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Consumer resistance to innovation: smart clothing

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Abstract

Smart clothing is believed to have an enormous growth potential, but at present, it is not so attractive in terms of sales. This study identified various obstacles affecting consumers' interest in smart clothing. Interviews were conducted with consumers who are resistant to innovation, those who would continue to use their phones and wearable devices of which safety and functionality have already been proven but reject smart clothing. Availability, which refers to the extent to which consumers can use a product or service, is also a significant factor influencing the innovation resistance of smart clothing. It was also observed that consumers reject smart clothing as an act of resisting innovation; many stated that they would not buy smart clothing unless a trustable brand produces it with appropriate functions and lower prices. Some people said that they refuse to purchase smart clothing due to aesthetic dissatisfaction despite the improved quality and performance. These results indicate that manufacturers should consider what functionality or technology would be appropriate to incorporate in clothing while ensuring fashionable styles and availability in many sizes.

Keywords: Grounded theory, Resistance to innovation, Smart clothing, Wearable device

Introduction

Recently, the Internet of Things, the incorporation of sensors and communication devices in objects which collect and share information and interact with each other as if they are living organisms, has received a great deal of attention. With the arrival of the era of the Internet of Things, wearable devices that can be attached to our body and collect data are getting more and more critical. These days, there are many attempts to transform cloth to digital technology by connecting fashion and IoT, using newly developed material technologies such as conducting fibers and textile sensors. Gartner, a US information technology research and advisory firm, forecasts that shipments of just four million smart apparel products in 2017 will steadily grow to twenty million in 2022 (Gartner 2018).

In the early stages of research on smart clothing, basic research such as explorative research on design development, development of usability an evaluation scale, research trends, and market trends related to smart clothing have been conducted. Since then, smart clothing has been regarded as an innovative product, and research focusing on

the acceptance and spread of smart clothing has been conducted, such as the evaluation of smart clothing according to the innovativeness of consumers, the study of purchase intention, and the survey of acceptance intention using the Technology Acceptance Model (TAM). However, the theory of innovation diffusion and technology acceptance model has a limitation in that it focuses only on the technical characteristics and does not consider the psychological factors of resistance that are involved in the adoption of innovation by the consumer.

Consumers don't always welcome innovation. Innovation involves change, and many consumers are reluctant to change. Indeed, consumer's resistance to innovation is one of the key reasons why many innovations fail to spread. Many consumers tend to consider wearable devices as unnecessary and expensive (Buehrer 2013; Stanley 2014).

This study interviewed consumers who are resistant to buy innovative products such as smart clothing. Although the structured questionnaire has the advantage of quantifying, comparing, and presenting the perceptions and attitudes towards smart clothing, there are still limitations in explaining consumers' understanding of and reaction on smart clothing. This study is a qualitative study that investigates consumers' perspectives on smart clothing through their explanations and expressions. The collected data were analyzed using the grounded theory method that can be useful when research on a specific group or special phenomenon is insufficient.

Literature review

Definition and types of smart clothing

Smart clothing is a type of wearable devices. A wearable device may be defined as an electronic device having a sensor that can receive data on a wearer or its surroundings. These devices operate wirelessly or through other devices, such as smartphones or tablets, and wearable devices are broken down by use or form. Son et al. (2014) classified wearable devices according to how they are worn, such as accessories that can be worn on the head, wrist, or arm, textiles which can be worn as clothing or a backpack, and bodily attachments such as patches.

Meanwhile, Kim (2013) classified wearable devices according to purpose in the following broad categories: fitness, healthcare, infotainment (information + entertainment), which provides entertainment as well as information, military/industry, and family care (Kim 2014). Wearable devices with a family care function can transmit the location of children to parents' smartphones or make it possible to check the health condition and sleeping patterns of family members in real-time. In France, several smart products are already available on the market so that people can check the health condition of their elderly parents at any time (Kim 2014).

According to Park (2014), smart clothing is a new concept of clothing with a high added value. It refers to high-functionality, high-performance, and multi-functionality clothing with unique emotional and functional nature of fashion clothing through the convergence of clothing, information, and communication technology (ICT). Kwon (2017) defined smart clothing as a textile product in which IT technology and cutting-edge textile are fused and applied the sensing and response system to the surrounding environment or human body stimulus. Other terms, such as wearable computers, digital clothing, and intelligent clothing are interchangeably used. According to preceding

studies, smart clothing has the relative advantages of visibility, complexity, health utility, manageability, stability, comfort, aesthetic appearance, and playfulness. (Jeong and Roh 2016; Noh and Park 2011; Park and Noh 2012).

Innovation and innovation resistance

Innovation originated from the Latin word *Novus*, which means "new." Biemans (1992) defined innovation as a newly developed idea or practice or object, which is perceived as new by the initial acceptor in an appropriate environment. In other words, what is essential for innovation is not how new an idea is objectively, but how new it is perceived to be by a person. In the meantime, most of the studies on innovation have been conducted based on the assumption that "innovation is good for consumers" and focused on developing communication and other strategies to facilitate the diffusion of innovation by identifying the characteristics of consumers with a high propensity to adopt innovation relatively earlier than others (i.e., early adopters). Studies on the adoption and diffusion of innovation, such as Rogers's diffusion of innovation theory (1983) and Davis's technology acceptance model (1989), have contributed enormously to explain the adoption and diffusion of diverse technological innovation (Yu and Tao 2009). Still, they have not demonstrated the heavy emotional burden felt by consumers regarding today's innovative products, which are based on radical and discontinuous technologies and require a high level of learning and adjustment for active use. The diffusion of innovation theory also has its limitations in that it merely focuses on the technical characteristics of innovation and only addresses influence factors of the adoption of innovation (Moldovan and Goldenberg 2004). Therefore, it cannot sufficiently explain why the diffusion of innovation is currently so slow (Ram 1987; Sheth 1981). The technology acceptance model has also attracted criticism for its failure to specify external factors that can affect the adoption process of technology (Jang and Park 2010). In other words, both the diffusion of innovation theory and the technology acceptance model are limited. They focus only on technical characteristics, paying attention to the acceptance and diffusion of innovation while failing to consider the psychological factor of resistance entailed in the process members of a society accepting innovation (Kleijnen et al. 2009; Sheth 1981). However, faced with a new change, some consumers will much welcome it while others will resist and object to it. As Ram (1987) pointed out, if the level of resistance is too high, the innovation will be discarded because it was not accepted. That is, innovation resistance must be overcome before innovation can be accepted and diffused; therefore, to fully understand how innovative products are adopted, it is necessary to pay attention to the innovation resistance manifested by consumers when they accept an innovation.

Innovation resistance, which means rejection or resistance to innovation, can be defined as the negative response to innovation and innovation-related changes that occurs in the process of accepting innovation as a factor influencing innovation resistance. Ellen et al. (1991) identified cognitive response and performance satisfaction as factors that deter people from accepting technology-based products and cause resistance among consumers. Sheth (1981) cited existing bias and perceived risk as two of the most useful psychological concepts to understand individuals' resistance to psychological innovation and pointed out that an individual's attitude toward innovation must be considered when assessing whether he or she will accept or reject innovation. Aside from

this, there are other reasons for resistance to innovation, such as conflict with previous behaviors and perceived risk related to innovation. Ram (1987) overcame the limitations of the prior diffusion of innovation theory and proposed the innovation resistance model by integrating many types of resistance factors such as innovation characteristics, customer characteristics, diffusion mechanism, and environmental factors.

Given the need to better understand the interpretation of consumer resistance through the innovation resistance perspective, the primary questions that these research addresses are as follows. Why do consumers not purchase smart clothing in consumption situations? What factors prevent the spread of smart clothing? Notably, it was difficult to obtain enough answers to the acceptance and resistance of smart clothing because the results of the study differed among previous studies that revealed the factors that influence the attitude and purchase intention of smart clothing. According to Noh and Park (2011), ease of use and perceived usefulness influenced consumers' attitudes toward smart clothing, but Chae et al. (2009) found that only perceived usefulness influenced attitude. Meanwhile, in a study revealing the influence of consumer characteristics on attitudes toward smart clothing, Chae (2010) stated that technological innovation had a positive effect on both perceived usability and perceived usefulness. However, Jeong and Roh (2016) and Park and Noh (2012) found that technological innovation did not affect perceived utility. On the other hand, Noh et al. (2016) proved that factors affecting purchase intentions for smart clothing might vary by country.

The development of smart clothing began in the late 1990s when the ICT industry began to develop at a rapid pace. However, the concept of smart clothing was not fully recognized by consumers until recently, and many consumers still confuse functional clothing with smart clothing. Besides, smart clothing is still developing, and there are not many ready-made products on the market. For these reasons, consumers responded to attitudes and acceptance intentions for smart clothing, not based on their experience, but based on what they know or what is described in a given scenario. However, to see smart clothing from the perspective of the participants and to understand them in the language of consumers, qualitative research through in-depth interviews with consumers is needed. It is also essential to make smart clothing that consumers find desirable, not only in terms of technology. In this study, we defined smart clothing as clothing that can interact with the wearer and sense and respond to the surrounding environment, situation, and human body stimulus. We studied a group of consumers who are rejecting smart clothing, to understand why the rate of diffusion of smart clothing is low among consumers, which is contrary to expectations and to identify the various obstacles affecting the process of accepting smart clothing.

Method

Research design

This study is an empirical study of consumers' attitudes toward smart clothing. To supplement the limitations of the study at the initial stage and to consider clothing behavior affected by diverse variables (Lee 1992), the grounded theory method was used. The grounding theory method is one of the qualitative research methods which began in an attempt to supplement the idealism that human understanding should focus on the human mind and the realism that only obvious things can be subject to research

as science. Because only those beings which objectively exist in the external world and which can be observed can be the subject of research as science (Blumer 1969; Mead 1934). According to the Sohn (2013), the grounded theory approach aims to develop a middle-stage theory that is easy to implement and explores a diverse array of the problems affecting human beings. Because it focuses on identifying and conceptualizing the essence of the phenomenon itself and creating a theory, it can be useful in researching a specific group or social phenomenon which has not been sufficiently studied so far, or if there is no theory (Glaser and Strauss 1967).

As this study was classified as a human subjects research project pursuant to the Bioethics and Safety Act, it was subjected to deliberation by the Institutional Review Board (IRB) on March 27, 2017. The research was conducted according to the standard procedures after the research plan was approved (IRB Approval No.: HYI 17-028-2).

Sample selection process

Currently, smart clothing with many different shapes and functions is being developed in accordance with the purpose and development subject. However, smart clothing is still in its early stages of development, and there are few products on the market. Many consumers are still confused between functional clothing and smart clothing. Therefore, it is imperative to find out the perceptions and attitudes of smart clothing among various consumers those who have had experience in purchasing smart clothing or responded that they know about smart clothing. Hence, research participants of this study consisted of those who are familiar with smart clothing and who have used smart clothing. The snowball sampling method and the convenient sampling method were used to select the study participants. Before the in-depth interview, all subjects participated in a preliminary interview to determine whether they knew about smart clothing, whether they had experience purchasing smart clothing, and they were willing to participate in the research on smart clothing. The in-depth interview participants were selected by considering the respondents' knowledge and interest in smart clothing, purchase experience, and purchase intention, based on the contents of the interviews. An in-depth interview was conducted with 30 consumers with various demographic characteristics that could contribute to the development of the theory and could identify various factors that affect the attitude and resistance to smart clothing. One researcher conducted each interview that lasted between 40 and 60 min in a location where the respondent felt comfortable unless compelled. If face-to-face interviews were not possible, they were interviewed by phone and e-mail. In this process, the researcher explained the study purpose, study participants' rights, and matters regarding the contents of the interview. The interview was recorded with the consent of the respondents. A third person later transcribed the voice recordings of the interviews.

Instrument development

Interview questions were organized by referring to the results of previous studies and preliminary interviews. The interview questions consisted of three sections. In the first section, multi-questions were developed to collect perceptions and attitudes about smart clothing. The second section consisted of asking questions about the consumer's fashion and technological innovativeness. The purchase and word of mouth intentions for smart

clothing were collected in the final section. The basic categories of interview questions are: ① What do you think smart clothing is? ② Have you ever bought a wearable device or smart clothing? ③ What factors do you consider important when purchasing smart clothing? ④ Are you interested in fashion/new products or technology? ⑤ Do you have any favorite brand? If your favorite brand launches smart clothing, are you willing to buy it? ⑥ Do you think people around you will buy smart clothing? ⑦ Are you willing to buy smart clothing in the future? If so (or not), why? ⑧ Are you willing to buy smart apparel with improved performance or design? ⑨ Are you willing to buy smart apparel that is affordable? These are only basic categories of questions, and different questions have been added for each participant.

Verification of the validity and reliability of the research

This study tried to ensure the internal validity and reliability of the collected data by having interviews based on the interview questionnaire, which was previously prepared and approved by the IRB. This study took note similar patterns that repeatedly occurred throughout the interviews rather than focusing on the opinions of only some of the interviewees to ensure the validity of the study results. To this end, researchers preserved the ideas put forward throughout the analysis process by storing the research design and analysis process like a documentary in various forms, including memos, drawings, voice recordings and summaries (Glaser and Strauss 1967; Lincoln and Guba 1985). Next, in conducting qualitative research, in which the subjective factors of the researcher were highly influential, efforts were made to secure the neutrality of the research process and the reliability of the research results by minimizing the intervention of subjectivity. Dey (1993) said that the larger the data, the more selective it is, and the more complex the data, the more likely to focus on the imagination, intuition, and instinct, which is likely to lead to a biased and partial result. To produce unbiased or unexaggerated findings, the researchers regularly assessed the consistency of the research process and shared the findings of the research process (Lincoln and Guba 1985; Wallendorf and Belk 1989). Also, in the process of comparing the concepts presented in the data, the researchers tried not to overemphasize the cases that could support the hypothesis or not to intentionally ignore the negative cases. Besides, specific numerical information about nodes was presented as the basis of analysis using NVivo. Furthermore, to increase the objectivity of the results, the researchers analyzed the data analysis process and the results with the expert group. They tried to maintain an open view of a concept from various perspectives and a skeptical attitude toward the analysis results.

Data collection and analysis

There are two ways to analyze qualitative data: a traditional method and a method using the software. Traditional methods encompass individual and diverse methods of qualitative data analysis, and do not use proprietary software developed for qualitative data analysis. Kelle (1995) believes that the stable coding function provided by the software enables the tracking of all information on a subject in the collected data. Thus, using software can increase the credibility of the findings in terms of organization and transparency. This study analyzes data using NVivo 11.0 software to ensure the ease and reliability of data processing. For the analysis of the data, the recorded

interviews were first transcribed and saved as text files. Each interview was created as a separate file so that the document includes only the interviews with specific interviewees. Next, the coding process of creating a node with words or phrases that can summarize the contents by designating meaningful words, phrases, and sentences while repeatedly reading the interview contents was carried out. In the coding process, data that could not be analyzed were excluded, and similar nodes were merged or categorized by specific subjects. After that, the relationship between nodes was identified and data was organized in a bottom-up form. This is a grounded theory-based approach that derives trends based on collected data. This process laid the foundation for inferring and interpreting whether the one-dimensional data described from the consumer's point of view can be theoretically agreed and conceptualized and related to the contents discussed in previous studies. To ensure the validity and reliability of the coding, three colleagues who have a doctorate and more than 3 years of qualitative research experience were asked to fill out the coding form independently. Then, the results of coding were shared, and secondary coding was conducted by adjusting opinions on different analysis results. The final analysis results were derived by listening to the views of the fourth researcher and reconciling researchers' coding results. The coding form for this is included in Appendix.

Results

Characteristics of respondents

In this study, 30 respondents consisting of potential consumers of smart clothing who are aware of smart clothing and have various demographic characteristics participated in one to three interviews. The first interview took place from March 28 to April 30, 2017, after the approval of the IRB. If necessary, additional interviews were conducted once or twice with the consent of the respondents in May 2017. A total of 10 respondents said they had purchased a wearable device or item of smart clothing; of these, seven had purchased a wearable device, two had purchased smart clothing, and one person had purchased both a wearable device and smart clothing. Those respondents who purchased smart clothing had bought the following items: smart socks to measure a child's heart rate, a smart jacket that can control temperature and humidity with a mobile phone, and a sports bra that can measure the wearer's heart rate via an attached heart rate monitor. The complete characteristics of the study subjects are listed in Table 1.

Analysis of consumer acceptance and consumption of smart clothing

To analyze the process through which consumers accept and consume smart clothing, which is an innovative product, segmenting, coding, and meaning were created using NVivo 11.0 and put through an abstraction process. As a result, they were classified into a total of 24 subcategories and 13 categories. By applying them to the axial coding stage, the second analysis stage of the grounded theory, a systematized paradigm model was extracted. Relation and causality among categories were summarized and schematized to understand the paradigm of the resistance of smart clothing, as illustrated in Fig. 1.

Table 1 Characteristics of respondents

No.	Age	Sex	Residence	Wearable device purchase experience	Purchased wearable device type	Smart clothing purchase experience	Smart clothing recognition path
1	31	Female	Gyeonggi	No	–	No	Internet
2	59	Female	Busan	No	–	No	TV News
3	39	Female	USA	No	–	No	Conference
4	43	Female	Seoul	No	–	No	Acquaintance
5	38	Female	Seoul	No	–	No	Internet
6	31	Male	USA	No	–	No	Conference
7	55	Male	Busan	No	–	Yes	TV News
8	32	Male	Busan	No	–	No	Internet
9	31	Female	Seoul	Yes	Smart band	Yes	Internet
10	38	Male	Gyeonggi	No	–	No	Acquaintance
11	34	Male	Seoul	No	–	No	Internet
12	31	Female	Seoul	Yes	Smart watch	No	Internet
13	31	Male	Seoul	Yes	Smart watch	No	Conference
14	28	Female	Busan	No	–	No	Internet
15	32	Female	Busan	No	–	No	Book
16	34	Male	Seoul	No	–	No	Internet
17	31	Female	Seoul	Yes	Smart watch	No	TV News
18	34	Female	Wonju	No	–	Yes	Acquaintance
19	32	Female	Gyeongju	Yes	Smart band	No	TV News
20	31	Female	Seoul	No	–	No	Internet
21	40	Female	USA	Yes	Smart band	No	Internet
22	71	Male	Seoul	No	–	No	TV News
23	35	Male	Seoul	No	–	No	Internet
24	34	Male	Seoul	No	–	No	Internet
25	29	Male	Seoul	No	–	No	Internet
26	32	Female	Seoul	Yes	Smart band	No	Acquaintance
27	31	Male	Gyeonggi	No	–	No	Internet
28	43	Male	Gyeonggi	Yes	Smart watch	No	Internet
29	67	Female	Seoul	No	–	No	TV News
30	40	Male	Seoul	No	–	No	Internet

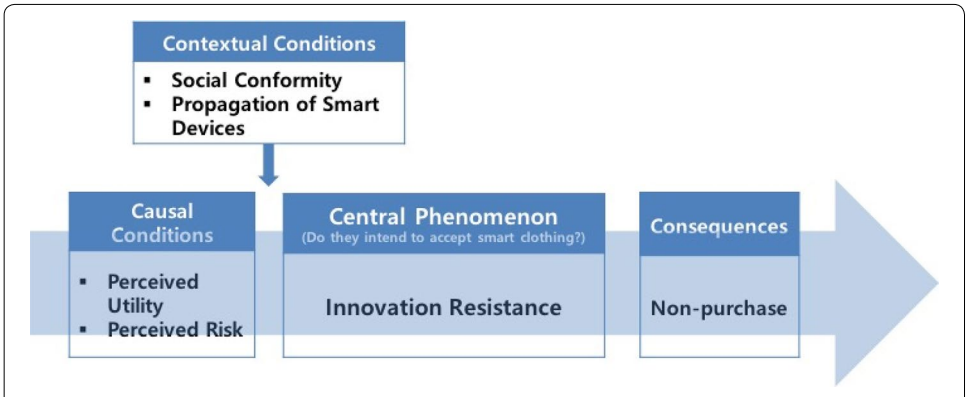

Fig. 1 A paradigm of smart clothing resistance and consumption

Central phenomenon

The central phenomenon in this study showed that in response to the acceptance or preference of smart clothing. All answers of respondents belonged in the category 'innovation resistance to smart clothing.' In general, resistance refers to every act to maintain current status, in opposition to the pressure to change that status (Zaltman and Wallendorf 1979), and it manifests in various forms, from simply avoiding trying an innovative product to strong protesting such products. In this study, most of the consumers responded that they do not need smart clothing, and they do not intend to accept smart clothing. Some consumers said that they would wait until diverse products appear in the market with improved functions or design. From these responses, "postponement," "rejection," and "resistance" were extracted as subcategories to explain the resistance behaviors of consumers. Horsky (1990) explained that if consumers were suspicious of the current performance of products or if they expected the quality of products to be improved in the future, they could postpone deciding to purchase innovative products. This study also verified that expectations for improved products can affect innovation resistance. It was revealed that respondents do not want to accept smart clothing at present because smart clothing is still in the development and initial launching stage; they expect that the function and design of smart clothing will continue to improve.

> ***"Maybe various products will be launched later. In many forms from many brands… Then I can have a broader range of choices, so let me see and think about it later."—Case 15, Innovation Resistance_Postponement***

Some respondents said that they would not accept smart clothing, not simply because they do not know or understand smart clothing, but due to resistance to a change of their current status, because they feel satisfied with what they have or do not feel that they need to make any changes. According to Ram (1987), among the various innovation resistance motives, rejection is closely related to relative advantages among the characteristics of perceived innovation; consumers reject new products when they conclude that there is no profit to be gained from them. Respondents in this study replied that they reject smart clothing because they do not recognize that they need it in any way.

Meanwhile, Youn and Lee (2019) revealed that consumers who experienced technical difficulties did not believe in ease of use. In this study, respondents who experienced technical difficulties in using smart clothing said they would not rebuy smart clothing. Because they believe the relative advantages are not that great even if improved smart clothing was released.

> ***"Is it necessary for a healthy person to consistently measure his/her heart rate every day?"—Case 3, Innovation Resistance_Rejection***

> ***"My daughter bought me last year a padding jumper which controls temperature and humidity* via *a smartphone, but the battery rarely lasts 2 h even after being charged for 3 h…And it does not work more often than not because it was told, the battery attaching area is not dried completely after washing. It is rather inconvenient. Well, maybe even if it will be improved and marketed later… I think I will buy a heavy padding jumper, but not this one."—Case 7, Innovation Resistance_Rejection***

Table 2 Categories, subcategories, and concepts of central phenomenon

Paradigm element	Category	Subcategory	Concept
Central phenomenon (do they intend to accept smart clothing?)	Innovation resistance	Postponement	Determine whether to purchase after waiting and seeing whether function or design is stabilized/improved
		Rejection	There is no intention to accept, as there seems to be no benefit from the product
		Resistance	Do not intend to accept, even in the future Dissuade people who want to accept

Resistance, in its strongest form, reflects a situation in which consumers actively participate in preventing innovation from being diffused. In general, resistance refers to a situation where consumers reject innovation even after using a test product. Still, according to the results of this study, consumers were also observed to reject products they had not used before. This means that resistance can occur only when an individual feels repulsed by innovation or inconvenience or complaints experienced by adopters. In particular, respondents said that they strongly disliked the design and functions of smart clothing. It was also found that if they were not satisfied with a design or were not sure about an item's functions, this could cause them to dissuade other consumers from accepting smart clothing actively.

> ***"Resistance to the items which are separately operated like Google Glass is a bit lower, but those embedded in the clothing itself is not so good…"—Case 5, Innovation Resistance_Resistance***

> ***"The underlying fact is that the integration of fashion and IT is very difficult. Providing convenience linked with IT can appeal to those not interested in fashion, but if they are interested in fashion or like clothes, the integration of fashion and IT technology, well, how can I say this…It is not hip… If you take an example of a necktie, it feels like a zip-out necktie…"—Case 10, Innovation Resistance_Resistance***

> ***"It seems that my favorite brand has not launched smart clothing. If they launch it… I think that I will wait and see, and I will rather happen to avoid that brand. For example, Rolex and i-Watch are a difference. And if there is a Rolex version of i-Watch in the market, I believe it will make me dislike Rolex instead."—Case 11, Innovation Resistance_Resistance***

> ***"If those around me say they will buy it… I believe there is no one to buy, but if it is my close friend, I maybe keep them from buying it. Asking why you buy it."—Case 16, Innovation Resistance_Resistance***

The above results are summarized in Table 2.

Causal conditions

Causal conditions are factors that directly affect a phenomenon. According to previous studies, the variables affecting attitude toward products and purchase intention include relative advantages, visibility, complexity (ease of use), health utility, ease of management, aesthetic appearance, entertainment(pleasure), consumer innovativeness, price sensitivity, etc. (Chae 2010; Jeong and Roh 2016; Kang and Jin 2007; Chae et al. 2009; Noh and Park 2011; Park and Noh 2012). This study designated causal conditions as the reference elements influencing innovation resistance to smart clothing, and the categories of "perceived utility" and "perceived risk" were extracted through data analysis. The categories were explained respectively through the subcategories of "usefulness," "convenience," "risk for health," "risk for performance," "risk from washing," and "risk for privacy infringement."

Perceived utility

Ram (1987) argued that innovation resistance falls as the relative advantages perceived by consumers regarding innovation grow, and many subsequent studies verified the fact that the higher the relative advantages, the lower the innovation resistance. By relative advantages, Ram meant that innovative products are more useful, or innovation makes the user's life more convenient. In this study, the relative advantage of smart clothing perceived by consumers was defined as "utility," which was aligned with the subcategories of "usefulness" and "convenience." Here, "usefulness" was defined as the subjective assessment of whether smart clothing functions are consistent with the user's lifestyle and how useful they are, while "convenience" was conceptualized as an individual's subjective assessment of the convenience provided by smart clothing compared to other smart devices. In preceding studies on the acceptance of smart clothing, perceived usefulness influences attitude and attitude influences purchase intention (Chae et al. 2009; Noh et al. 2016; Noh and Park 2011). However, respondents said that smart clothes are not useful or rather uncomfortable due to frequent washing, so they reject or resist smart clothes.

> ***"These days, people attach navigation or smartphone to the bicycle. So, I don't know why such functions to get a phone call or play music are necessary for clothes. Even a smartwatch is so great, isn't it?"—Case 16, Usefulness***

> ***"There is the issue of washing for clothes and I cannot wear the same cloth for every season. Isn't it that it is rather inconvenient…"—Case 5, Convenience***

Perceived risk

Perceived risk means that when consumers cannot predict with certainty the result of a purchase or they feel that it is different from their expectations, they become anxious that their next purchase may also have an undesirable result. Many studies have found that perceived risk has a negative impact on consumers' explorations, assessments, and decision-making. Ram (1987) claimed that innovation resistance is a response to the risk inherent in innovation, and the higher the risk is, the higher the innovation resistance becomes. According to preceding studies, perceived risk affects attitude differently

depending on the target item (Jacoby and Kaplan 1972), the form of risk (Huh 2003; Tanawat and Audhesh 2006), and the difference in consumers' shopping environments (Lee and Choi 2007). It was also reported that in some cases, perceived risk has no significant impact on attitude. In this study, risks perceived by consumers included the subcategories of 'risk for performance,' meaning the concern over whether the product works as expected, 'risk for health,' meaning the concern over physical risk such as electromagnetic waves, 'risk from washing,' meaning the concern that the product's performance will deteriorate after being washed, 'risk for availability,' meaning the concern about unavailability when desired due to weather, washing, or fashion trend, and 'risk for privacy infringement,' meaning the concern over the possibility that communication devices in the product can reveal or be used to steal personal information. This study found that consumers are also concerned about situations in which they cannot use smart clothing due to laundry, fashion trends, and seasonal changes. This factor has not been revealed in other preceding studies, but it proved to be a strong negative reaction in many of the respondents and dissuaded them from purchasing a variety of such products. This factor does correlate with availability as explained by Hiltunen et al. (2002), who identified it among the factors which influence a user's experience. Availability means the form in which consumers can use a service whenever they wish to, or how often they can expect the service to be available. Services should be available when a user wants to use them, and as availability is reduced, consumers become more dissatisfied. Therefore, it is important to manage expectations for the service; if any potential problems regarding the availability of the product or any event where the provision of service is expected to be suspended can be anticipated, consumers should be notified in advance. However, consumers' expectations regarding these products are currently not managed even though the availability of smart clothing is lower compared to other wearable devices due to factors such as washing, seasonal factors, fashion trends, etc. Since as many consumers are already concerned about being unable to use a product or service that the impact of perceived availability on the acceptance of innovation products needs to be verified in future research.

> ***"Mobile phone batteries explode these days, so clothes are more worrying. It directly touches our body."—Case 10, Health***

> ***"I still have some resistance. It feels like I could get an electric shock, and there can be a problem if it is torn down… Durability is also suspicious." Case 23, Health/Performance***

> ***"What can I do if I wash the cloth? It is that I should buy several items to wear them one by one, but it is probably more expensive than ordinary clothes because of their functions. It is a bit burdensome to buy several items."—Case 28, Availability***

> ***"I have to wash clothes every day after sweating, so I wonder until when its functions work well… Isn't it that there should be problems"—Case 2, Washing/Function***

"There probably be noises a lot if it gets wet with sweat and the measurements will not be accurate? Those who like sports put more emphasis on accuracy of measurement, so I believe that they would use the products which can accurately measure rather than prefer convenience coming from using clothes…—Case 19, Performance

"But how can I throw away the clothes? Well, can it do initialization or something like that… But it's still uneasy. All of my personal information is there as it is…"—Case 15, Privacy

The above results are summarized in Table 3.

Contextual conditions

Contextual conditions refer to the socio-cultural context which affects the causal conditions and phenomenon, and the situational factors arising from the environment or conditions surrounding innovation are important factors influencing the acceptance of innovation (Midgley and Dowling 1978; Ram 1987). Situational factors include various specific personal elements as well as detailed situations, such as whether consumers can afford a product or whether the manufacturer needs the profits expected to be obtained from a specific innovation. Reduction in price, expansion of services, technological advances, social atmosphere, etc., can work as situational factors that affect an individual's acceptance of an innovation. These situational factors can explain a lot more than the factors related to the person, but except for a few specific studies (Dabholkar and Bagozzi 2002; Mallat 2007), preceding studies on innovation acceptance focused on the property factors of innovation which affect acceptance. In this study, contextual conditions were designated as those sociocultural factors which affect the acceptance of smart clothing and extracted "social compatibility" and "propagation of smart devices" as the socio-cultural factors which affect the acceptance of smart clothing. First, "social compatibility" can be explained as "social assessment," meaning that the purchase or use of the product is positively assessed by those around the user, such as family or friends. Son et al. (2014) said that the higher the

Table 3 Categories, subcategories, and concepts of causal conditions

Paradigm element	Category	Subcategory	Concept
Causal conditions	Perceived utility	Usefulness	Assessment of how useful smart clothing is
		Convenience	Assessment of how much more convenient it provides compared to other smart devices
	Perceived risk	Performance	Concern over whether the product will work properly, as expected
		Health	Concern over threats to the human body, including electromagnetic waves
		Washing	Concern over the deterioration of function after being washed
		Availability	Concern about unavailability when desired due to weather, washing, or fashion trend
		Privacy	Concern over the possibility that personal information can be consistently leaked

social impact that users and their neighbors believe that the wearable device is desirable, the more receptive the wearable device is. According to Lee et al. (2014), social images that users believe can improve their social position or image or attract more people's attention by using devices such as smartwatches have a positive impact on perceived usability and perceived usability.

> ***"If it goes wrong, people can laugh at me by saying "nerd" or "geek."—Case 6, Social Compatibility***

> ***"If you look at Google Glass, does it look nice? I believe it rather looks a bit funny."—Case 10, Social Compatibility***

"Propagation of smart devices" was extracted as a factor hampering the spread of smart clothing. In the interviews, respondents said that they would not stop using their smartphones even if they bought smart clothing. Therefore, smart clothing would not replace their smartphones but would rather cause financial loss and inconvenience. Many also thought that purchasing other wearable devices instead of smart clothing would be more efficient. Respondents who had already purchased wearable devices also felt that it would be difficult for smart clothing to be widely accepted due to its limitations. The details of the interview based on which the contextual conditions in the above were extracted are as below.

> ***"I can use the functions of smart clothing only when I wear them. And if you talk about payment, we can already do it with a smartphone, so should we particularly wear it? Smart clothing should overwhelm smartphones in terms of convenience or safety, but it does not seem to be the case, and if we have to carry one more when we can do it here, it becomes duplicated investment."—Case 23, Impossible to replace the smartphone***

> ***"If you compare purchasing a suit of cloth with smart functions together with other ordinary clothes and purchasing ordinary clothes together with a smart device, the device is better because I can use it whenever I want regardless of what cloth I wear."—Case 14, Purchasing other wearable devices***

> ***"I am using a smartwatch while running, and there is no reason that I feel uncomfortable with the watch. So, I don't think I will buy clothes. That's it for now."—Case 17, Purchasing other wearable devices***

The above results are summarized in Table 4.

Consequences

After analyzing the intention to purchase smart clothing according to the consequences of paradigm factors, the results indicated that most of the respondents were either postponing their purchase of or refusing to purchase smart clothing. In this study, the postponement of purchase of smart clothing indicated that individuals were waiting to purchase such products until an item with the appropriate function(s), design, and/or price is available. Ram (1987) and Horsky (1990) both stated that dissatisfaction with the functions of existing products and the expectation that the quality will be improved in

Table 4 Categories, subcategories, and concepts of contextual conditions

Paradigm element	Category	Subcategory	Concept
Contextual conditions	Social conformity	Social assessment	Assessment by others (family, friends) on the purchase or use of the product
	Propagation of smart devices	Inability to replace smart phone	Do not feel the inconvenience of using a smartphone as smartphones have been already widely used There are more functions performed by a smartphone than those performed by smart clothing
		Purchase of other wearable devices	Believe that purchasing other wearable devices than smart clothes is more efficient

Table 5 Categories, subcategories, and concepts of consequences

Paradigm element	Category	Subcategory	Concept
Consequences	Non-purchase	Postponement of Purchase	Postpone purchase until an appropriate product is launched
		Rejection of Purchase	Reject the purchase of smart clothing

the future could affect the postponement of the decision to purchase innovative products. Purchase rejection, however, means that consumers will refuse to purchase such an item, even if smart clothing with improved functions or design becomes available; this is the result of strong resistance to innovation. Previous studies also have shown that there is a negative relationship between consumer resistance and purchase intention (Bass 1980; Horsky 1990). The details of the interviews from which the result in the above was extracted are as below.

"Whatever is marketed first is like for test, well… There were also a lot of problems with wind-free air conditioners. It is probably better to buy it next year than this year."—Case 2, Postponement of Purchase

"Cloth is just cloth. I would not buy it even if it has wonderful functions."—Case 1, Purchase Rejection

"First, once such function is imbedded in cloth, it looks like out of fashion. It does not have heritage even if it has a classic design."—Case 10, Purchase Rejection

The above results are summarized in Table 5.

Conclusion and implications

This study analyzed consumer's attitudes toward smart clothing. The research consisted of in-depth interviews with consumers who indicated that they are aware of smart clothing, and the interview was analyzed using the grounded theory method. The analysis of the process in rejecting and consuming smart clothing revealed that innovation resistance to smart clothing occurs as a central phenomenon, and causal conditions affecting this resistance included the perceived utility of and the risks derived from smart clothing. Many participants responded that they do not want smart clothing because they do not need it and further mentioned several risks factors related to functioning, health, washing, availability, and privacy, which deter them from wanting it. Here, technology is applied technology, and it means technology that users want and can change an existing way of life or thinking and form a completely new category. Innovative products can only succeed if there is a group of innovators who are enthusiastic about technology. In this study, the participants responded that they would not accept smart clothing because it is no necessity for them. In other words, smart clothing is struggling in the market because smart clothing is not the technology or product that users desire.

On the other hand, consumers who perceive the usefulness of smart clothing have low intention to replace it with smart clothing due to the spread of smartphones and wearable devices that have already been proven to be stable and functional. The study participants also anticipated that it would take a long time for a socially acceptable product to emerge. Among the participants of this study, consumers with a high level of innovativeness were more interested in purchasing the latest devices than smart clothing. In addition, they expressed concerns that although smart clothing could be convenient, its measurements may be inaccurate or other functions may not work properly. Respondents who indicated that they are very interested in clothes or sensitive to fashion trends did not perceive smart clothing as a trendy item. In the case of smart functions included in clothes, they said that they would not buy such items at present because they were aesthetically unattractive and consequently unfashionable, particularly because of the electronic devices attached to or embedded in the fabric. The economic burden felt by consumers from continuously purchasing expensive smart clothes along with changes in fashion trends was also given as a reason why consumers with a high level of trend innovativeness would not accept smart clothing. Finally, some participants responded that they would withhold the purchase of smart clothing until the product with the proper function, design, and the price is released. Others responded that they would not purchase smart clothing even if smart clothing is released with improved performance and design.

The result of this study, which is derived from the grounded theory, show the following differences from previous major studies on the acceptance of smart clothing. First, as a factor affecting the rejection of smart clothing, this study derives the availability of products or services. Also, the popularization of smartphones and the dissemination of wearable devices have been identified as a socio-cultural factor influencing the resistance to smart clothing.

This study is significant in that it identifies factors influencing resistance to and rejection of smart clothing and help understand the socio-cultural reasons that the rate of purchasing and using smart clothing is lower than expected. This study shows that if

the popularity of smart clothing rises, it is necessary to develop smart clothing with functions that are irreplaceable and suitable for clothing rather than simply improving the functions and design of existing smart clothes. In addition, in order to boost the smart clothing industry, it is important to incorporate and redesign smart features suitable for clothing into the clothing itself, such as comfort, convenience and aesthetics. Similarly, as clothing is affected by trends and seasons and because it must be washed, efforts should be made to resolve these unique problems, particularly if its availability is to be increased to compare to that of wearable devices that can be attached to the body. In addition, this study has academical significance because it focuses on the resistance behavior of smart clothing consumers, which has not been studied so far and uses the method of the grounded theory to theorize a paradigm of smart clothing resistance and consumption.

However, the results of this study are limited in that they are based on the responses of a few individuals in artificial situations. Also, this study used snowball sampling and convenience sampling methods to recruit participants who are suitable for the research purpose. In the process, three Koreans living in the United States were introduced by the other participants. Three Koreans living in the United States are not enough for cross-cultural comparisons. In the future, if a study is conducted to find out if there is a difference between Korean and American consumers in the process of smart clothing resistance, it is expected that the overall understanding of consumer resistance to innovative products will be enhanced. Furthermore, quantitative research is required to deepen and generalize the theoretical system. It is believed that attempts to develop a smart clothing resistance scale based on the theory established in this study, together with quantitative research on consumers with various demographic characteristics, will make it possible to identify the diverse factors which influence the acceptance of and resistance to smart clothing.

Authors' contributions
NJ designed the study and developed the theoretical framework, besides analyzing data, and drafted the manuscript. KHL guided the development of the theoretical framework, results, and conclusion and reviewed the manuscript. Both authors read and approved the final manuscript.

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Ethics approval and consent to participate
This research was conducted under the approval and supervision of Hanyang University Institutional Review Board (IRB Approval No.: HYI 17-028-2) regarding ethical issues including consent to participate.

Competing interests
The authors declare that they have no competing interests.

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Appendix: Form for evaluating the adequacy of coding

Review of adequacy of coding (Perceived Risk)

Reviewer _____
Date

_____

Health	Function	Privacy	Washing	Improved product appearance	Social mocking
1	2	3	4	5	6

1. Read the data in each item and write the number you think is appropriate among the nodes listed above. (Multiple responses are possible)

Item	Data	Node
1	*I still have some resistance. It feels like I could get an electric shock, and there can be a problem if it is torn down... Durability is also suspicious*	
2	*My friend told me that there is smart clothing which measures the heart rate of the baby, but I am concerned if it is dangerous... Things like electromagnetic waves.*	
3	*Mobile phone batteries explode these days, so clothes are more worrying. It directly touches our bodies.*	
4	*I must wash clothes every day after sweating, so I wonder until when its functions work well... Isn't it that there should be problems*	
5	*If there is a climbing cloth which controls the body temperature, it is useless if it does not work at a critical moment. If it does not work or I should charge the battery while I am climbing the mountain, it's just a burden. Simply a plain cloth to change could be more valuable.*	
6	*Whatever is marketed first is like for test, well... There were also a lot of problems with wind-free air conditioners. It is probably better to buy it next year than this year.*	
7	*If it goes wrong, people can laugh at me by saying "nerd" or "geek.*	

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