

The Effect of Product Technology to Product Acceptance— An Assessment of Activity Tracker Products

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Abstract

Wearable Technologies is an important subject which must be studied properly in terms of interaction with human among all cyber physical systems. This technologies “epitomizes the interaction of humans and technology and as such, covers a very broad area” (Park, Chung, & Jayaraman, 2015). Today, it is seen by the common use of computers, internet, information, communication, electronic and textile technologies that many products in many wearable forms with different functions are launched to the market. Many of those products consist of products that are designed within the scope of health benefits. Wearable sensors and devices being highlighted as one of the key technologies in advancing health informatics (Poon, Zheng, Luo, Ding, & Zhang, 2015).

In this study, wearable technologies are examined within the framework of close and uninterrupted contact/touch to the user. Considering from this perspective; the first impression of wearable products as one of the physical systems providing the usage of those technologies on the user is very important in terms of the product choice. Especially when considered in terms of health products; it is important to determine the differences of positive and negative factors affecting the product acceptance motivation of the user. In this study, about the interaction of products with human, the focus is on the concern/anxiety on health that could be arisen in the user related to technologies included in the product. To determine and analyze due to which factors does such an anxiety/a concern exists is can be considered as the subject of design. Thus, in this study, the interaction process of the wearable technologies with the user is assessed in terms of product design. The focus is on the wearable factor which is deemed and considered as to be the first factor that is considered by the user in the first impression process and as to have an effect on product choice in the interaction of those products with human.

The “health concern factor due to technology used in the product” factor is examined / studies in the first part of this study with the support of literature and in the second part of this study, The effect of that factor in terms of the user was examined by means of field-work, where four healthcare and wellness products are tested by potential users on short term. The

comments of the users are coded to determine the factors that are of primary concern for users in the initial interaction with the product. The role of the "health concern due to technology used in the product" factor that can occur at the first phase of product-user interaction, will be discussed at the end of the field study.

Keywords: *Wearable Technologies, Cyber Physical Technologies, Wearable Healthcare, Wearable - User Interaction*

1. Introduction

Cyber Physical Systems (CPS), which are among the systems that are introduced to our lives through Industry 4.0, "refers to a new generation of systems with integrated computational and physical capabilities that can interact with humans through many new modalities" (Baheti & Gill, 2011). Today these systems are integrated to developing mobile systems. Mobile CPS can cooperate with people to be used in a various areas in daily life (Guo et al., 2017).

Currently the mobile device technology is simultaneously improved with development of technologies such as computer, communication, electronics and information. With the improvement of mobile device technologies, the diversity of products in this field is also increased and together with the technologies that are used in these devices, new concepts appear in the literature. One of these concepts that refer to the use of these products is "wearability". Gemperle et. al. (1998) define wearability as the "interaction between the human and the wearable object. James and Petrone (2016) also stress that wearable technology consists of items that are worn and technological. The concept of wearability points out to the utilization of products with these specifications on human body. When product-human interaction is considered, use of these products is long-term and uncut, when compared to other mobile products.

Along with the improvement of the referred technologies, it is stated that the meaning addressed to the term "mobility" is changed from being just carriable to wearable technologies that are almost invisible which improve personal interaction (Kim & Shin, 2015). The wearables, which can be used all day without limitation of space with body contact, continuously interact with information technologies through this specification. When the transformation of human body to an interaction ground is considered, it can be stated that wearables need a more in-depth examination than the mobile devices.

In this study, the materials and technology that are used in wearables are evaluated through their potential physical harm to the body, to understand if this factor has a negative impact on user preferences. The referred potential problem can be defined as "the concern that will be caused by uninterrupted interaction of wearables on human body". The fact that wearables have a direct contact with body and the inclusion of technologies that originate from computers and electronics, may lead to fears related to material and technology. In their study which aimed to build human centered design principles for early design phase of wearables, while defining "safety" factor, Motti and Caine (2014) classified the damage that wearables may cause on users as social, physical and psychological. Examples for physical damages are overheating and electric shock. Also they refer to Gemperle et. al. (1998) study to stress that long term use of wearables have unknown physiologic effects on human. In this study, the problems that are related to materials and technology are evaluated as physical problems. This study questions the effect of the referred worry on users' decisions to accept or reject the product. Wearables are studied in a multidisciplinary way and they have various kinds in

many different fields. In this research, to discuss the “negative effect” topic, fitness devices designed to be used different parts of the body are chosen within the context of health products. This study forms the preliminary phase of a larger research, and through the chosen fitness equipments, the users’ first impressions and short term use processes are investigated. In this research, questions are asked to the user group about their experiences on selected products to evaluate the process over their answers. It is aimed to derive results which will direct more comprehensive studies that are to be made on this field.

2. Wearable - User Interaction

Bodine and Gemperle (2003) stress that the user preferences of wearing things depend on several factors and the appearance, feel and function of products are among them. Wearables can be accepted or rejected based on other functions associated with apparels along with their original functions; “...though, approaching wearability of smart clothing through theories of dress leads us to emphasize the social wearability of wearable systems equally with their physical wearability” (Dunne, Profita, & Zeagler, 2015). It can be said that both physical functions and social effects of the product have influences on users’ preferences on wearables. When at the product range of the wearables are considered, a lot of different types on different fields from products giving external information with sensors are encountered such as measuring air pollution to products that provide internal information by measuring body temperature and heart rhythm. From the perspective of physical function value and social status value, wearable products with such a wide use range can be said to have different acceptance motivations for the users of these products. As an example, a wearable as a communication product and a wearable with a illness monitoring function can derive different motivations to be used for purposes such as aesthetics, functions and promised identity.

Parallel to the development of wearable technologies, designs of various wearable products are also accelerated in information communication, electronics and medical devices in addition to computer technologies. These improvements brought the multidisciplinary evaluation of wearables. Wearables in electronics are discussed as “wearable sensors” and physical functions of wearables are focused in the field of health. As the efficiency of wearable products increases in the market, the disciplines working on this issue are also diversifying. Wearability has begun to be considered as a concept that includes functional factors in the interaction of the products with human, as well as cognitive, physical and social interaction. As an example, in their study focusing on social elements of wearables’ user interaction, Dunne et. al. (2015) claim that, rejection of a technology due to social factors, lead to overall invalidity of its functions. From the perspective of physical interaction, the use of system technologies integrated into these products will also have an effect in the user acceptance process. Users will need to trust the system's operation to accept cyber physical systems, as they include internet connection and computer technologies that allow the collection and management of personal data (Sha et. al., 2008).

3. Study Method

For the pilot study, fitness products designed within the scope of health were selected. These products are preferred as they were present on the market during the study. As these products can be evaluated under the scope of "health benefits", they can provide an effective ground for questioning the negative effect. Wearable fitness products used during sports activities, as medical products and health monitoring devices, can generally be studied under the healthcare

product category. For this reason, all products covered in this context are evaluated under the name of “health benefit scope” in this study.

Since the negative effects described in the study were assessed in terms of the “uninterrupted interactions of the wearable products on the body”, the negativity is evaluated through a broad scope and the most mentioned factors that are related to continuous use of technology on the body are going to be studied under themes related to mentioned concerns.

In this study, a user group with an age over 15 years who could make their own purchasing decision is formed. The reason for this preference is to eliminate existence of any other third parties in decision making process. Within the field study, results of the use experience research that has been conducted with this group of 8 users are shared. This is a pilot study for the field, therefore a user group of 8 people is considered enough for the outcomes that are expected from the study.

The study focuses on the users' first impressions and the short-term use process while questioning the presence of the probable negative effects. The referred process is the period in which the user experiences the product before purchasing it. The main question of this study is how decisive are the negative effects to the user at this stage.

In this study, 4 fitness products designed for different areas of the body are used within the scope of health products to question the existence of the negative factors which are mentioned before in the study. Activity monitoring products which also do health monitoring are usually designed in portable form to be carried at the wrist. This area is a place where many products such as watches and accessories can be used. Since this product form is familiar to the user and the area for using of the product is not expected to generate a significant concern to the people. Therefore, products designed to be used in different parts of the body have also been selected for this study. These four products are designed to be used at the user's wrist (Figure 1), ankle (Figure 2), head (Figure 3) and waist (Figure 4) areas.



Figure. 1_1. Product



Figure. 2_2. Product



Figure. 3_3. Product



Figure. 4_4. Product

At the beginning of the study, in order to test the wearability factors defined at the first part of the paper, the users selected as participants were asked to wear the products in a defined short period of time in the public space. Later users were informed about the products' function. The duration of the initial trial was 2-3 minutes and participants kept wearing the products during interview which lasted about 10-15 minutes for each product.

In the second phase of the study, semi-structured questions were asked to the users; questions related to impressions about the product and experience were asked and the answers were recorded with a voice recorder.

The scripting of the voice records and analyze of the pre-defined wearability factors (concerns related to materials and included technologies) through thematic coding is done at the third phase of the study (Braun & Clarke, 2006).

After the thematic coding, a table for each product was created by interpreting the data. The criteria in this tabulation are divided into 3 groups for each product in the following way to examine the effects of the short-term use of the products in a meaningful way:

Effective Criteria (4 people and more): The criteria that are questioned in case study are indicated by 4 or more users during product use.

Less Effective Criteria (3 people and less): At least 1 user and at most 3 users are required to specify the criteria that are questioned in case study when using the product.

Ineffective Criteria: The criteria that are questioned for existence in the case study are not indicated by the user during product use.

4. Results

The data obtained through thematic coding in the study were evaluated under two themes: *Safety Concerns Related to Materials* and *Safety Concerns Related to Included Technology*. Also, it was seen that there was one other factor that was worth considering while evaluating users' concerns, which was the *Proximity to Body Parts*. These two themes were identified from users' comments, while evaluation of proximity to vital organs was done through their suggested use.

The questions asked to the users are semi-structured or open-ended questions. Questions were not directly asked about the existence of certain concerns, as it is aimed to understand if the user is indeed experiencing these shortcomings during the short-term product experience. In this respect, the users are not directed. Results have been assessed to the extent that there is a reference to the factor, even though users are not specifically directed to talk about them.

The overall results can be seen in the Table 1. The numbers refer to the total mentions of the factor within 8 users, while for the proximity evaluation, only existence or absence is presented.

Table1. Study Results

	1. Product Wrist-Worn	2. Product Akle-Worn	3. Product Head-Worn	4. Product Chest-Worn
<i>Safety Concerns Related to Materials</i>	1	0	2	1
<i>Safety Concerns Related to Included Technology</i>	0	0	1	2
<i>Proximity To Essential Body Parts</i>	-	-	+	+

The number of persons who refer to the “safety concern related to materials”, which is derived from the results of the study, is shown in the table. This factor is referred at a maximum of 2 times in the products. Therefore, it has been found out that the “safety concern related to materials” is a less effective criterion for three products in terms of the users' first impressions and short-term usages. A rare example for mention of this factor, which is originated from uninterrupted use of the product, can be seen below;

"Maybe I may think that the material which is like silicon is not harmful to the skin. I may think about whether it will cause a problem if you wear it for a long time. "(P8, Product 1)

Also, some of the users mentioned concerns related to materials based on the area the products are used.

"I think that when I pull this out, the chip part can leave a mark on my forehead. This is where it constantly puts pressure" (P2, Product 3)

It can be seen that there is a consideration of continuous contact, even if it is at a very low level. However, considering the number of mentions in this measure, it is hinted that the measure is not being evaluated to such a degree that at this level (short-term experience) this criterion will generate major concern to the user.

The number of persons who refer to "*Safety Concern Related to Included Technology*" is again shown in the table for all four products. It can be seen this factor is referred at a maximum of 2 times within the user group for each products. So, it can be said that this factor is also a less effective one for the users' first impressions and short-term usages.

The inquiry about the existence of this measure in the case study has been made with the question "Do you have a safety concern about the product?". From answers given to this question by the users, it can be argued that the safety concern is expected to occur in the parts of the product, rather than the product itself. Also, when expressing their remarks, users also mentioned other concerns that are not directly related to their health. Some examples can be seen below.

"It does not look like something that can be stolen, but it looks a bit like something that can fall" (P2)

"I won't (have a safety concern), it looks stable" (P7)

However, there were also concerns that were directly related to health.

"Some negative things are said for the battery powered products that operate close to the hearth, such as they may be harmful, not good. I would not wear such a product in daily life." (P1, Product 4)

"I wonder if there is any side effect. I would wonder more about this in my mind. Talking on the phone for a long time can also cause a psychological headache because you know that you have some radiation, maybe this can create such a problem. I won't use this unless I have to use it." (P4, Product 4)

"I would ask how it works, its guarantees, whether it is harmful to me. We can panic when we put something strange in the body. This is close to the head-brain region." (P6, Product 3)

Participants have expressed concern about the product that is worn close to the heart and brain; they stated that it may lead to a long-term damage. One participant referred to product technology while expressing his concerns about whether such a product is harmful in the head quarter.

When the results are evaluated, it can be inferred that participants did express concerns related to the material and technology; however they are rather less effective factors. Since the functions of the products are similar or the same, it is sensed that users' do not reflect a technological difference between them.

People have also concerns related to proximity to vital organs. For the products which are placed near heart or brain, more safety concerns are mentioned. However, some users mentioned that their knowledge on technology reduced their doubts about these products.

“It does not scare me as I have known about biosensors.” (P5, Product 1)

Also,

- Products 1 and 3 have been evaluated by users with their resemblances to an accessory or watch.
- As the 2nd and 4th products were not identified as similar to any specific product, users were uncertain about their function. Participants were more focused on function and style in these products.
- 6 participants stated that they would not prefer to use 2nd, 3rd and 4th product unless there is an obligation (mandatory use for medical function as well as activity monitoring function).

5. Conclusions And Further Studies

In this study, negativities that can be detected in wearable products are examined through the first impressions and short-term uses of people. However, when the results of the study are evaluated, it can be inferred that the area of product use seems to be a more determinative factor for raise of concern.

Two concern themes related to materials and technology were detected from the user responses. However their main concern appeared as the area of use.

Activity tracking devices are widely accepted wearable technologies (Shih, Han, Poole, Rosson, & Carroll, 2015). Although most of the products commonly attached to the wrist, there are also different products related to the movement and function; like the wrist chest, head and neck, upper arm. In this study, products that fall into the category of activity monitoring were used as they appear with various types in the market.

Wearables are able to make direct and continuous contact with the body due to their primary functions. The kind of factors for concern that can be originated from the place of use is undefined at the level of product acceptance. This work was done with a group of wearable product samples that are existent on the market. The aim of the study is to draw attention to the concerns that may arise by questioning the relationship of the wearable with the body compared to other products. While developing a design, all of the physical risks due to product must be addressed in order to ensure the success of the design of a new product (Brusco, 2015). Anxiety that may arise in the user regarding continuous use and contact-related risks is also an important issue to consider in the product design process. As wearable products with a wide range of uses are becoming even more diversified, short-term and long-term use process evaluations will be required depending on the scope of use.

Regarding the design of wearable technologies since users declare concern on products that are closer to vital organs, it might be helpful to consider other body parts. Body parts such as

limbs are regarded as safer by users therefor they maybe more appropriate areas for application of technologies that are unknown to users.

Wearables are studied in multidisciplinary ways and have a wide range of use possibilities, loaded with different functions by accommodating different technologies in many areas. This study is limited only to activity monitoring devices. The research may be repeated to medical devices with mandatory use, such as disease monitoring devices, to evaluate preliminary concerns related to materials and technology along with the appearance and functions. The effects of these factors were questioned in this study within the first impressions and short-term use. The research may be repeated for long-term uses, and results may be evaluated to develop this study.

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