Consumers' knowledge and acceptance of smart clothing

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ABSTRACT

To help innovative products breakthrough in the marketplace, it is necessary to gain consumer trust. However, consumers do not necessarily receive innovations positively and may have various concerns. Innovation involves change, and many consumers are reluctant to change or need more time to gain confidence in an innovative product, whether in terms of its usefulness, benefits, price, appearance, etc. Therefore, consumers' lack of knowledge and acceptance of innovations may be one of the key reasons why many innovations fail to come to life in the market. Smart clothing, as a kind of wearable device that combines information and communication technologies and textile materials in a clothing system, has great potential for development and market breakthrough today. In this study, we investigated the prevalence of smart wearable devices and smart clothing in terms of consumers' knowledge and acceptance of smart clothing by consumers. The results of the survey both serve as a guide for the development of the most desirable smart clothing and indicate the necessary communication strategies for its breakthrough in the market.

1 Introduction

Innovation involves change, and many consumers are reluctant to change or need more time to gain confidence in an innovative product, whether in terms of its benefits, advantages, price, appearance, etc. Therefore, consumers' lack of knowledge and acceptance of innovations may be one of the main reasons why many innovations fail to come to life in the market. Smart clothing, as a type of wearable

devices that combines information and communication technologies and textile materials in clothing systems, has great potential for development and market breakthrough today. However, research shows that it is not yet very attractive in terms of sales [1,2]. This may be related to a resistance to innovation due to a lack of consumer knowledge about the functionality, benefits and advantages of smart clothing.

It is well known that smart clothing provides advanced features to consumers, by being able to detect, respond, and adapt to the stimuli they are exposed to in different environments. The development of smart clothing began many years ago with early birth of wearable devices in 1955 for the purpose to beat Las Vegas casinos at roulette [3-5] and the first smart clothing in 2000, called Cyberia survival suit [6]. Today, the development of smart clothing is very advanced as the development of smart or intelligent textile materials collaborates with various sciences. Energy efficiency, connectivity, and miniaturization of electronics as well as a drastic reduction in the price of components have also contributed to the remarkable improvements in smart clothing development. The latter is also reflected in the prices of smart clothing on the market, which are still high due to their added value of high functionality and intelligence. Smart clothing must be developed from the consumer's perspective, taking into account several factors: (a) technical requirements (batteries that power embedded electronics while monitoring activities), (b) functionality (comfortable, safe and easy use), (c) aesthetics (acceptance of smart clothing), and (d) consideration of cultural requirements. In addition, it must be washable like conventional clothing [7-9]. Nowadays, human health monitoring is one of the most important and priority issues. Therefore, everyday smart clothing is being developed with various types of sensors to monitor the wearer's biometric data and vital signs (e.g., respiration, heart rate, blood sugar etc.), which are able to predict, prevent and monitor chronic diseases online. The goal is to reduce hospitalizations and enable the elderly to remain independent [10]. In addition, several types of smart sportswear are in development or on the market to improve performance and health of athletes. Due to the many sources the latest brief reviews of smart clothing applications can be found in [11-13].

According to [14], the global smart textiles market was valued at USD 674.8 million in 2015 and is expected to grow at a CAGR of over 33% from 2017 to 2024. Regardless of this assessment, research shows that consumers are reluctant to accept innovation, which is reflected in the purchase of smart clothing [1,2]. Resistance to innovation can be defined as a negative response to innovation and changes associated with innovation [2]. The study by Ju and Lee [1] identified different obstacles that affecting consumers' interest in smart clothing. It was found that consumers would accept and buy smart clothing if a trusted brand produced it with appropriate features and at reasonable prices, which means they resist the innovations of unknown brands. In addition, consumers refuse to buy smart clothing due to aesthetic dissatisfaction, therefore, the manufacturers should consider what functions or technology should be incorporated into smart clothing to ensure an aesthetic appearance. The main findings of a study conducted by Ju and Lee [2] show that knowledge of consumers about fashion innovation plays a role in strengthening innovation resistance to smart clothing. The authors of this study concluded that fashion-conscious consumers purchase relatively expensive smart clothing and emphasized the need to spread smart clothing to reduce consumers' perceived risk and improve the performance, durability, and availability of smart clothing. In addition, a 4-factor, 15-elements WEAR Scale was developed for examining consumers' acceptance of smart clothing. The four WEAR dimensions are: (a) design and aesthetics (four elements), (b) self-expression (four elements), (c) consequences (three elements), and (d) reflection (four elements) [15].

Consumer resistance to innovation is an aspect of consumer behavior and can be described in the simple way as the unwillingness among consumers to try newer innovations in the market [16-18]. Since consumer resistance to innovation is one of the main causes for failure of innovations in the market [19], it is important to disseminate knowledge about digital innovations, which plays an important role in smart clothing. At the same time, it is important to continuously integrate new research achievements into the study process and extracurricular activities of students in the interdisciplinary field of smart clothing. One of the possibilities are the EC Erasmus+ programs through projects, such as the Erasmus+ project OptimTex – Software tools for textile creatives, which is fully aligned with the new trends in the digitization of the whole textile and clothing sector [20]. This project aims to improve the knowledge and

skills in the field of software applications for students of higher education, as well as their employability within textile enterprises, by providing the adequate training instruments for their profession.

The aim of this study is to investigate the prevalence of smart wearable devices and smart clothing in terms of knowledge and acceptance of smart clothing among Slovenian consumers through a survey.

2   Method

Survey was conducted on the prevalence of the use of smart wearable devices and smart clothing with the help of a survey of randomly selected consumers in Slovenia. The survey was conducted in 2021 using the online tool 1ka and distributed via social media.

The questionnaire, in addition to basic questions about gender and age, was divided into two groups: (1) current use and (or) experience with smart wearables and (or) smart clothing, and (2) the purpose of using and (or) buying of smart clothing. The questionnaire was answered anonymously, and contained different types of questions, such as dichotomous, multiple-choice and open-ended questions, to obtain the best possible opinions about the experience, use, and purchase of smart wearables and smart clothing. Descriptive statistics was used to analyse the survey, as the main purpose of the questionnaire was to obtain a clear need and idea regarding the prevalence of the use of smart wearable devices and smart clothing.

A short form of the questionnaire can be found as an appendix at the end of this paper.

3   Results with discussion

113 randomly selected consumers responded to the survey, and only 33 people completed the entire survey, while the rest stopped at answering question 3 (Do you use or have you used any of the smart clothes?). The survey was completed by 84% of women and 16% of men representing all age groups: up to 19 years (5%), 20-30 years (58%), 31-40 years (16%), 41-50 years (11 %), 51-60 years and over 60 years (3%), which reveals that there is an interest in smart clothing in all age groups. Based on a low response to the survey and the large number of abandoned responses, we can conclude that respondents felt from the beginning that they did not have enough experience with smart clothing or were not ready to wear it to continue responding. We can also conclude that they are not aware of innovations related to smart clothing and its advantages. The low number of responses to the questionnaire indicates that there is a need to disseminate knowledge about the benefits of smart clothing with appropriate promotional/communication instruments, which can stimulate consumers acceptance and desire to purchase smart clothing. The acceptance of the innovation and the desire to buy it creates the need to buy it and enables the sustainable development of smart clothing.

This was followed by questions about current use and (or) experience with smart wearables and (or) smart clothing. Analysis of the survey shows that more than half of the respondents already use or have used smart wearable devices (56%), namely a smartwatch (70%), a smartphone (35%) and a heart rate sensor (7%). The majority of randomly surveyed consumers have not yet used smart clothing (97%), and only one respondent has already used a smart T-shirt. Among the various response options to the question of where respondents found out about smart clothing, the answers were as follows: internet (44%), none of the above (38%), television (18%), friends (15%), magazines and newspapers (12%) and others (12%). Under other, respondents indicated that they had heard about smart clothes at the faculty or that they had not heard about them yet. The answers to this question show that social networks have the greatest impact on consumers in terms of acceptance of innovation and their interest in buying products. At the same time, we should not neglect that young people are a pillar of social development and the transfer of knowledge and information from the learning environment to family, friends and acquaintances.

The latter is also evidenced by the answers to the next question, where 44% of respondents answered that they know between three and 30 friends/acquaintances who have already used a smart wearable device (smartwatch, amethyst phone, heart rate monitor, polar ribbon). Of all randomly surveyed

consumers, only 6% know someone (between one and five people) who has already used smart clothing (smart T-shirt for sports). The latter answers suggest that smart clothes are not yet well enough known among Slovenian consumers. The smart technology built into the smart clothing is not a barrier to wearing smart clothing for 73% of respondents (sensors, electrical components, conductive threads, and other conductive signalling pathways), while the remaining 27% are detained until use due to the sensation of radiation, oversized components, discomfort while wearing, unsuitability for daily use, and most importantly, the possibility of misuse of data obtained while wearing smart clothing. Therefore, when developing smart clothing, we need to ensure data protection at the highest possible level.

The last set of questions concerned the purpose of using smart clothing. From Figure 1 it is evident that consumers are most interested in using smart clothing for health monitoring (82%) and smart sportswear (70%), while 36% would use smart clothing for rehabilitation monitoring and smart workwear. Interest in using smart clothes for entertainment and fashion is the lowest (15%). Under the other, respondents would use smart clothing for health problems, such as elevated heart rate or blood sugar. They also indicated that they would primarily like to buy smart clothing for health monitoring (45%) and smart sportswear (45%). The results of this part of the survey give us the answer to the necessity of developing the most desirable smart clothing for health monitoring and sports activities, which must be properly communicated for its acceptance and breakthrough in the market, as an analysis of the second set of questions showed.
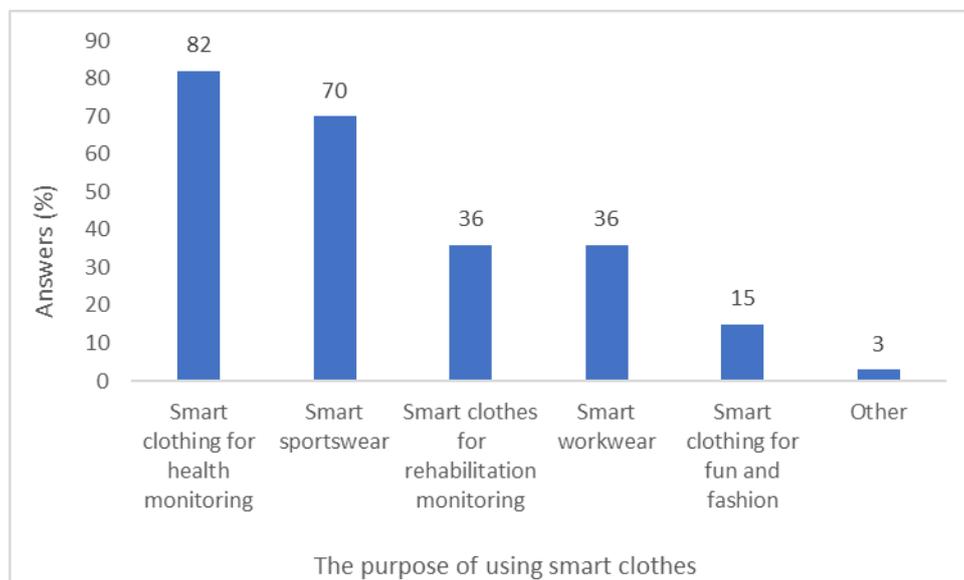

Fig. 1 The purpose of using smart clothing

When asked about the features of smart clothing, which are important for consumers to decide to buy a product, it was possible to choose several features at once (Figure 2). The most decisive feature for the purchase of smart clothing is its functionality (88%), followed by the price of the product (64%) and the aesthetic appearance of the product (61%), while the fashionable appearance of smart clothing was highlighted by only 21% of consumers. The latter also coincides with the previous question if the fashion brand is important to the consumers when buying smart clothing. Indeed, only 18% of respondents answered that a fashion brand is important to them when deciding to buy a product. This finding contradicts a study by Ju and Lee [1] which showed that consumers would accept and buy smart clothing if a trusted brand made it. More than half of consumers care about the purchase of smart clothing for its sustainability (52%), and only 33% of consumers pointed out the ease of maintenance of smart clothing. Based on the latter, we can conclude that consumers are not yet familiar with smart clothing and its components, which may limit the sustainable properties of smart clothing, especially in terms of care, and is the subject of today's in-depth research on smart clothing [21,22]. The answers to this question reflect that the functionality, price, aesthetic appearance, and sustainable properties of smart clothing play the most important role in the smart clothing purchase decision.
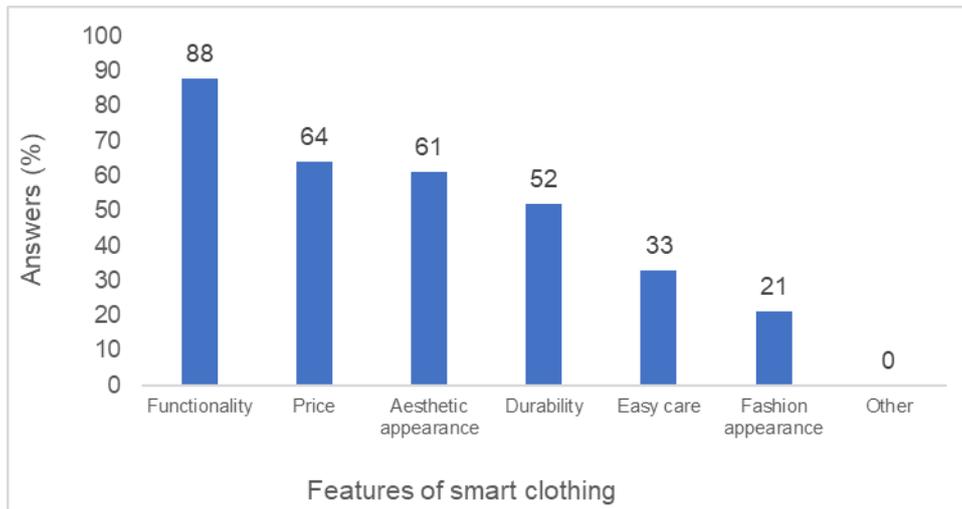
Fig. 2 Features of smart clothing

The last question was about the price of smart clothing, or at what price consumers are willing to buy smart clothing (Figure 3). Of the three price ranges available for the answer, the majority of respondents (48%) answered that they would buy a smart garment if the price was between 30.00 and 50.00 EUR. Almost the same percentage of respondents (42%) would buy smart clothing if the price of the product was between 50.00 and 100.00 EUR. Only 6% of consumers expressed interest in the third price range for smart clothing between 100.00 and 150.00 EUR, which is also the most realistic price for smart clothing on the market. The remaining 4% of consumers among the other did not give clear answers regarding the desired price for smart clothing.
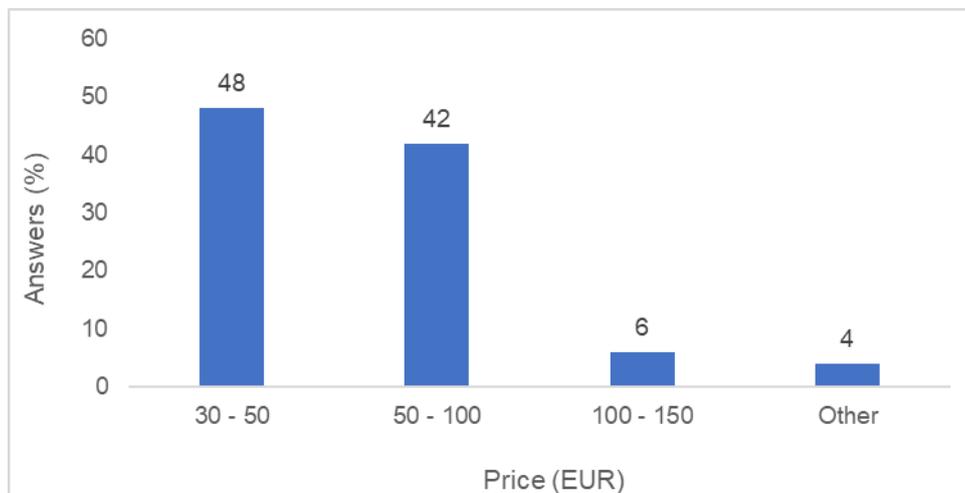

Fig. 3 Price of smart clothing

3   Conclusions

The aim of this study was to investigate the prevalence of smart wearable devices and smart clothing in terms of consumers' knowledge and acceptance of smart clothing among Slovenian consumers. 113 randomly selected consumers participated in the survey, and only 33 completed the entire survey. Respondents stopped completing the questionnaire already at the third and fourth basic questions about their experience with wearable devices and smart clothing. Based on the findings, we can conclude that randomly surveyed consumers do not know much about innovations related to smart clothing and their benefits, and that smart clothing is not yet sufficiently known among Slovenian consumers. This addresses the need to spread the knowledge about benefits of smart clothing with appropriate promotional instruments, which can stimulate consumers' acceptance and desire to buy smart clothing.

The survey showed that social networks have the greatest influence on consumers regarding the acceptance of innovation and their interest in purchasing such products. It was found that Slovenian consumers most desire smart clothing for health monitoring and smart clothing for sports activities. The most important factors in the purchase decision are high functionality, affordable price, aesthetic appearance, sustainable features of smart clothing and protection of data collected with smart clothing.

Author Contributions

A. Rudolf, Z. Stjepanovič and M. Kuharič: conceptualization, methodology, investigation, writing—original draft preparation, writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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Appendix – Questionnaire

Demographic
1. Gender
2. Age

Current use and (or) experience with smart wearables and (or) smart clothing
3. Do you use or have you used any of the smart wearables? If yes: Which smart wearable device did you use or are you using?
4. Do you use or have you used any of the smart clothes? If yes: Which smart clothing have you already used or are you using?
5. Where did you find out about smart clothing?
6. Do your friends / acquaintances use a smart wearable device? If yes: How many such friends / acquaintances do you know? Which smart wearable device do your friends / acquaintances use?
7. Do your friends / acquaintances use smart clothing? If yes: How many such friends / acquaintances do you know? Which smart clothing do your friends / acquaintances use?
8. Is the smart technology built into your clothing a barrier to wearing smart clothing (sensors, electrical components, conductive threads, and other conductive signalling pathways)? If yes: Please indicate why this is a barrier for you?

The purpose of using and (or) buying smart clothing
9. Which of the following smart clothing items would you use? (health monitoring, rehabilitation, sports, workwear, fashion and entertainment clothing, other)
10. Which of the following smart clothes would you buy first? (health monitoring, rehabilitation, sports, workwear, fashion and entertainment clothing, other)
11. Is the fashion brand important to you when buying smart clothing?
12. Which of the following features are important to you when buying smart clothing?
13. How much are you willing to pay for a smart t-shirt that shows, for example, blood pressure, heart rate, blood oxygen and body temperature?