as buckles, can be difficult to remove (Graf et al., 2018), so using elastic silicone (Yi et al., 2016) is recommended.

4) Wearability

Wearables need to be physically, psychologically, emotionally, and societally comfortable to wear (Dunne & Smyth, 2007; Shin & Lee, 2015). In their work, hair designers usually stand and move their arms and whole body. Wearables that can be worn in various ways enables comfortable wearing according to various environments and situations (Redding, n.d.).

5) Sustainability

Wearables now need to be biocompatible and eco-friendly (Kaiser et al., 2016). Modular design is recyclable and allows for partial repairs for long-term use (Berzowska et al., 2010).

6) Ease of Care

Wearables should be developed to be easy to charge (Shin & Lee, 2015) and clean. WHDs are likely to be contaminated by various chemicals during work, so they should be easy to wash. Prior studies have used silicone and textiles to construct washable wearables (Montazerian et al., 2019). Modular design also allows a product to be separated by components (Berzowska et al., 2010), which enables partial washing and replacement.

7) Lightweight

Wearables should be lightweight and easy to use (Kim, 2018; Koo & Fallon, 2017; Shin & Lee, 2015). In 2019, popular smart watches and fitness bracelets such as Apple Watch, Samsung Watch, and Fitbit typically weighed between 30.05g and 391.22g (Scarano, 2019). With regard to wearables advertised as ultra-lightweight, the wearable camcorder was 45g (Bae, 2016), and Nreal's AR glass was 88g (Han, 2019).

8) Flexibility

As consumers' preference for flexible and collapsible portable electronic devices increases, there is a need for flexible electronic circuits and human body-friendly electronic materials (Jung et al., 2015). Superior device flexibility can also improve the user's movement comfort and wearability.

9) Information Agility

Wearables process information to monitor, transfer, and analyze real-time data, and the speed of information processing is important (Lee et al., 2007). The faster the information processing, the faster one can respond to customers and deal with a situation. There is also a need for other forms of connections like Bluetooth in case WiFi is unavailable (Redding, n.d.).

10) Information Accuracy

Wearables must provide accurate information the user needs (Yan, 2019). A large amount of data can be improved by applying self-learning artificial intelligence (AI) and big data technology that can analyze large amounts of data (Swan, 2013).

11) Ease of Use

Wearables must be easy to operate and use with elements such as user-friendly interfaces and simple designs (Redding, n.d.). It was found that the easier it is to use a wearable, the higher the intention to use related products is (Kim & Shin, 2015).

12) Portability

If the portability of wearables is better, users perceive them as easier to use (Kim & Shin, 2015). Hair designers work in various areas in a shop rather than in one place; thus, portability is important. Among many types, accessory types such as bracelets in small sizes have good portability (Song et al., 2019).

13) Waterproof

Hair designers use and come into contact with various chemicals (H. S. Kim, 2010). Thus, it is recommended that WHDs be waterproof.

14) Small Size

Small size is also a important feature for wearables (Koo & Fallon, 2018). The size of the device can influence its portability and wearability. Many made wearables as small-sized accessories for portability. In 2019, the screen size of popular smart watches was 1.2-1.78 (about 3.05-4.52cm), and their area ranged from 3×3cm to 4×4cm (Peckham, 2019).

15) Price Competency

A wearable's price competency has been shown to increase product use intentions (Kim & Shin, 2015). In 2019, the average price of wearables purchased by U.S. consumers was about $79.75 (Statista, 2019).

4. Customer Characteristics

To find out the differences in preference for wearable designs according to users, previous studies (Shin & Lee, 2015; You, 2015; Yun, 2015) of consumer characteristics of innovativeness, trend leadership, and self-efficacy were reviewed.

1) Innovativeness

Innovativeness indicates a user's degree of acceptance of new technologies, products, and services (Shin & Lee, 2015). It was found that the more innovative the device is, the higher the user's purchase intention is (Kim, 2009), and the more useful the wearable is (Shin & Lee, 2015). In the hair industry, accepting new ideas and innovative behaviors can result in success and enhance the competency of a hair designer and shop (Kwon & Sheen, 2018).

2) Trend Leadership

Trend leadership means influencing others to embrace new styles or innovative products as they spread (Kim, 1987; Shin & Lee, 2015). The proliferation of mass media, the popularity of stars, and the radical changes in the fashion industry are affecting the trends of hair designs (H. J. Kim, 2010).

3) Self-efficacy

Self-efficacy is a belief in one's ability to organize and execute the course of action needed to achieve goals (Kim, 2011; Shin & Lee, 2015). Hair designers need to perform appropriate procedures and methods of hair styling treatments, and such skills and confidence come from the full experience and self-esteem of hair designers themselves (Kim, 2011). It was found that hair designers with higher age, education, and work experience showed higher self-efficacy than other hair designers (Kim, 2011).

5. Perceived Usefulness and Purchase Intention

Perceived usefulness refers to the degree to which one thinks technology, products, or services can help improve performance, and purchase intention indicates the consumer's willingness to purchase technology, products, or services (Koo, 2017; Shin & Lee, 2015). In previous studies, factors such as differences in user background and consumer characteristics influenced the perceived usefulness and purchase intention.

1) User Background

Men perceived wearables as more useful than women and younger consumers in their 10s-30s or those who were more than 55 years old did (Koo, 2017). Positive attitudes are expected to increase the likelihood of purchasing and using related wearables. Thus, it is necessary to investigate hair designers' different thoughts, perceptions, and opinions according to their characteristics, preferences, and backgrounds to improve perceived usefulness and ultimately purchase intentions of wearables in the development process.

2) Consumer Characteristics

The higher the trend leadership, the higher the purchase intention tended to be (Kim & Kim, 1997; Shin

& Lee, 2015), but trend leadership did not appear to affect perceived usefulness (Shin & Lee, 2015). If a consumer was sensitive to fashion and trends, the consumer did not consider wearables as useful but showed high use intention. However, the more useful the technology, products, and services, the more users want to purchase and use them in general (Kim & Shin, 2015; Koo, 2017). For example, if a consumer showed higher self-efficacy, he or she perceived wearables as easier to use (Shin & Lee, 2015) and had higher intention to use them (Gao et al., 2015).

III. Research Methods

1. Phase 1: Perception, Preference, and Intention

The 1st online survey was conducted using a survey website tool, Survey Monkey (www.surveymonkey.com). The participants were recruited through purposive sampling and limited to adult hair designers who had worked for more than 2 years and lived in the U.S., which is the largest hair market and the second largest wearables market worldwide. The survey questions were borrowed from priorre search (Shin & Lee, 2015; You, 2015; Yun, 2015) on wearables, consumer characteristics, perceived usefulness, and purchase intention, and the terms were modified to fit hair designers and wearables. The survey questionnaire included a nominal scale and five-point Likert scale (1=strongly disagree, 5=strongly agree) and open-ended questions. In total, there were 92 questions (Qs): 6Qs on user background (gender, age, income, ethnicity, residence area, prior use experience with wearables), 6Qs on perceived usefulness (Shin & Lee, 2015), 10Qs n consumer characteristics (innovativeness, trend leadership, and self-efficacy) (Shin & Lee, 2015), 32Qs on expected improvement level (16Qs each on work efficiency and customer satisfaction), 22Qs on design preference, 15Qs on requirements when purchasing, and 1Q on purchase intention. The collected data was analyzed using the descriptive analysis method, independent samples' *t*-tests, one-way analysis of variance (ANOVA), and linear and multiple regression analyses to investigate significant differences among variables. In addition, the major theme-extraction and color-coding methods (Creswell & Poth, 2016) were applied for the qualitative data acquired from the open-ended questions. The Cronbach's α values were measured for reliability of the measurement tools, and the values were all over 0.60, which showed acceptable internal consistency (Mahler et al., 2010) (Table 1).

2. Phase 2: Design Guidelines and Design Prototyping

Design guidelines for WHDs were developed based on the survey and literature review results. Designs were developed referring the design guidelines and modeled with Rhino software for 3D virtual designs and prototyped using the 3D printing technology. The prototype was fabricated with flexible thermoplastic polyurethane (TPU) filaments (Flex, white) using a 3D printer (Shindo 3DWOX 2D) in condition of zig-zag support, 0.20 mm layer height, 15% density, 200°C nozzle temperature, 60°C bed temperature, and finished with acrylic colors (Liquitex, black).

3. Phase 3: Design Evaluation and Modification

The 2nd online survey was performed to evaluate and modify the design through the same survey website tool, requirements of participants through purposive sampling, and data analysis methods. There were 71 survey questions in total: 6Qs on user background (gender, age, income, ethnicity, residence area, prior use experience in wearables), 3Qs on overall satisfaction (function, design, requirements to purchase), 43Qs on evaluations referring to the design guidelines, 2Qs on modification suggestions, 6Qs on perceived usefulness (Shin & Lee, 2015),10Qs on consumer characteristics (innovativeness, trend leadership, self-efficacy) (Shin & Lee, 2015), and 1Q on purchase intention. The measurement scales showed acceptable internal consistency, with Cronbach's α values above 6.0 (Table 1).

Table 1. Results of Cronbach's alpha values of measurement scales

	Variable	Measurement scale	Cronbach's α	
			1st survey	2nd survey
Product characteristic	Perceived usefulness	The information obtained from WHD will be very useful to me.	.62	.62
		WHD will provide the services I need in time.		
		WHD will be an important part of my life.		
	Perceived ease of use	It will be easy to learn how to use WHD.	.71	.64
		It will be easy to adjust to newly added functions of WHD.		
		The use of WHD will be convenient.		
User characteristics	Innovativeness	I know more about products with new technology or ideas than others.	.61	.61
		I have more products with new technology or ideas than others.		
		I tend to have no hesitation in using new technologies or products with ideas.		
	Trend leadership	I like new and unique styles of clothes.	.63	.60
		I am sensitive to the latest fashions.		
		I always try to dress in a new way.		
	Self-efficacy	I tend to use new technology or products better than others.	.75	.60
		I tend to be aware of and effectively use functions that new technology and products offer.		
		I tend to learn how to utilize new technology or products on my own.		
		I am good at collecting necessary information through smart devices.		

According to the evaluation results, the design modification directions were suggested.

IV. Results and Discussion

1. Phase 1: Peerception, Preference, and Intention

1) Background of Participants

There were a total of 248 participants, and 201 (81.05%) useful responses were analyzed. In 2019, the U.S. population was about 329.27 million (Plecher, 2020), and there were about 578 K hair designers and cosmetologists (Data USA, 2018; United States Census Bureau, 2020), about 1.97% of the total population. The average age of participants was 31.39 (SD=7.92, R= 18-68), and the largest group were in their 20s (52.74%), followed by 30s (35.32%) (Table 2). Of the participants, 55.22% were men and 44.78% were women and most participants were White/Caucasian (74.63%) and living in the West (29.00%) and South (27.50%). The sample of the survey had similar characteristics to the U.S. population, and the average age was 38.2, with those in their 20s and 30s being the majority (Duffin, 2019), and the major consumers of wearables were in their 20s-30s (Statista, 2019). Most people were living in the West (23.8%) and South (38.1%) (United States Census Bureau, 2020). Regarding the prior use experience of wearables, 89% of participants had use experiences. It was anticipated that about 57 million people in the U.S. use wearables in 2019 and about 67% in 2022, which is about 25.3% of the U.S. population (Wurmser, 2019). More people who had prior use experience participated in the survey, which may be because they had more interest and felt that the survey topic was relevant to them than inexperienced users.

2) Improvement Expectancy of Work Efficiency and Customer Satisfaction

The candidates of functions were identified to en-

Table 2. Background of participants

Variable	Category (n=248)	Frequency (Persons)	Percentage (%)
Gender	Men	111	55.22
	Women	90	44.78
Age	-20s	108	53.73
	30s	71	35.32
	40s	12	5.97
	50s-	10	4.98
Ethnicity	American Indian or Alaskan Native	4	1.99
	Asian or Pacific Islander	9	4.48
	Black or African American	19	9.45
	Hispanic or Latino	17	8.46
	White/Caucasian	150	74.63
	Prefer not to answer	2	1.00
Residence area	West	58	29.00
	Midwest	22	11.00
	South	55	27.50
	Northeast	40	20.00
Wearable technology use experience	Yes	178	88.56
	No	23	11.44

hance hair designers' work efficiency and customer satisfaction by analyzing and providing the following information: customer condition (hair loss, hair type, hair damage, head shape, face shape), providing procedure method (device use, hair coloring/perm, product use, styling), customer record (visit record and hair designers in charge, hair styling history, demographic information), trends (hair/beauty, fashion), and hair designer condition (stress level, sales information). According to the results, all functions were considered to be helpful for both hair designer's work efficiency and customer satisfaction ($M \geq 3.54$), and analyzing customer's condition was considered to be the most helpful (Table 3). Hair designers need to provide appropriate styling procedures and methods to each customer while identifying the customer's hair condition using their professional skills and knowledge (Jang & Jin, 2016; Jeon, 2010). Thus, participants might be considered that analyzing and providing those data would be helpful. Although there was no significant difference in expected level of helpfulness of those functions between work efficiency and customer satisfaction, but there were differences in rankings by functions.

Work efficiency. Among functions for understanding customer conditions, information on hair loss (M =3.80, SD=0.93) was considered to be the most helpful to enhance work efficiency. This may because that the hair loss is becoming the important issue with the aging population (Grand View Research, 2018b). The next most helpful functions were hair type (M=3.76, SD=0.99) and hair damage (M=3.75, SD=0.96). The common method that hair designers do to analyze the hair type and damage level was by viewing our touching the hair which could result in errors. This type of work can also be a burden to hair designers, especially those who have short or limited career experience. Coloring or perming hair can cause hair damage due to chemical and heat effects (H. S. Kim, 2010). If hair designers can accurately know the degree of a customer's hair loss with a camera/sensor and photography (Kang,

Table 3. Improvement expectancy of work efficiency and customer satisfaction using WHDs

	Variable		Mean (SD)
Work efficiency	Customer condition	Hair loss	3.80 (0.93)
	Customer condition	Hair type	3.76 (0.99)
	Customer condition	Hair damage	3.75 (0.96)
	Customer record	Hair styling history	3.75 (0.98)
	Procedure method	Device use method	3.73 (1.00)
	Customer record	Customer's visit record and hair designers in charge	3.72 (0.97)
	Procedure method	Hair coloring/perm method	3.70 (1.02)
	Hair designer condition	Sales information	3.69 (1.02)
	Procedure method	Product use method	3.67 (0.94)
	Trend	Fashion trend	3.64 (0.98)
	Procedure method	Styling method	3.64 (0.95)
	Customer condition	Head shape type	3.63 (1.00)
	Customer condition	Face shape type	3.60 (0.99)
	Customer record	Demographic background	3.60 (1.01)
	Trend	Hair/beauty trend	3.56 (1.06)
	Hair designer condition	Stress level	3.54 (1.11)
Customer satisfaction	Customer condition	Hair damage	3.81 (1.00)
	Customer record	Hair styling history	3.78 (1.00)
	Customer condition	Hair type	3.77 (1.03)
	Procedure method	Hair coloring/perm method	3.76 (0.98)
	Customer condition	Head shape type	3.76 (0.99)
	Customer condition	Hair loss	3.72 (0.97)
	Trend	Hair/beauty trend	3.68 (1.09)
	Procedure method	Product use method	3.68 (0.98)
	Hair designer condition	Sales information	3.67 (1.09)
	Customer record	Customer's visit record and hair designers in charge	3.64 (0.96)
	Procedure method	Device use method	3.63 (1.03)
	Procedure method	Styling method	3.61 (1.07)
	Customer condition	Face shape type	3.61 (1.04)
	Hair designer condition	Stress level	3.61 (1.05)
	Trend	Fashion trend	3.55 (1.03)
	Customer record	Demographic background	3.54 (1.03)

2013; Lee & Cho, 2010), they can choose appropriate chemical procedures and products for coloring and perms and also recommend a hairstyle that can cover up the hair loss. Thus, WHDs are expected to help diagnose the correct customer condition, reducing mistakes, and helping to advance the procedure. Participants also preferred information that is directly related to their work, such as customers' hair styling history (M=3.75, SD=0.96) and visit record and hair designers in charge (M=3.72, SD=0.97), rather than customers' demographic information (M=3.60, SD=1.01). The function least perceived as helpful was monitoring hair de-

signer's stress level (*M*=3.54, SD=1.11). Even though many hair designers show high stress levels (Cho et al., 2017; Kim & Ji, 2019), they considered information about their health or stress condition not that helpful to their compared to other functions. Thus, it is recommended to include functions of analyzing and informing about customers' conditions (hair loss, hair type, and hair damage) to improve hair designers' work efficiency.

Customer satisfaction. Among functions, participants perceived analyzing and providing information about hair damage (*M*=3.81, SD=1.00), hair type (*M*=3.77, SD=1.03), and hair styling history (*M*=3.80, SD=1.06) are helpful to increase customer satisfaction. Hair designers need to actively communicate with the client (Ko, 2009; Sung & Jin, 2019), and it might be possible to provide inform about the customer's hair condition and type while providing natural response to the customer. Also, these functions could be used to increase elderly consumers, who are interested in their hair health due to aging (Grand View Research, 2018b), and for people who have damaged hair due to frequent hair styling. Providing appropriate hair treatment is important to satisfy customers (Jang & Jin, 2016; Jeon, 2010), and they can search for the appropriate coloring and perm methods (*M*=3.76, SD=0.98) in real time with WHD. Hair/beauty trends (*M*=3.68, SD=1.09) were ranked as more helpful for customer satisfaction than work efficiency. This might be hair designers already know the hair/beauty trends so it could be more helpful to customers. Customer satisfaction is not just a service but an important influence on the customers' intention to return (Sung & Jin, 2019), and the need for personalized service is increasing (Lisa, 2017). Based on the results, it is recommended to include functions of analyzing customer hair condition, informing about hair/beauty trends and hair styling history for the customer satisfaction.

3) Design Preference

The most preferred item type was a bracelet/watch (*M*=3.80, SD=1.06) followed by necklace (*M*=3.54, SD=0.97), apparel, shoes, and earring, and the least preferred was a hat (*M*=3.39, SD=1.16) (Table 4). Accessory types like bracelets are small in size and portability is superior (Song et al., 2019). People preferred black color (*M*=3.65, SD=0.95) and prominent design (*M*=3.64, SD=1.05). Black color was also the most preferred for wearables, but people preferred unnoticeable design more than prominent design for health tracking wearables (Koo et al., 2018). In the case of WHDs, they might be that they prefer a prominent design so that they can recognize the product by providing new services to customers. Also, casual style (*M*=3.70, SD=1.01), USB charging (*M*=3.75, SD=0.99), touch activation (*M*=3.70, SD=1.00), and ability to connect to a cell phone (*M*=3.67, SD=1.02) were preferred. Thus, WHDs could be designed as black bracelets/watches type that are casual and prominent, can be activated by touch, can be charged with USB, and can be connected to a cell phone.

4) Requirements for WHDs

Participants showed intention to purchase WHDs (*M*=3.84, SD=0.95), and they considered safety (*M*=3.95, SD=0.96) and soft materials (*M*=3.95, SD=0.87) important requirements when they purchase WHDs (Table 5). This is consistent with the previous results that it is important for wearables to be easy to wash, as well as to ensure the safety of elements such as batteries and electromagnetic waves (Kang, 2015; Lee, 2015) and to use soft materials to prevent skin damage (Yeo et al., 2016). Next ranked requirements were ease of use, ease of wear and removal, waterproof, and wearability. These were also considered to be important for wearables in other research (Dunne & Smyth, 2007; Guo et al., 2008; Kim & Shin, 2015), but the waterproof element has not been much discussed. The reason for considering the waterproof element important might be that hair designers are frequently exposed to chemicals while coloring, bleaching, and perming (Choi & Joung, 2011; H. S. Kim, 2010). However, the small size (*M*=3.77, SD=0.96) and price competency (*M*=3.73, SD=0.96) were less considered than other requirements. This might be because the small size is helpful for portability (Song et al., 2019), but a bigger screen makes information more readable. Hair designers also might

Table 4. Preferred design attributes of WHDs

Category		Mean (SD)
Item type	Bracelet/watch	3.80 (1.06)
	Necklace	3.54 (0.97)
	Apparel	3.46 (1.14)
	Shoes	3.43 (1.25)
	Earring	3.39 (1.05)
	Hat	3.39 (1.16)
Color	Black	3.65 (0.95)
	Beige	3.45 (1.08)
Obtrusiveness	Prominent design	3.64 (1.05)
	Unnoticeable design	3.50 (1.08)
Style	Casual style	3.70 (1.01)
	Sporty style	3.68 (0.97)
	Classic style	3.57 (0.97)
	Futuristic style	3.56 (1.00)
Power	USB-charged	3.75 (0.99)
	Eco-friendly charging system	3.65 (1.00)
	Batteries	3.41 (1.17)
Actuation	Touch	3.70 (1.00)
	Button	3.60 (1.00)
	Voice	3.56 (1.05)
Connected device	Cell phone	3.67 (1.02)
	Computer	3.66 (0.99)

Table 5. Important requirements for WHDs

Important requirements	Mean (SD)
Safety	3.95 (0.96)
Soft material	3.95 (0.87)
Ease of use	3.93 (0.97)
Ease of wear and removal	3.91 (0.93)
Waterproof	3.89 (1.00)
Wearability	3.89 (0.82)
Sustainability	3.88 (0.94)
Ease of care	3.86 (0.96)
Lightweight	3.85 (0.95)
Flexibility	3.85 (0.99)
Portability	3.82 (0.97)
Information agility	3.81 (0.94)
Information accuracy	3.81 (1.00)
Small size	3.77 (0.96)
Price competency	3.73 (0.96)

consider other qualities more than the price. Although the requirements were ranked, all of them were above 3.73, indicating that they are all important requirements for WHDs.

5) Differences in Consumer Characteristics

(1) Innovativeness

People with a higher level of innovativeness (IH) perceived the information about customers' visit record and hair designers in charge to be helpful to improve their work efficiency more than those with a lower level of innovativeness (IL) ($p \leq .05$) (Table 6). Regarding the customers' record information, IH participants considered customers' demographic information ($p \leq .05$) and hair/beauty trends ($p \leq .001$) to be more helpful for customer satisfaction than IL participants did. This might because IH participants already know about new products and devices (Shin & Lee, 2015) and preferred customers' record information rather than procedure or method information. Although, these are not top ranked functions when asked to all participants, these two could be included to the WHD for IH but not for IL. Also, IH participants preferred casual style ($p \leq .05$) and connection with a cell phone ($p \leq .001$) which are the top ranked design options when asked to all participants. The requirements that were considered to be more important for IH than IL participants did were size ($p \leq .01$), ease of use ($p \leq .05$), lightweight ($p \leq .05$), wearability ($p \leq .05$), information agility ($p \leq .001$), and sustainability ($p \leq .01$). There were differences on important requirements between IH and IL, but the mean was over 3.0 for both groups indicating those requirements are somewhat important.

(2) Trend Leadership

The trendy group (TH) considered the customer's visit record and hair designers in charge, hair styling history, and hair loss ($p \leq .05$ for each) to be more helpful for their work efficiency than the less trendy group (TL) did (Table 7). These were also top ranked when asked to all participants. They also considered the functions of analyzing hair damage ($p \leq .01$) and head shape ($p \leq .001$) to enhance customer satisfaction more than the TL group did. This might be because the TH group are very sensitive to rends (Kim, 1987; Shin & lee, 2015), so they already knows about the hair/beauty trends, new products and devices, and hair styling methods. Thus, they more preferred to know customers' hair condition and records than those information. The TL group less preferred alayzing the head shape type function than TH group with an average of below 3.0, thus this function could be excluded for the TL group. The TH group showed more diverse preferences in terms of item types such as a hat ($p \leq .05$) and shoes ($p \leq .001$) than the TL group. Thus, more diverse items besides bracelets/watches and necklaces like a hat or shoes could be developed for TH.

(3) Self-efficacy

The high self-efficacy group (SH) perceived that demographic information of customers would be helpful to improve their work efficiency more than the low self-efficacy group (SL) did ($p \leq .05$) (Table 7). The hair designers who were older, had higher education, and had more work experience showed higher self-efficacy (Kim, 2011), which might enable analyzing many information based on their experiences only from the customers' demographic background data. The SH group preferred a battery use ($p \leq .05$), and button activation ($p \leq .05$) more than the SL group did. Self-efficacy is a belief in one's ability to organize and execute one's actions to achieve a goal (Kim, 2011; Shin & Lee, 2015); the method of button activation might be considered more controllable than touch activation, and the battery could be a convenient way to control the situation by eliminating the need for charging time. Thus, the battery option could be added for the SH group and excluded the function of informing demographic data for the SL group.

6) Perceived Usefulness and Ease of Use, and Purchase Intention

Participants perceived the WHDs to be useful (M=3.84, SD=0.92), and easy to use (M=3.80, SD=0.94), and they wanted to purchase WHDs (M=3.83, SD=0.95). The Durbin-Watson values were close to 2.0, indicating that the residual is independent (Da et al., 2009), and variance inflation factor (VIF) values were all less than 10 indicating that there was no multicollinearity among

Table 6. Results of independent *t*-tests according to innovativeness

Variable		Innovativeness		*t*
		Low (n=18) Mean (SD)	High (n=183) Mean (SD)	
Work efficiency	Customer record-customers' visit record and hair designers in charge	2.89 (1.23)	3.80 (0.90)	–3.07*
Customer satisfaction	Customer record-demographic information	2.50 (1.34)	3.64 (0.94)	–3.54*
	Trend hair/beauty trend	3.11 (1.45)	3.73 (1.04)	–1.79***
Design	Preferred style-casual style	3.17 (1.29)	3.75 (0.97)	–1.87*
	Connected device-cell phone	2.89 (1.45)	3.75 (0.94)	–2.46***
Important factor	Small size	3.11 (1.37)	3.83 (0.89)	–2.19**
	Ease of use	3.33 (1.19)	4.00 (0.93)	–2.29*
	Lightweight	3.17 (1.25)	3.92 (0.89)	–2.51*
	Wearability	3.44 (1.04)	3.94 (0.79)	–1.96*
	Information agility	3.33 (1.28)	3.86 (0.89)	–1.71***
	Sustainability	3.33 (1.24)	3.94 (0.90)	–2.03**
Variable		Trend leadership		*t*
		Low (n=45) Mean (SD)	High (n=156) Mean (SD)	
Work efficiency	Customer record-customer' visit record and hair designers in charge	3.02 (1.10)	3.92 (0.83)	–5.10*
	Customer record-hair styling history	3.04 (1.15)	3.95 (0.83)	–4.93*
	Customer condition-hair loss	3.18 (1.03)	3.98 (0.81)	–4.82*
Customer satisfaction	Customer condition-hair damage	3.13 (1.16)	4.01 (0.86)	–4.72**
	Customer condition-customers' head shape	2.95 (1.17)	4.00 (0.80)	–5.60***
Item type	Hat	2.84 (0.80)	3.54 (1.16)	–3.99*
	Shoes	2.87 (0.89)	3.83 (0.89)	–4.31***
	Ease of use	3.33 (1.19)	4.00 (0.93)	–2.29*
	Lightweight	3.17 (1.25)	3.92 (0.89)	–2.51*
	Wearability	3.44 (1.04)	3.94 (0.79)	–1.96*
	Information agility	3.33 (1.28)	3.86 (0.89)	–1.71***
	Sustainability	3.33 (1.24)	3.94 (0.90)	–2.03**
Variable		Self-efficacy		*t*
		Low (n=34) Mean (SD)	High (n=167) Mean (SD)	
Customer satisfaction	Customer record-demographic background	2.83 (1.12)	3.77 (0.90)	–4.72*
	Power-batteries	2.84 (0.93)	3.54 (1.18)	–3.95*
	Actuation-button	3.16 (1.12)	3.83 (0.95)	–5.37*

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

factors (Midi et al., 2010). Among people with different consumer characteristics, the more they had a tendency for innovativeness, trend leadership, and self-efficacy, the more useful they perceived WHD to be (PU: .05≤

Table 7. Linear regression test results on PU, PEU, and PI

Independent variable	Dependent variable	B	Constant B	β	t	Adjusted R^2	Durbin-Watson	VIF
IN		0.15		0.15	2.05*			2.31
TL	PU	0.22	0.78	0.23	3.62***	0.54	2.15	1.80
SE		0.44		0.44	5.64***			2.60
IN		0.15		0.14	2.09*			2.31
TL	PEU	0.34	0.28	0.34	5.70***	0.62	2.09	1.80
SE		0.44		0.42	5.90***			2.60
IN		0.24		0.18	2.04*			2.31
TL	PI	0.25	0.41	0.20	2.56*	0.35	2.04	1.80
SE		0.42		0.31	3.34***			2.60
PEU	PI	0.63	0.61	0.46	6.00***	0.35	2.13	1.80
PU		0.22		0.17	2.19*			1.80

*$p\leq.05$, ***$p\leq.001$
IN: Innovativeness, TL: Trend leadership, SE: Self-efficacy, PU: Perceived usefulness, PEU: Perceived ease of use, PI: Purchase intention

$p\leq.001$, adjusted R^2=0.54), as well as easy to use (PEU: $.05\leq p\leq.001$, adjusted R^2=0.62), and they wanted to purchase those products (PI: $.05\leq p\leq.001$, adjusted R^2=0.35)(Table 7). These results were similar to the results of other studies that consumer characteristics affect the perceived usefulness and ease of use, and purchase intentions of wearables (Gao et al., 2015; Kim, 2009; Kim & Kim, 1997; Koo, 2017; Shin & Lee, 2015). However, Kim and Shin (2015) found no relationship between the level of trend leadership and the perceived usefulness of wearables. WHDs might be considered new trials in the market, which could have affected the results of a positive correlation between trend leadership and perceived usefulness. Among the three characteristics, self-efficacy positively influenced PU, PEU, and PI the most. This might mean functions like providing appropriate procedures and methods of hair styling of the WHDs are perceived as useful to increase their self-efficacy, and the more they were able to organize and execute their work (Kim, 2011; Shin & Lee, 2015), the more they perceived the product as easy to use. Also, people who perceived the WHD as more useful and easy to use, showed more intention to purchase them (PI: $.05\leq p\leq.001$, adjusted R^2=0.35).These results are consistent with the previous research (Koo, 2017; Shin & Lee, 2015). Thus, WHDs could be appealed and being purchased by hair designers in the U.S. market.

2. Phase 2: Design Guidelines and Design Prototyping

1) Design Guidelines for WHDs

Based on the survey and the literature review results, the design guidelines for WHDs were developed (Table 8). First, a total of eight functions, the most preferred and highly ranked out of 16 functions (half of the total functions, M≥3.70), were included: customer condition (hair loss, hair type, hair damage, head shape), customer record (hair styling history, customer's visit record and hair designers in charge), and procedure method (device use method, hair coloring/perm method). If there were differences in the user background and consumer characteristics, the additional functions were noted under the category of others. Second, the most and/or the second most preferred design options and their differences in user background and consumer characteristics were indicated in the design guidelines. Third, requirements for WHDs were ranked according to their perceived importance, and the design options were identified from the literature.

Table 8. Design guidelines of WHDs

Category		Details	User difference
Work efficiency	Customer condition	Hair loss	TH>TL
		Hair type	-
		Hair damage	-
	Customer record	Hair styling history	TH>TL
		Customers' visit record and hair designers in charge	IH>IL, TH>TL
	Procedure method	Device use method	-
		Hair coloring/perm method	-
	Others	Face shape, stress level	
Customer satisfaction	Customer condition	Hair damage	TH>TL
		Hair type	-
		Head shape type	
		Hair loss	-
	Customer record	Hair styling history	TH>TL
	Procedure method	Hair coloring/perm method	-
	Others	Demographic information	IH> IL, SH>SL
		Hair/beauty trend	IH>IL
		Head shape	TH>TL
Design	Item type	Bracelet/watch	-
		Necklace	-
	Color	Black	
	Obtrusiveness	Prominent designs	
		Unnoticeable designs	
	Style	Casual	IH> IL
	Power	USB-charged	-
		Battery	SH>SL
	Actuation	Touch	EU>IU
		Button	SH>SL
	Connected device	Cell phone	EU>IU, IH>IL
	Others	Futuristic style	
		Hat, shoes	TH>TL
Requirements	Safety	Safety tests (e.g., electrical · chemical · mechanical safety, specific absorption rate, biocompatible tests) (TÜV SÜD, n.d.)	-
	Soft material	Silicone material (Yi et al., 2016)	-
	Ease of use	User-friendly interface, simple design (Redding, n.d.)	IH>IL
	Ease of wear and removal	Avoid buckle (Graf et al., 2018), elastic silicone (Yi et al., 2016)	-
	Waterproof	Silicone sealed (Yi et al., 2016), waterproof case (Wortley et al., 2017)	

IH: Innovativeness high group, IL: Innovativeness low group, TH: Trend leadership high group, LH: Trend leadership low group, SH: Self-efficacy high group, SL: Self-efficacy low group, EU: Experienced user, IU: Inexperienced user

Table 8. Continued

Category		Details	User difference
Requirements	Wearability	Changeable design for diverse situations (Redding, n.d.)	IH>IL
	Sustainability	Modular design (Berzowska et al., 2010)	IH>IL
	Ease of care	Washable silicone (Montazerian et al., 2019), modular design (Berzowska et al., 2010)	
	Lightweight	Less than 391.22g (Scarano, 2019)	IH>IL
	Flexibility	Silicone (Yi et al., 2016)	
	Portability	Accessories (Song et al., 2019)	
	Information agility	High speed processor, WiFi and Bluetooth connection (Redding, n.d.)	IH>IL
	Information accuracy	AI/big data (Swan, 2013)	
	Small size	3×3cm-4×4cm (Peckham, 2019)	IH>IL
	Price competence	Less than 100,000won (Jacobs et al., 2019; Statista, 2019)	IH>IL

IH: Innovativeness high group, IL: Innovativeness low group, TH: Trend leadership high group, LH: Trend leadership low group, SH: Self-efficacy high group, SL: Self-efficacy low group, EU: Experienced user, IU: Inexperienced user

2) Design and Prototype of WHD

(1) Function

The WHD were developed based on the design guidelines (Fig. 1)–(Fig. 2). The design identified eight of the most preferred functions: analyzing customers' condition (hair loss, hair type, hair damage, and head shape), providing customers' records (hair styling history, customers' visit records, and hair designers in charge), and providing procedural methods (device use methods and hair coloring and perm methods). The WHD consisted of three modules: a pendant, a strap band, and a necklace chain. The pendant consists of a touch screen with three push buttons and a sensor/camera. To analyze customers' conditions, a camera/sensor is attached to the screen, and it can extend to easily reach to the customers. Three buttons control selection, up and down, reset, and power on and off options. The touch screen can automatically rotate to fit users' various positions and wearing methods. The screen has four icons for customers' condition (hair icon), records (people icon), and procedural methods (letter 'i' icon). The last icon concerns the system and screen settings. Using the camera/sensor enables analysis of scalp amount, moisture level, and hair thickness (Kang, 2013), as well as diagnosis of hair types and evaluation of hair damage based on hair thickness and cuticle photography (Lee & Cho, 2010). The attached camera/sensor is capable of taking photos, magnification, and analyzes the captured images to identify customer condition and the data appears on the screen. Hair designers can search customers' record through the screen by touching or pressing buttons. Videos and photos with texts about procedure methods such as how to dye and perm can be searched on the Web through the screen. Frequent cell phone use at work can give others false impressions and distract users from work. Thus, phones should not be used while working except for important calls (McKay, 2019). The WHD can connect to a cell phone only when necessary. The wearables specially developed for hair designers' work can be helpful to provide positive impressions to customers while enhancing work efficiency and customer satisfaction.

(2) Design

The WHD was developed in the form of a pendent that can be worn as a bracelet/watch or a necklace by inserting a band strap or a necklace chain to be comfortable in varied situations and to match with diverse styles. The band strap is made of elastic silicone with four holes to adjust the size, and the necklace chain can also change size with small clips. The bracelet/watch and necklace types were hair designers' most wanted type of wearables. These accessory types can also enhance

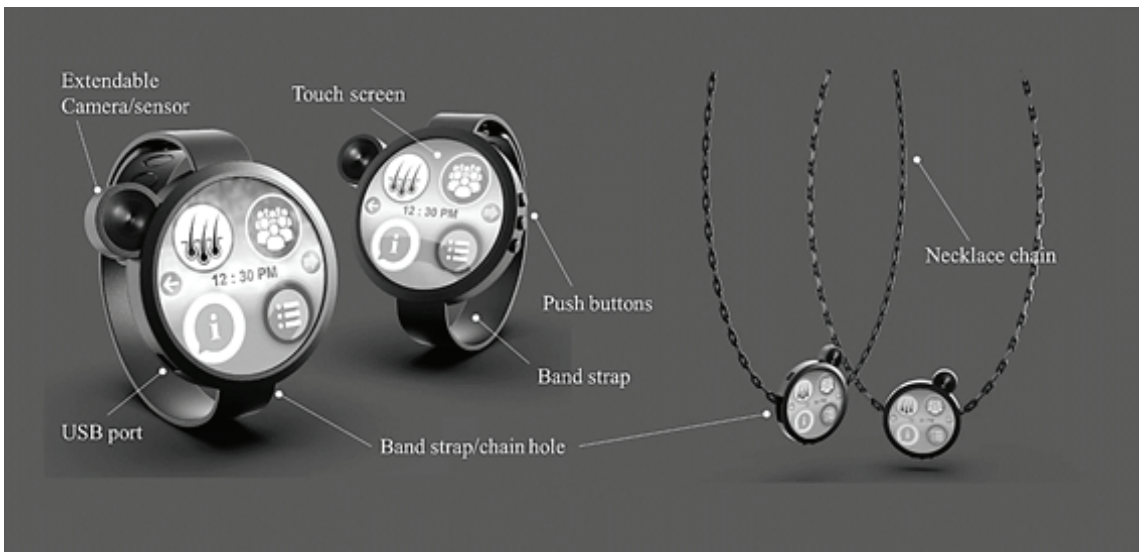

Fig. 1. 3D virtual design for hair designers (Left: bracelet/watch type with a band strap, Right: necklace type with a chain).

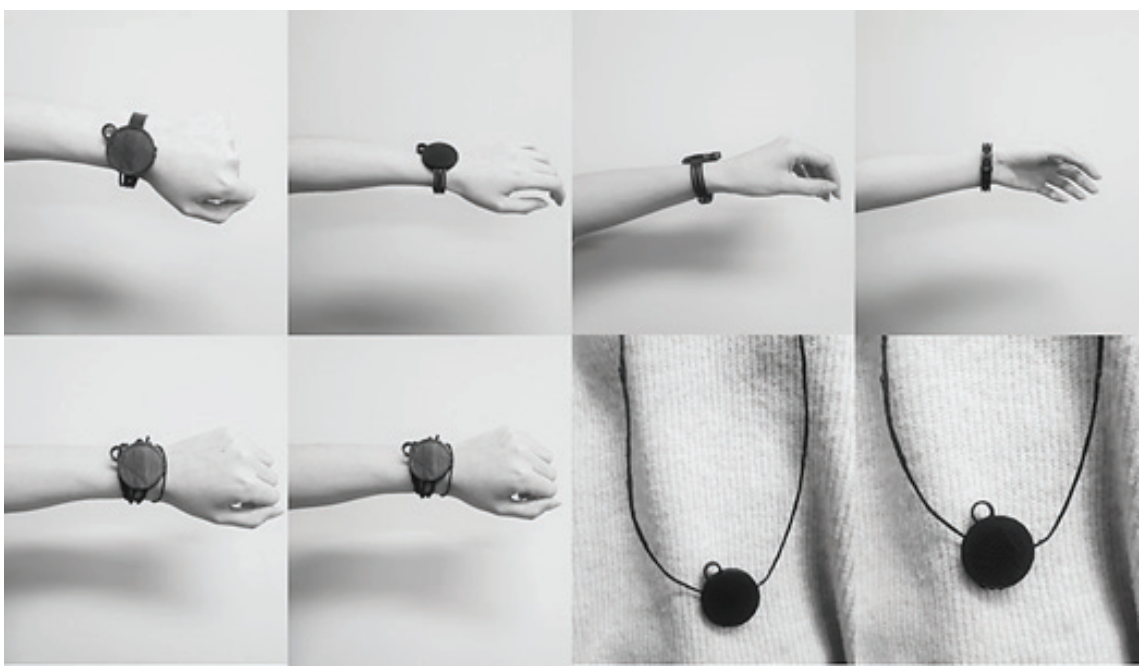

Fig. 2. 3D printed prototypes (First row and second row-left: bracelet/watch type, second row-right: necklace type with a different strap).

portability (Song et al., 2019) for hair designers who frequently move while working. The color is black in a casual style to be match well with various styles, but the detail of the protruded camera/sensor differentiates

it from other wearables by intuitively delivering the functions and deriving a customer's curiosity. It can be charged by USB and a battery can possibly be inserted. The WHD can also be activated by touch and also with buttons on the sides so it can be operated when the user is wearing regular gloves.

(3) Requirement

Safety. Electrical safety tests on moisture, chemicals and heat, chemical hazard tests, mechanical tests such as burst strength and friction, and electromagnetic wave absorption rates would be conducted to verify the device's safety. The WHD is covered with a waterproof case and another layer of silicone for insulating, waterproofing, and preventing damage from chemicals. Soft material. Soft silicone material is used, and offers wearability, ease of care, and flexibility. Ease of use. The protruded camera/sensor and the watch screen style, as well as dual operation methods of touching and pressing buttons, enable the recognition of immediate use method. Ease of wear and removal. The elastic silicone band and necklace chain make it easy and quick to remove and clean, even if it gets wet with water or chemicals. The band strap and the chain sizes can be adjusted via four holes on the band strap and via the chain's clips. Waterproof. The waterproof case is applied (Wortley et al., 2017), and this can protect the USB charging part and other gaps or holes. Wearability. The interchangeable different colors of band straps and chains enable the device to be worn comfortably in various situations. Sustainability. The modular design is applied and allows for partial repair and replacement and easy recycling. Ease of care. The device is made of washable silicone, and a modular design is applied to make it easy to repair. Lightweight. The weight is less than 30g, intended to be an ultra-light wearable device. Flexibility. It is made of flexible silicone to enable it be worn comfortably in various situations. Portability. It is made as an accessory type to be easy to carry. Information agility. Fast processors were used, and it can be connected with WiFi and Bluetooth to send or receive data, even if one connection system is not working. Information accuracy. In conjunction with self-learning AI and big data technology, it provides accurate diagnostics and information. Small size. The pendant is 4cm in diameter and 0.6cm in height, and the band is slim at 1.2cm in width. Price competency. The price is less than about $75.

3. Phase 3: Design Evaluation and Modification

1) Sample Characteristics

A total number of usable responses were 229 (99.57%) out of 230, and there were more men (65.07%) than women (34.93%). There were many 20s (72.49%) and 30s (20.96%) and about 65% were White/Caucasian and mostly lived in South (32.06%) and West (13.97%). Most of them had experiences of using wearables (Table 9). These participant backgrounds were similar to the 1st survey, characteristicsof population and hair designers of the U.S., or consumers of wearables.

2) Satisfaction, Perception, and Intention

An evaluation was conducted through an online survey to investigate potential consumers' satisfaction on the developed design. Overall, respondents were satisfied with the function, design, and requirements of the WHD, perceived the WHD as useful and easy to use, and also had intentions to purchase the WHD. First, more than 75% strongly agreed or agreed that the developed WHD was useful (75.55%) and easy to use (75.11%) and that they would want to purchase it (76.42%). Regarding overall satisfaction on the WHD, about 70% of participants were satisfied with the function (68.56%), design (65.94%) and overall requirements (72.05%).

Second, participants showed overall satisfaction with all functions, designs, and requirements of the WHD ($3.72 \leq M \leq 3.94$), the most satisfying aspect being the requirements (M=3.91, SD=0.86) (Table 10). Among the options for each requirement, using a waterproof case to make the device waterproof yielded the most satisfaction (M=3.94, SD=0.85) (Table 10). Differently from other types of wearables, waterproof functionality has been considered important for WHDs, which might be due to hair designers being exposed to water and chemicals (Choi & Joung, 2011; H. S. Kim,

Table 9. User background

Variable	Category	Frequency (Persons)	Percentage (%)
Gender	Men	149	65.07
	Women	80	34.93
Age	-20s	166	72.49
	30s	48	20.96
	40s	12	5.24
	50s-	3	1.31
Ethnicity	American Indian or Alaskan Native	9	3.93
	Asian or Pacific Islander	31	13.54
	Black or African American	18	7.86
	Hispanic or Latino	20	8.73
	White/Caucasian	148	64.63
	Prefer not to answer	3	1.31
Residence area	West	32	13.97
	Midwest	17	7.42
	South	78	32.06
	Northeast	18	7.86
Wearable technology use experience	Yes	210	91.70
	No	19	8.30

2010). It can be a good sign that the developed design satisfied one of the most important requirements. The next satisfied requirement was the price competency, with the price being about $75 (*M*=3.94, SD=0.89), followed by the use of silicone for flexibility (*M*=3.93, SD=0.87). The average price of wearables that U.S. consumers purchase is $80 (Statista, 2019), and silicone's advantage of flexibility can provide ease of care (Montazerian et al., 2019), ease of wear and removal, softness, and waterproof functionality (Yi et al., 2016).

Third, the most satisfying function was analyzing customers' conditions (hair loss, hair type, hair damage, and head shape type) (*M*=3.87, SD=0.92), which was the top preference for both work efficiency and customer satisfaction in the first survey's results. The results confirmed which function is the key aspect that the WHD should have and focus on.

Fourth, regarding the design, people were also satisfied with the cell phone connectivity (*M*=3.91, SD=0.86), as well as by the casual style (*M*=3.88, SD=0.88) for the design. Ability to connect to a cell phone was more preferred by experienced than by inexperienced users in the first survey, which may be because the inexperienced users did not consider the importance of connecting to a cell phone; however, once this feature is included in the design, people were satisfied with it. Participants considered the design to represent a casual style (*M*=3.87, SD=0.88,) which was the most preferred style in the first survey, and the respondents were satisfied with this detail. Participants also liked both the bracelet/watch type (*M*=3.87, SD=0.95) and the necklace type (*M*=3.87, SD=0.97). Thus, the WHD could be developed into either of these two types. More people considered the design prominent (*M*=3.83, SD=0.90) than unnoticeable (*M*=3.61, SD=1.05), and the least satisfying aspect was the obtrusiveness of the design (*M*=3.72, SD=0.93).

Next, when participants were asked about the colors they would prefer if other options besides black were available, the most preferred color was white (*N*=82,

Table 10. Potential customer's satisfaction on the WHD

Category		Mean (SD)	Rank
Overall	Overall requirements	3.91 (0.86)	5
	Overall design	3.85 (0.89)	22
	Overall function	3.78 (0.92)	33
	Perceived usefulness	3.87 (0.91)	13
	Perceived ease of use	3.86 (0.94)	16
	Purchase intention	3.97 (0.88)	1
Function	Analyzing customer's condition (hair loss, hair type, hair damage, and head shape type)	3.87 (0.97)	14
	Providing procedure method information (device use method, hair coloring/perm method)	3.85 (0.85)	23
	Providing customers' information (styling history, visit record and designers in charge)	3.77 (0.92)	34
Design	Connected device (cell phone)	3.91 (0.86)	6
	Style (casual)	3.88 (0.90)	10
	Color (black)	3.86 (0.87)	17
	Item type (bracelet/watch and necklace)	3.84 (0.96)	25
	Activation method (touch)	3.81 (0.89)	30
	Charging method (USB, batteries)	3.76 (0.91)	35
	Obtrusiveness	3.72 (0.93)	36
Design options to meet requirements	Use waterproof case for the waterproof	3.94 (0.85)	2
	The price is about $75 for the price competence	3.94 (0.89)	3
	Use silicone for the flexibility	3.93 (0.87)	4
	Make it as an accessory type for the portability	3.91 0.87)	7
	Conduct safety tests (e.g., electrical · chemical · mechanical safety, specific absorption rate, biocompatible tests)	3.90 (0.94)	8
	Make it to be less than 30g for the lightweight	3.89 (0.89)	9
	Make interface to be user-friendly for the ease of use	3.88 (0.88)	11
	Apply modular design for the ease of care	3.88 (0.89)	12
	Use high speed processors for the information agility	3.87 (0.91)	15
	Use washable silicone for the ease of care	3.86 (0.92)	18
	Design to be simple for the ease of use	3.86 (0.89)	19
	Seal with silicone of the product for the waterproof.	3.86 (0.92)	20
	Use both WiFi and Bluetooth for the information agility	3.86 (0.94)	21
	use AI/big data technology for the information accuracy	3.85 (0.92)	24
	Use clips and press buttons for the ease of wearing and taking off	3.84 (0.88)	26
	Use elastic silicone for the ease of wearing and taking off	3.83 (0.92)	27
	Make it as 4cm (Width) × 4cm (Wide) × 0.6cm (Hight) for the small size	3.83 (0.84)	28
	Apply modular design for the sustainability	3.82 (0.87)	29
	Use silicone material for the softness	3.79 (0.93)	31
	Apply changeable design for diverse situations (e.g., either as a necklace/watch or necklace type or changing colors of bands/chains)	3.79 (0.89)	32

35.81%), followed by pink (*N*=43, 18.78%), purple (*N*=32, 13.97%), light blue (*N*=24, 10.48%), red (*N*=17, 7.42%), and green (*N*=8, 3.49%); beige, yellow, and brown each trailed by the same amount (*N*=6, 2.62%), orange (*N*=3, 1.31%) was even less preferred, and other (*N*=2, 0.87%) colors named were silver and rose-gold. Thus, the device itself or the interchangeable components could be made with different colors such as the preferred ones of white, pink, purple, light blue, and red.

Last, people were asked through open-ended questions to suggest what might improve the design. The suggestions included more functions (*N*=15) for analyzing different customer conditions (16.67%), such as their hair length and grey hair percentages, ability to track hair designers' conditions (e.g., burned calories, activity, hair styling timing) (16.67%), hair growth improvement functionality (11.11%) and providing information to hair designers (best ingredients or vitamins for specific hair types) (11.11%). Regarding the design (*N*=21), respondents suggested more color options (57.14%), such as making the WHD in rose-gold, gun-metal, white, and other bright colors, with interchangeable band straps or chains. Even if the basic color is black, providing different color options for wearables has been recommended (Redding, n.d.). Thus, the design of the wearable could be modified to accommodate band straps and chains of different colors. Other suggestions were to make ring types as well (19.05%) and to change the size (9.52%), either by decreasing the overall size or by increasing the screen size. Related to the options to meet the requirements (*N*=8), several participants suggested different charging methods (25.00%) such as wireless charging pads.

3) User Differences on Satisfaction, Perception, and Intention

(1) User Background

There were significant differences on satisfaction within groups between experienced and inexperienced wearable users, but not between demographic backgrounds (Table 11). The results indicated that both groups were satisfied with the WHD, and the experienced user group showed more satisfaction than the inexperienced group. Participants who had prior use experiences were more satisfied with the overall functions ($p \leq .01$) and perceived higher usefulness ($p \leq .001$) for the WHD than those who lacked use experience. Thus, the design could be further developed into different versions for experienced and inexperienced users, and marketing approaches could also be different.

(2) Consumer Characteristics

The higher consumers were placed in innovativeness, trend leadership, and self-efficacy, the more likely they were to perceive the WHD as useful and easy to use and to show higher intention to purchase. The results are consistent with Kim and Kim's (1997) and Shin and Lee's (2015) studies, with the exception (Shin & Lee, 2015) that this research found that trend leadership also affected perceived usefulness. This finding might indicate that the WHD could help groups in TH look more trendy with functions useful for them. The WHD could accordingly target these IH, TH, and SH hair designers. Although all groups of IH, TH, and SH hair designers showed mean averages of close to 4.0, TL designers, who had less self-efficacy, perceived the WHD to be less useful and easy to use, with an average of below 3.0. This confirms the results of previous studies reviewed in the literature (Gao et al., 2015; Shin & Lee, 2015), and it is necessary to make the WHD useful and easy to use for the SL group. This could be achieved by reinforcing the function informing customers about procedures and methods of hair styling to increase the ease of use for SL designers, who have less ability to organize and execute their works (Kim, 2011; Shin & Lee, 2015).

4) Modifications and Suggestions for WHD

Based on the results, the design guidelines were modified. First, the design could be diversified considering consumer characteristics—differences that were included in the design guidelines from the first survey's results. These differences were also confirmed in the second survey's results. Second, the design could be diversified through different colors, such as white, pink, purple, light blue, or red, and interchangeable band straps and necklace chains in those preferred colors could

Table 11. Results of independent *t*-tests according to consumer characteristics

Variable	Prior use experience		*t*
	EU (n=210) Mean (SD)	IU (n=19) Mean (SD)	
Overall function	3.81 (0.88)	3.47 (1.31)	1.10**
PU	3.90 (0.62)	3.47 (1.15)	1.60***
Variable	Innovativeness		*t*
	Low (n=193) Mean (SD)	High (n=36) Mean (SD)	
Overall requirements	3.25 (1.05)	4.04 (0.76)	–4.28**
PU	3.24 (0.98)	3.98 (0.55)	–4.43***
PEU	3.04 (0.81)	4.01 (0.58)	–6.91**
PI	3.22 (1.20)	4.12 (0.72)	–4.35***
Variable	Trend leadership		*t*
	Low (n=36) Mean (SD)	High (n=193) Mean (SD)	
Overall function	3.25 (1.11)	3.88 (0.85)	–3.25**
Overall requirements	3.39 (1.05)	4.01 (0.78)	–3.38***
PU	3.05 (0.95)	4.02 (0.50)	–5.99***
PEU	3.13 (0.93)	3.99 (0.57)	–5.40***
PI	3.19 (1.14)	4.12 (0.73)	–4.71***
Variable	Self-efficacy		*t*
	Low (n=32) Mean (SD)	High (n=197) Mean (SD)	
Overall function	3.22 (1.10)	3.87 (0.86)	–3.21*
PU	2.97 (0.85)	4.01 (0.53)	–6.72***
PEU	2.81 (0.75)	4.03 (0.54)	–8.77*
PI	3.09 (1.17)	4.12 (0.73)	–4.81***

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

be prepared. Third, the item type as bracelet/watch and necklace could be could diversified to be hats or shoes for trendy hair designers or even rings. The WHD could be designed with the ability to change into these diverse items, or it could be attached to them. Fourth, the charging method could make use of a wireless charging pad, which might make the WHD easier to use and more appealing to hair designers with low self-efficacy levels. Next, it is necessary for appeal and utility to reinforce functions for inexperienced users and hair designers with low self-efficacy. For example, possible additional functions that were suggested included analyzing more customer conditions (e.g., hair length and grey hair percentages), tracking hair designers' conditions (e.g., burned calories, activity, and hair styling timing), improving hair growth, and providing information to hair designers (best ingredients or vitamins for specific hair).

V. Conclusion

As competition of the hair market becomes more severe, improving working efficiency and customer satisfaction through personalized services and technolo-

gies is becoming more important. Wearables can facilitate these goals by analyzing customers' and hair designers' conditions and informing customers about procedures and methods. This research first investigated preferred functions, designs, and requirements of WHDs in the U.S., which is the largest hair market and second-largest wearable market worldwide, as well as the perceived usefulness, ease of use, and purchase intentions of hair designers related to WHDs. Second, with the results, design guidelines and prototypes of WHDs were developed using Rhino and 3D printing technology. Third, satisfaction, perceptions, and purchase intentions of potential U.S. hair designer customers were evaluated regarding the WHDs, and the results produced suggestions for modifications. The responses are expected to be helpful for technology designers in developing WHDs, for hair designers in improving work efficiency and customer satisfaction.

The major results are as follows: first, the preferred functions, designs, and requirements were identified. The eight major important functions are customer conditions (hair loss, hair type, hair damage, and head shape), customer records (hair styling history, customers' visit records and hair designers in charge), and procedural methods (device use method, hair coloring/perm method).

Second, the suggested design features based on the results are as follows: a bracelet/watch or necklace type in black color and a casual style, a USB or wireless charging method with batteries, activation by touch and buttons, and cell phone connectivity. In addition, the pendant or the band straps and necklace chains could be interchangeable, with different colors of white, pink, purple, light blue, and red. The important factors and detailed options to meet each requirement for WHDs were the following: safety, soft material, ease of use, ease of wear and removal, waterproofness, wearability, sustainability, ease of care, light weight, flexibility, portability, information agility, information accuracy, small size, and price competence.

Third, more than 75% of the people surveyed agreed that the developed WHD would be useful and easy to use and that they intended to purchase it, and more than 70% of people were satisfied with the overall function, design, and requirements of the developed WHD. On the details of the WHD, respondents showed satisfactions with mean averages all above 3.79 out of 5. Thus, the WHD has potential to appeal to hair designers in the U.S. with high satisfaction rates, positive perceptions, and strong intentions to purchase.

Fourth, there were differences on preferences, perceptions, and intentions between people of different consumer characteristics (innovativeness, trend leadership, and self-efficacy). It could be difficult for companies to make diverse versions of products when starting out in a business, especially if the product and the market is pretty new. Thus, a WHD was developed to satisfy the preferences of most of the participants, and the results showed that many were satisfied with the design.

However, if the market is growing and the company can afford greater manufacturing costs and risks, developing multiple designs for different user backgrounds and consumer characteristics is recommended. For highly innovative users, companies could reinforce functions of tracking customers' visit records and hair designers in charge or of providing demographic information and hair/beauty trends, as well as stress design features of casual style, cell phone connectivity, and superior ease of use, wearability, sustainability, light weight, information agility, small size, or price competency. For trendy users, companies could reinforce the functions of analyzing hair loss, hair damage and hair styling history, and the item type could be extended to other types, such as hats or shoes. For high self-efficacy users, companies could focus on functions of demographic information, battery use, and button activation.

Fifth, potential users who had prior use experiences with wearables and were innovative, trendy, and highly self-efficacious perceived the WHD to be more useful and easy to use. They also reported higher purchase intentions than inexperienced users or those with lower levels of those consumer characteristics. Thus, the WHD could first be targeted at hair designers who are innovative, trendy, highly self-efficacious, and experienced with wearables, and then it could be diffused to others.

This study only investigated U.S. hair designers, so conducting research in diverse countries is recommended to understand if there are any differences and to develop different design guidelines fitting to target markets. Second, uneven groups were compared, so it is recommended to test with even subgroups in future study and with different user characteristics besides the backgrounds and consumer characteristics sought out in this study. Third, qualitative research would be helpful in addition to quantitative data. Thus, future research could be conducted through interviews and user tests with working prototypes that were developed into various designs considering the differences among user groups. Where there used to be no such research, this study has provided insight on how to design and evaluate WHDs. Further, companies and designers are expected to be able to develop marketing and retail strategies considering the targeting consumers.

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